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Preliminary survey on disease prevalence in dominant massive coral *Porites lutea* in three reef communities at Sichang Island group, the Eastern Gulf of Thailand

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Abstract

Three shallow-water reef communities at Sichang Island groups, the Eastern Gulf of Thailand were chosen for diseases assessment in dominant massive coral *Porites lutea* during summer month and rainy season in 2014. Sites were selected to represent reefs that were relatively undisturbed (Khang Khao Island) and reefs that have been impacted by anthropogenic influences from human activity (Kham Yai and Kham Noi Islands). Results showed that a total of 5 coral diseases (pink line syndrome, White Plague Disease, White Patch Disease, Yellow Band Disease and Growth Anomaly) were found in *P. lutea*. Pink line syndrome (PLS) was the highest prevalent disease occurred in *P. lutea* for all study sites and both summer and rainy seasons. Total infected colony and PLS prevalence in *P. lutea* during summer was significantly lower than those in rainy season for all study sites ($P<0.05$). This study provides preliminary baseline data on the occurrence of coral diseases within the shallow water reef communities of the Eastern Gulf of Thailand for further reef management and monitoring of coral disease outbreak in Thai waters.

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Introduction

Coral disease is an abnormal condition of an organism that impairs organism functions, associated with specific symptoms and signs. Up to date, coral reef ecosystems are increasingly at risk from numerous anthropogenic stresses and natural factors. In particular, coral disease outbreaks are having a significant, negative impact on the structure and appearance of coral reefs, and have contributed to unprecedented decline in live coral cover and productivity of coral reef ecosystems (ICRI/UNEP-WCMC, 2010). Coral disease generally caused by both biotic and abiotic stressors. Biotic stressors are those caused by a living organism (e.g., pathogen, parasite) and abiotic stressors are environmental stressors such as changes in salinity, temperature, light, land-based pollution, sedimentation, overfishing and human activities (Mohamed *et al.*, 2012). Several diseases are playing an increasingly important role in controlling coral population size, diversity and demographic characteristics. Critically, coral diseases threaten the major reef coral species on which the structure and function of the reef ecosystem depends, with potential to further reduce the productivity and diversity of vulnerable coral reef ecosystems (ICRI/UNEP-WCMC, 2010).

In addition, coral disease may potentially acts as a bioindicator of reef health and recently increasing in coral disease occurrences have been linked to environmental stress and climate change. Coral disease diagnosis is primarily macroscopic, taking into account characteristics such as the extent of tissue loss, tissue color and exposure of coral skeleton (Mohamed *et al.* 2012).

Coral diseases have been widely reported from coral reef around the world such as Central Visayas and Lingayen Gulf, Phillipines (Raymundo *et al.*, 2005; Kaczmarsky, 2006), Gulf of Mannar, Southern India (Thinesh *et al.*, 2009) Gulf of Kachchh, India (Kumar *et al.*, 2014), Florida Keys (Santavy *et al.*, 2001), Red Sea, Egypt (Mohamed *et al.*, 2012), Hawai'I Island (Couch *et al.*, 2014), Sabah, Borneo (Miller *et al.*, 2015), West Indies, Dominica (Borger, 2003), Western Indian Ocean (Sere *et al.*, 2015). As well, corals of the Genus Porites are the most important and dominant members of many reef in the Indo-Pacific and are commonly affected by disease. Documented diseases of poritid corals in this region include growth anomalies, Porites ulcerative white spot disease, bleaching with tissue loss, and trematodiasis (Raymndo *et al.*, 2005). Very little is currently known about the prevalence, distribution and pathology of coral diseases in the Gulf of Thailand (Kenkel, 2008; Lalita *et al.*, 2012; Kritsanapuntu and Angkhananukroh, 2014). The aims of this study were to provide baseline knowledge on occurrence of pink line syndrome in massive coral *Porites lutea* in three shallow water coral communities of Sichang Island group, the Eastern Gulf of Thailand, as part of an attempt to contribute to coral reef management in Thai waters.

Materials and methods

Three shallow-water reef communities at Sichang Island groups, the Eastern Gulf of Thailand were chosen for diseases assessment (Fig 1). Sites were selected to represent reefs that were relatively undisturbed (Khang Khao Island) and reefs that have been impacted by anthropogenic influences from human activities (Kham Yai and Kham Noi Islands). This survey was assessed to compare disease prevalence in dominant massive coral *Porites lutea* during summer month of February and rainy season of September in 2014 using both SCUBA diving and snorkeling. At each site, three replicate 20 m long and 2m wide belt transects (English *et al.*, 1997) were surveyed at fixed interval of 2m on the reef flat at a uniform depth of 3-5m. All *P. lutea* colonies within each transect were identified, counted, underwater photographed and checked for signs of disease, bleaching, predation and compromised health (pigmentation response, sediment damage, algae and sponge overgrowth). Diseases were identified in situ using the underwater cards for assessing coral health on Caribbean and Indo-Pacific reefs (Weil and Hooten, 2008; Raymundo *et al.*, 2008; Beenden *et al.*, 2008).

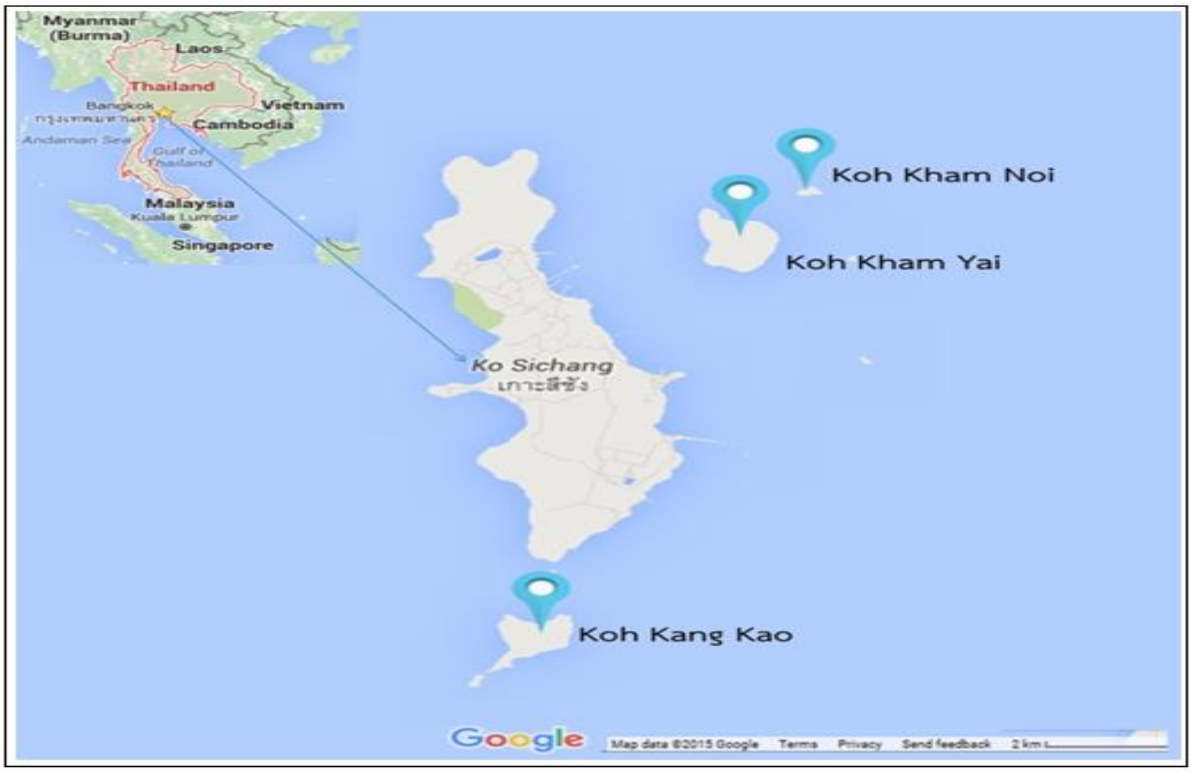

Fig. 1. Three study sites of shallow water coral communities at Sichang Island groups, Eastern part of the Gulf of Thailand.

The number of disease infected *Porites lutea* colonies was recorded. Disease prevalence and frequency of disease occurrences were calculated using the formulation of Aeby (2009) as following: Disease prevalence = (number of diseased colonies per site) / (number of colonies examined per site) × 100 and Frequency of disease occurrence = (number of sites with disease) / (total number of sites surveyed)] × 100.

Data analysis

The prevalence of coral diseases and compromised health was expressed as a percentage of the total number of *P. lutea* colonies surveyed per transect. Mean prevalence and standard errors were calculated from all four replicate transects per site. Differences in the prevalence of disease among *P. lutea* and sites were tested using one-way analysis of variance (ANOVA**)** by using SPSS version 19 program.

Results

The highest percentage coral coverage of three shallow-water reef communities at Sichang Island group was the reef community of Khang Khao Island (62.5%), followed by Kham Yai Island (48.2%) and Kham Noi Island 32.8%), respectively. All reef communities were dominated by massive coral, *Porites lutea*, followed by *Pavona frondifera*, *P. decussata*, *Platygyra* sp., *Favia speciosa*. A total of 5 coral diseases (pink line syndrome, White Plague Disease, White Patch Disease, Yellow Band Disease and Growth Anomaly) were occurred in *P. lutea*. Pink line syndrome (PLS) and white patch disease (WP) were the most frequency of occurrence in *P. lutea* for all study sites and seasons, followed by whit plaque disease (WPS) and growth anomaly. The highest occurrence of disease in *P. lutea* was recorded in Kham Noi Island and Khang Khao Island for both seasons (Table 1). There was no significantly differences in total infection of disease in *P. lutea* among study sites ($F = 1.29$, $P>0.05$) but not for seasons ($F = 15.93$, $P<0.05$). The highest total infection in rainy season was found in reef community of Kham Yai Island (31.9%), followed by

Khang Khao Island (30.0%) and Kham Noi Island (22.6%), respectively (Fig 2; Table 2). There was a significantly differences in PLS prevalence in *P. lutea* among study sites ($F = 12.54$, $P<0.05$) and seasons ($F = 19.05$, $P<0.05$) (Table 2). PLS prevalence in summer was significantly lower than that in rainy season ($P<0.05$). The highest PLS prevalence in summer was found in reef community of Kham Yai Island (14.6%), followed by Kham Noi Island (4.0%) and Khang Khao Island (3.6%), while the highest one in rainy season was found in reef community of Kham Yai Island (26.8%), following by Khang Khao Island (15.7%) and Kham Noi Island (10.7%), respectively (Fig 3). In addition, prevalence of pink line syndrome (PLS) in *Porites lutea* in all three transect study per site at three shallow water coral communities of Sichang Island group was presented in Figure 4. There was a high variations in occurrence of PLS prevalence and other coral diseases among transect of each study site.

Table 1. Occurrence of coral disease of *Porites lutea* in two seasons at three shallow water coral communities of Sichang Island group.

Study sites	PLS	WP	WPS	YBD	GA	Frequency of occurrence (%)
Summer						
Kham Yai Island	X	X				40
Kham Noi Island	X	X	X	X	X	100
Khang Khao Island	X	X	X	X	X	100
Frequency of occurrence (%)	100	100	66.7	66.7	66.7	
Rainy season						
Kham Yai Island	X	X				40
Kham Noi Island	X	X	X		X	80
Khang Khao Island	X	X	X			60
Frequency of occurrence (%)	100	100	66.7		33.3	

Remarks: pink line syndrome (PLS), white patch disease (WP), white plague disease (WPS), yellow band disease (YBD), growth anomaly (GA).

Discussion

Our preliminary field surveys showed that a total of 5 coral diseases occurred in dominant massive coral *P. lutea* in three reef communities of Sichang Island group, the Eastern Gulf of Thailand and Pink line syndrome (PLS) was the highest prevalent disease occurred in *P. lutea* in all study sites and both summer and rainy seasons. Total infected colony and PLS prevalence in *P. lutea* during summer was significantly lower than those in rainy season for all study sites.

Table 2. Mean disease prevalence (±SE) of *Porites lutea* in two seasons at three shallow water coral communities of Sichang Island group.

Season	Healthy colony (%)	Infected colony (%)					Total infection (%)
		PLS	WP	WPS	YBD	GA	
Kham Yai Island							
Summer	81.5±7.3	14.6±6.3	4.5±3.2	–	–	–	18.5±7.3
Rainy	68.1±7.4	26.8±9.4	5.1±2.6	–	–	–	31.9±7.4
Kham Noi Island							
Summer	81.8±4.4	4.03±1.7	3.4±1.5	3.7±1.2	3.8±1.1	3.2+1.5	18.1±4.4
Rainy	77.4±2.7	10.7±2.7	5.6±2.6	4.3±1.4	-	2.0+1.8	22.6±2.7
Khang Khao Island							
Summer	82.3±3.1	3.6±1.3	3.6±1.2	3.4±1.2	2.50±0.8	4.6+2.1	17.7±3.1
Rainy	69.93±5.1	15.7±2.5	8.4±2.5	5.9±2.8	–	–	30.0±5.0

Remarks: pink line syndrome (PLS), white patch disease (WP), white plague disease (WPS), yellow band disease (YBD), growth anomaly (GA).

This result agreed with those studies in Southern part of Thailand and in Andaman Sea (Kritsanapuntu and Angkhananukroh 2014, Kenkel 2008, Putchim *et al.* 2012). In addition, Thinesh *et al.* (2009) reported that most common coral host for disease was *Porites* sp. and the most common disease was pink spot, followed by black band in Red sea reefs. Erinn *et al.* (2012) reported that the most significant syndrome detected was white syndromes, which affected 13 different coral genera in Indonesia reefs.

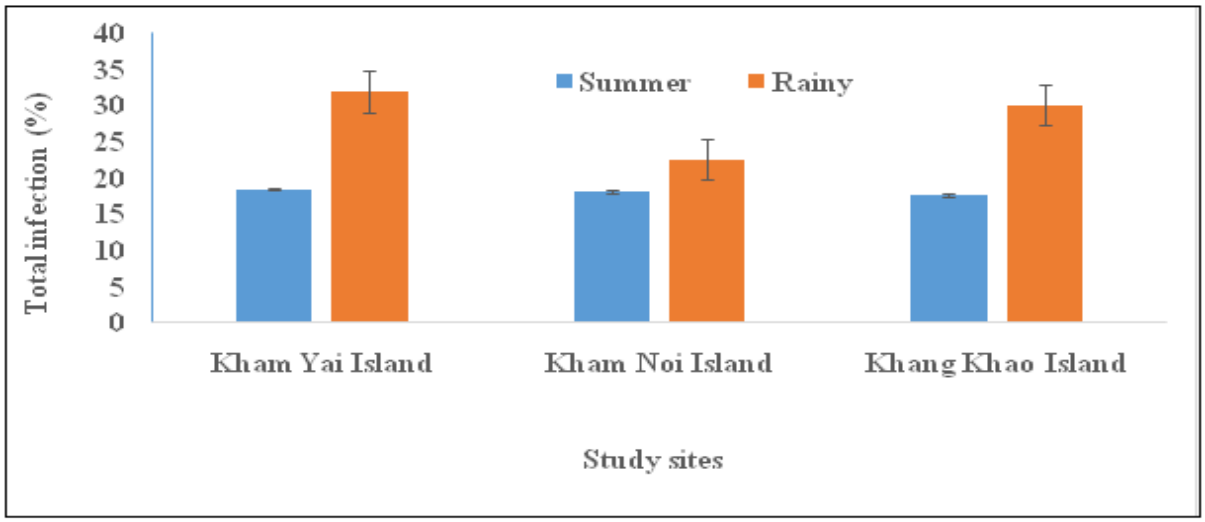

Fig. 2. Total disease infection in *Porites lutea* at all stations in two seasons at three shallow water coral communities of Sichang Island group (N= 3 sites; n=4 transect per site; mean ±SE).

The most significant syndromes detected were white syndromes, black band disease, and a yellow tissue discoloration syndrome that was similar macroscopically to Caribbean yellow band disease. Mohamed (2012) showed that the highest prevalence of coral diseases in Northern Red Sea, Egypt was recorded on the coral *Favia stelligera*, followed by *Porites lutea*, and *Goniastrea edwardsi*. Enhanced local anthropogenic stresses and increasing sea surface temperature due to global warming are the suggested potential factors responsible for the initiation and the persistence of some coral diseases in the studied reefs. In addition, many study reported that various factors both natural and human impacts from the main land may cause in infection of coral diseases such as climate changes (Sokolow 2009), rainfall and freshwater runoff (Haapkyla *et al.* 2011), nutrient loading (Vega *et al.* 2014), physical contacts, ballast water (Macedo *et al.* 2008), physical contact of seaweeds (Maggy *et al.* 2004) and human impacts (Bruno *et al.* 2003). This study also showed that total infected colony and PLS prevalence in summer was significantly lower than those in rainy season for all study sites. Haapkyla *et al.* (2011) reported that rainfall and associated runoff may facilitate seasonal disease outbreaks, potentially by reducing host fitness or by increasing pathogen virulence due to higher availability of nutrients and organic matter. Thurber *et al.* (2014) also suggested that coastal nutrient loading is one of the major factors contributing to the increasing levels of both coral disease and coral bleaching. Bruno *et al.* (2003) indicated that changes in the environment caused by human activities have impaired host resistance and/or have increased pathogen virulence. The causes of coral disease emergence at large spatial and temporal scales has been hindered by several factors. In a rapidly changing global environment, the consequences of increasing coral disease may be severe, leading to elevated extinction risk and loss of critical reef habitat (Sokolow 2009). However, a long-term, multi-disciplinary research and monitoring program for coral diseases is necessary to assist resource managers in identifying and responding to emerging coral diseases.

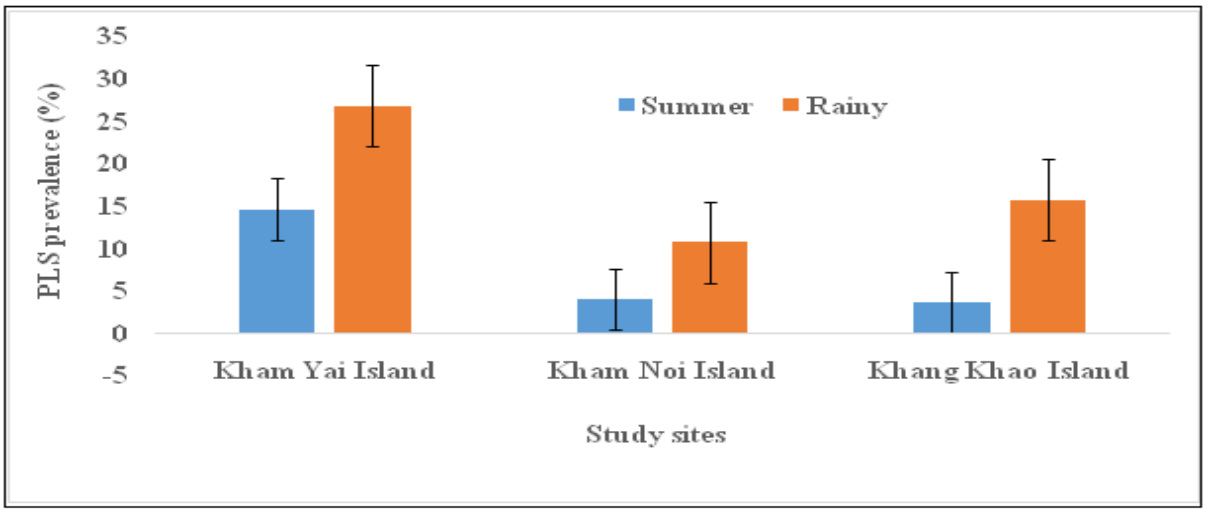

Fig. 3. Prevalence of pink line syndrome (PLS) in *Porites lutea* in two seasons at three shallow water coral communities of Sichang Island group (N= 3 sites; n=4 transect per site; mean ±SE).

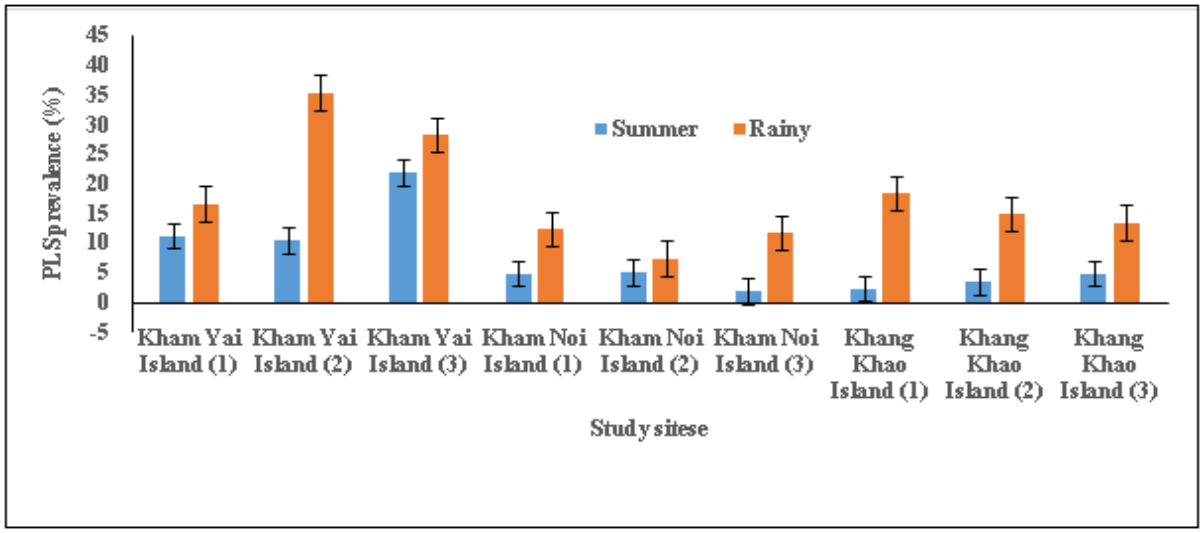

Fig. 4. Prevalence of pink line syndrome (PLS) in *Porites lutea* in all three transect study per site at three shallow water coral communities of Sichang Island group (N= 3 sites; n=4 transect per site; mean ±SE).

Conclusion

Pink line syndrome (PLS) was the most prevalent disease occurred in dominant massive coral *P. lutea* at all study sites and in both summer and rainy seasons. Total infected colony and PLS prevalence in *P. lutea* during summer was significantly lower than those in rainy season for all study sites. This study provides preliminary baseline data on the occurrence of coral diseases within the shallow water reef communities of the Eastern Gulf of Thailand for further reef management and monitoring of coral disease outbreak in Thai waters. Further investigation of disease outbreak, appropriate monitoring of physical and chemical parameters of seawater should be done in relation with disease prevalence at all sites which affected by natural and human impacts.

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