**ORIGINAL PAPER**

# Distribution of different coral morphs of the coral *Porites lutea* in the Gulf of Thailand

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**Abstract**. The scleractinian corals Porites complex are dominant corals generally found in coral reefs in the Gulf of Thailand. However, understanding of their biology and ecology is relatively limited. This study aimed to explain the taxonomy and ecology of the massive *Porites* complex in the Gulf of Thailand by focusing on the distribution patterns and ultrastructures of *Porites* complex that have different morphs in the eastern, inner and western Gulf of Thailand. Permanent belt-transects, 1x100 $m^2$, were used to observe coral colonies at fifteen study sites. In order to investigate the ultrastructure of corals. Based on the field observations, three major morphs of *Porites* complex were clearly observed, i.e., brown (B), green (G), and yellow (Y). The B-morph was the most dominant at all study sites. The Y-morph was more abundant than G-morph at the study sites in the eastern and inner Gulf of Thailand. The similarity of multidimension scaling analysis and hierarchical clustering showed analogous results. The size classes of colored different *P. lutea* revealed that colonies ranged of 25-50 cm were found as an abundant size in the Gulf of Thailand. However, the G-morph was more abundant than Y-morph at the study sites in the western Gulf of Thailand.

**Keywords**: abundance, coral reefs, diversity, Porites, Gulf of Thailand

## 1. Introduction

There are more 140 species of coral that belonging to the family Poritidae that commonly distributes in tropical. The several important species in the family Poritidae that built coral reefs up. Six genera of Poritidae was classified, which three dominant genera that commonly found: Porites Link, 1807 (73 species), *Goniopora* de Blainville, 1830 (31 species) and *Alveopora* de Blainville, 1830 (18 species) and three rare genera with limiting geographical regions found including *Stylaraea* Milne Edwards & Haime, 1851, *Poritipora* Veron, 2000, and *Machadoporites* Neme´sio, 2005.

The scleractinian coral Porites have been studied in many coral reefs around the world. Several research studies about biology, ecology, especially in the area of global climate change (Veron, 2000; Lough and Barnes, 2000; Bessat and Buigues, 2001; McClanahan et al., 2009). In addition, there is also an extensive study of molecular genetics in the genus Porites. However, the corals genus *Porites* are also difficult to classify, such as the classification between *Porites lutea* and *Porites lobata* because they are very variable in the patterns of corallite, including few studies on other coral species of the Poritidae family have been studied.

The scleractinian coral *P. lutea* is one of the tolerance species and can be adapted with stressful environments. The coral *P. lutea* distributes in many coral reefs, and it can be growing under high temperature and high light intensity, including severe coral bleaching in 1998 and 2010 (Sutthacheep et al., 2013). The scleractinian coral *Porites* complex are dominant corals generally found in coral reefs in the Gulf of Thailand. The coral *P. lutea* plays an important component of coral reefs in all areas. The colonies of colored different *P. lutea* were brown, green and yellow, but no study report about the distribution and abundance of these corals. Moreover, understanding of their biology and ecology is relatively limited. Therefore, this study aimed to explain the taxonomy and ecology of the massive *Porites* complex in the Gulf of

Thailand by focusing on the distribution patterns and ultrastructures of *Porites* complex that have different morphs in the eastern, inner and western Gulf of Thailand

## 2. Materials and Methods

### *2.1 Study sites*

The surveys were conducted at fifteen study sites including: Koh Wai (13°06'46.30"N, 100°48'31.10"E), Koh Thong Lang (13°01'25.78"N, 100°49'16.25"E), Hin Gurk Maa (12°56'45.64"N, 100°47'25.77"E), Laem Ao Salat (07°48'45.41"N, 98°47'47.50"E) and Hin Ao Salat (12°34'52.05"N, 101°30'35.92"E) in Trat Province, the eastern Gulf of Thailand. Koh Kham Noi (12°33'41.12"N, 101°26'53.59"E), Koh Kham (12°30'52.09"N, 101°26'32.28"E), Koh Prong (12°34'52.05"N, 101°30'35.92"E), Koh Ran Dok Mai (11°54'54.40"N, 102°28'14.56"E) and Koh Khang Khao (11°49'40.43"N, 102°23'46.78"E) in Chonburi Province, the inner Gulf of Thailand. Koh Ngam Yai (10°23'54.33"N, 99°20'49.12"E), Koh Ngam Noi (12°34'52.05"N, 99°30'35.92"E), Koh Rang Kachiu (10°19'30.31"N, 099°17'56.81"E), Koh Kula (12°33'41.12"N, 099°26'53.59"E) and Koh Sam Sao (09°39'52.28"N, 099°40'46.66"E) in Chumphon and Surat Thani Provinces, the western Gulf of Thailand as shown in Figure 1.

### *2.2 Sample collection*

The coral communities of fifteen study sites were shallow approximately 1-9 m in depth. At each study site, the coverage of colored different *P. lutea* and their size class distribution were observed by using 50 $cm^2$ of quadrat to each side of the permanent belt-transects of 100 m (Figure 2).

### *2.3 Data analysis*

Cluster analysis of the nMDS method and hierarchical clustering was performed to categorize study sites on the basis of the Bray–Curtis similarity, using PRIMER version 7.0. A two-way ANOVA was used to test the differences in the coverage of colored different *P. lutea* cover among study sites. The Tukey HSD (honestly significant difference) test was employed to determine which reef sites differed.

## 3. Results

Based on the field observations, three major morphs of *Porites* complex were clearly observed, i.e. brown (B), green (G), and yellow (Y). The B-morph was the most dominant at all study sites, which has a significantly difference (ANOVA test, $F=320.60$; $df=44$; $p<0.001$). The highest cover of B-morph was found in the eastern Gulf of Thailand, ranging from 2.33 to 21.17 %, followed by the western Gulf of Thailand and the inner Gulf of Thailand, which ranged from 2.67 to 18.17 % 2.33 to 7.84 %, respectively (Figure 3).

However, the Y-morph was more abundant than G-morph at the study sites in the eastern and inner Gulf of Thailand, which has statistically difference ($F=46.59$; $df=44$; $p<0.001$). The highest cover of G-morph was found in the eastern Gulf of Thailand ranged from 1.16 to 12.99%, followed by the western Gulf of Thailand and the inner Gulf of Thailand ranged from 0.78 to 9.08% and 2.73 to 4.54 %, respectively.

The coverage of colored different *P. lutea* in the Gulf of Thailand from hierarchical clustering at 70% similarity was clearly separated into 3 groups: Firstly, Koh Mattra, Koh Thong Lang, Hin Ao Salad, Hin Gurk Maa, and Koh Lawa. Secondly, Koh Wai, Leam Ao Salat, Koh Ranka Chio, Koh Kula, and Koh Sam Sao. Lastly, Koh Ran Dok Mai, Koh Kham, Koh Khang Khao, Koh Kham Noi, and Koh Prong (Figure 4). In addition, the results from Multidimension Scaling analysis (MDS) were similar to hierarchical clustering, as shown in figure 5.

The size distribution of colored different *P. lutea* was investigated. The results revealed that the size range of 26-50 cm of colored different *P. lutea* was found as abundant size, followed by below 25 cm as shown in Figure 6.

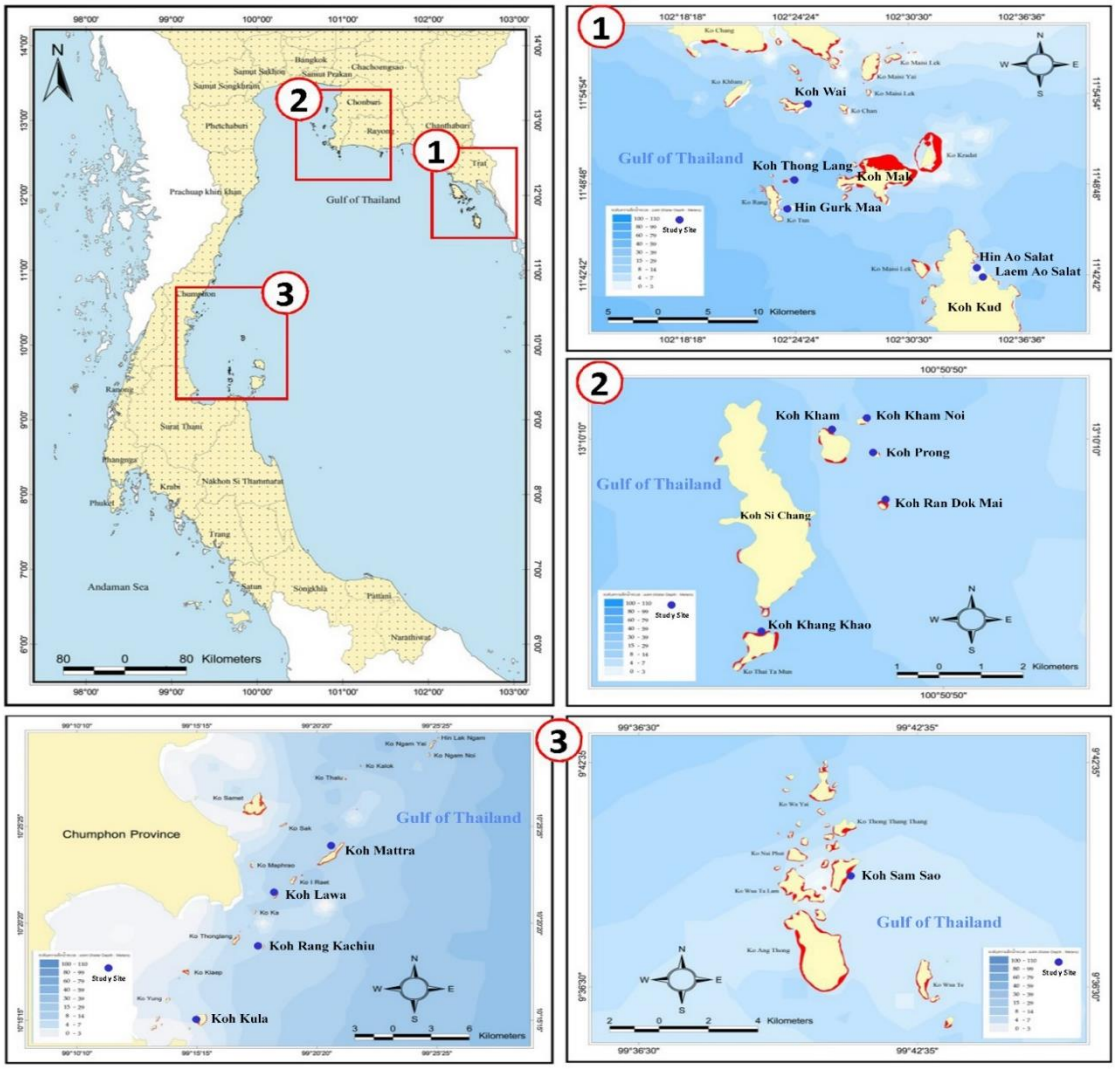


**Figure 1.** Map of study sites at (1) Trat Province, the Eastern Gulf of Thailand, (2) Chonburi Province, the Inner Gulf of Thailand, (3) Chumphon and Surat Thani Provinces, the Western Gulf of Thailand

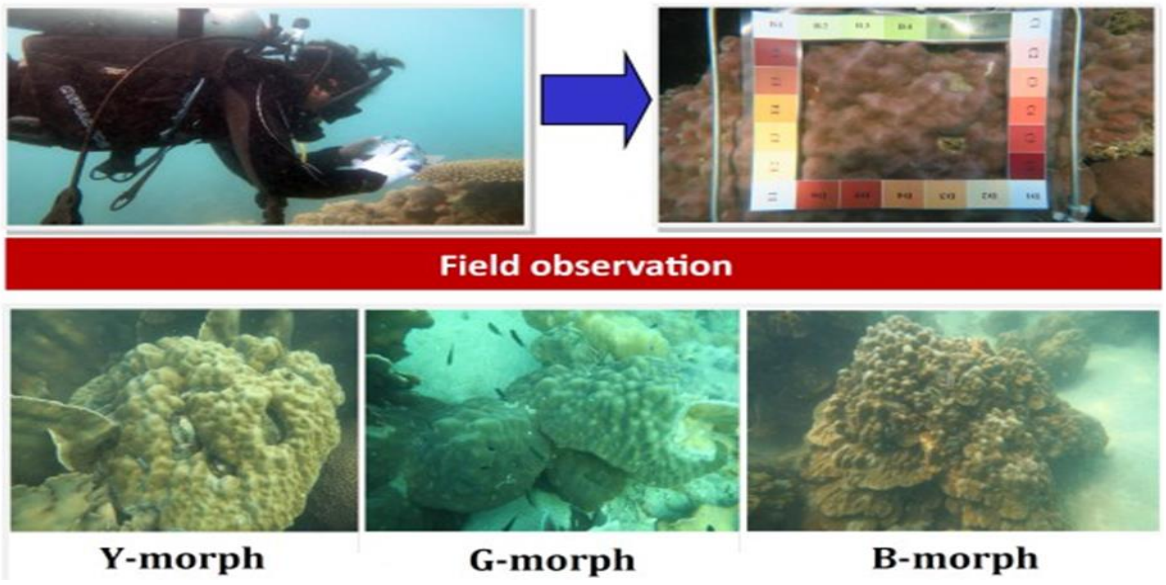


**Figure 2.** Field observation of the colored different *P. lutea*

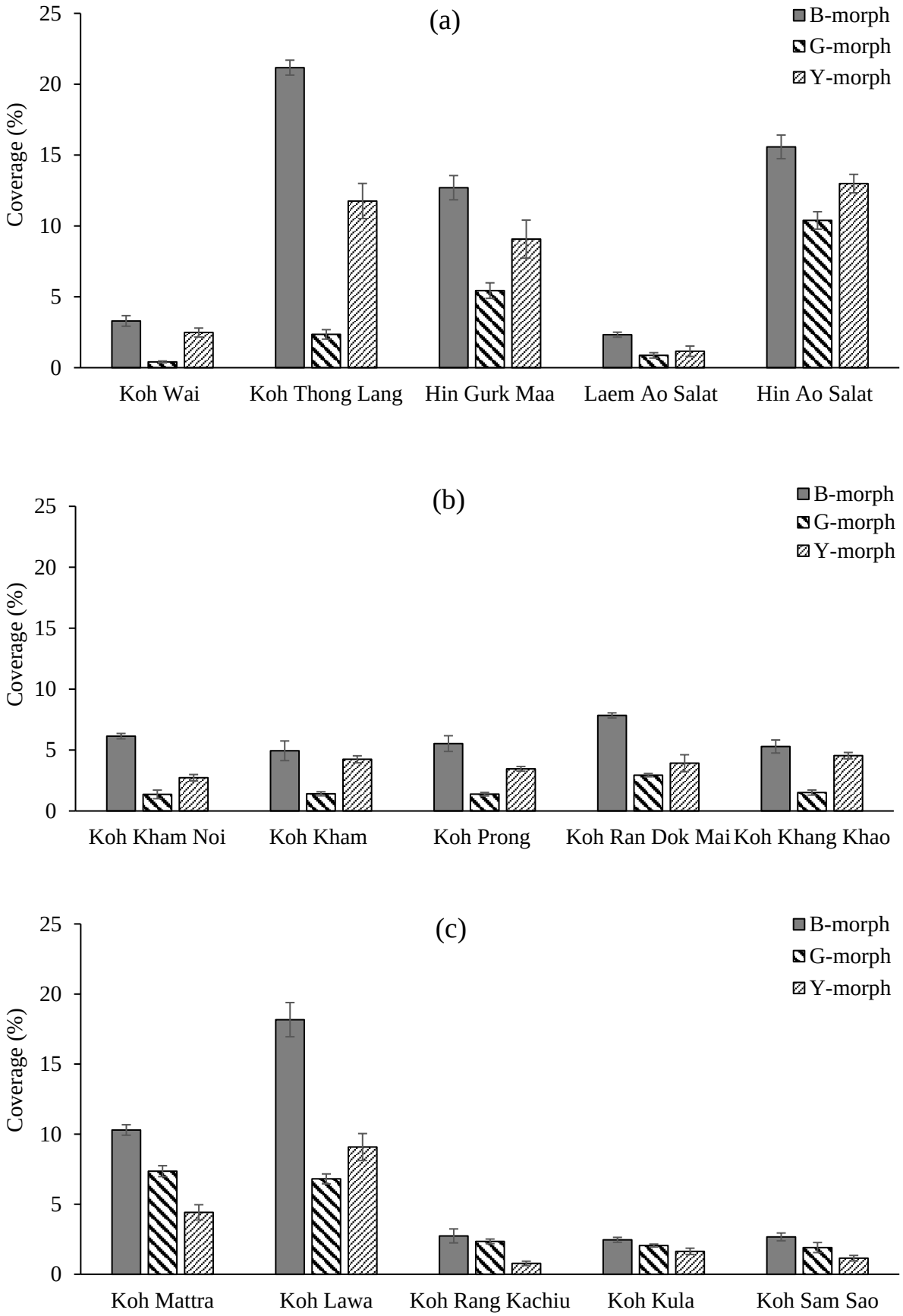


**Figure 3.** Abundance of colored different *P. lutea* at each study site (a) coverage of colored different *P. lutea* in eastern Gulf of Thailand (b) coverage of colored different *P. lutea* in inner Gulf of Thailand (c) coverage of colored different *P. lutea* in western Gulf of Thailand

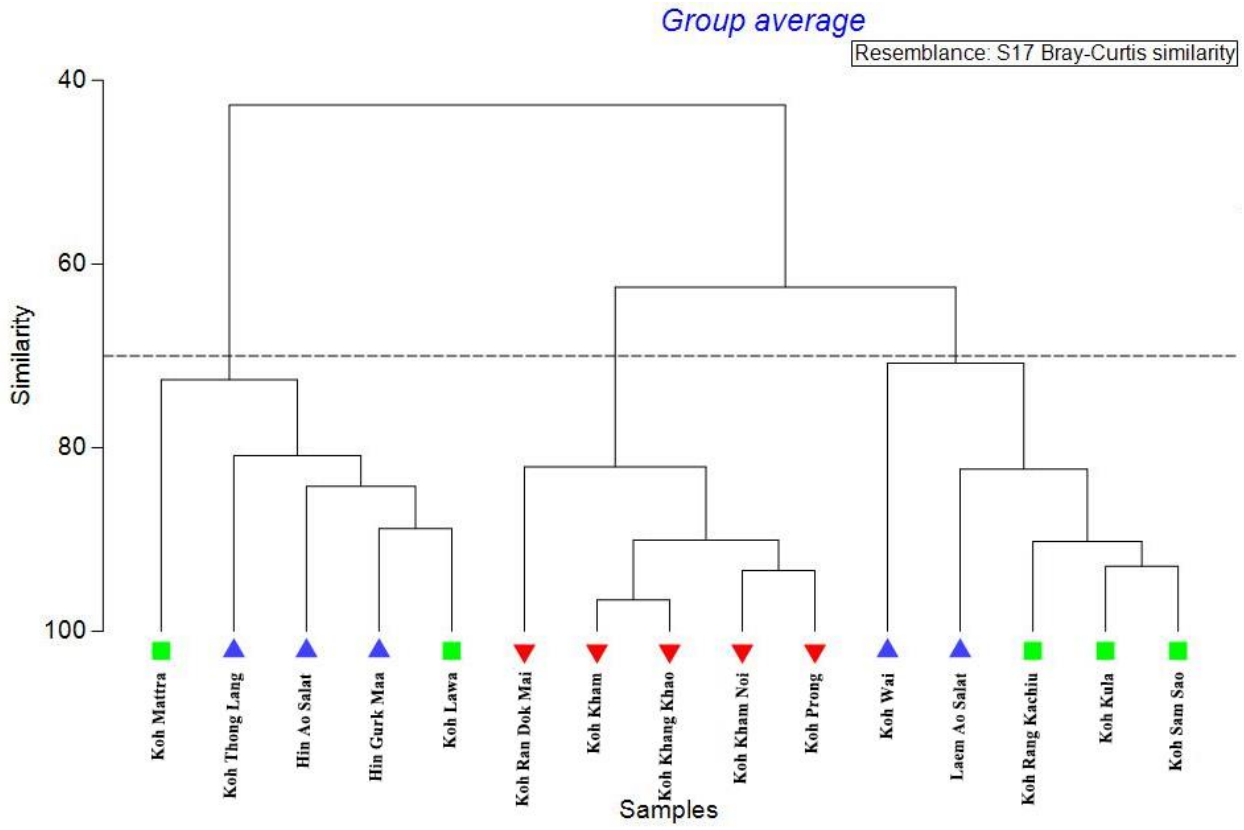


**Figure 4.** Dendrogram for hierarchical clustering of 15 study sites using complete linkage of Bray-Curtis similarities of each study site

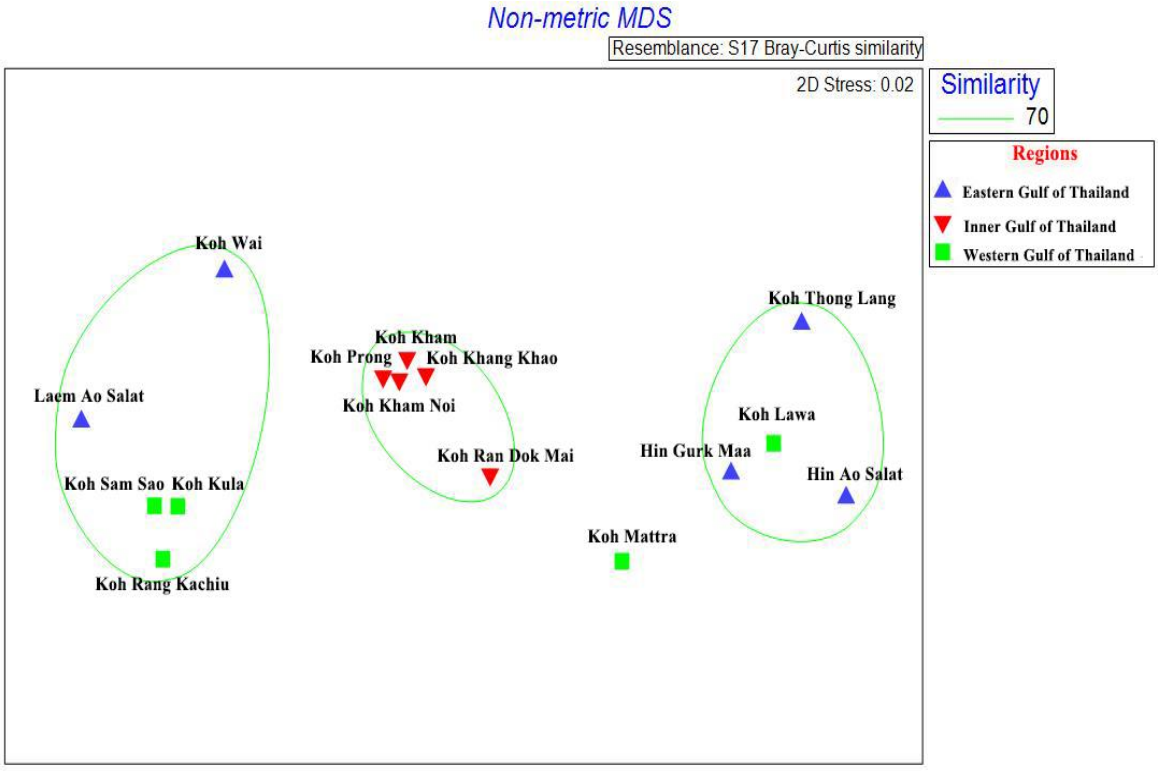


**Figure 5.** Two-dimensional non-metric multidimensional scaling (nMDS) plot

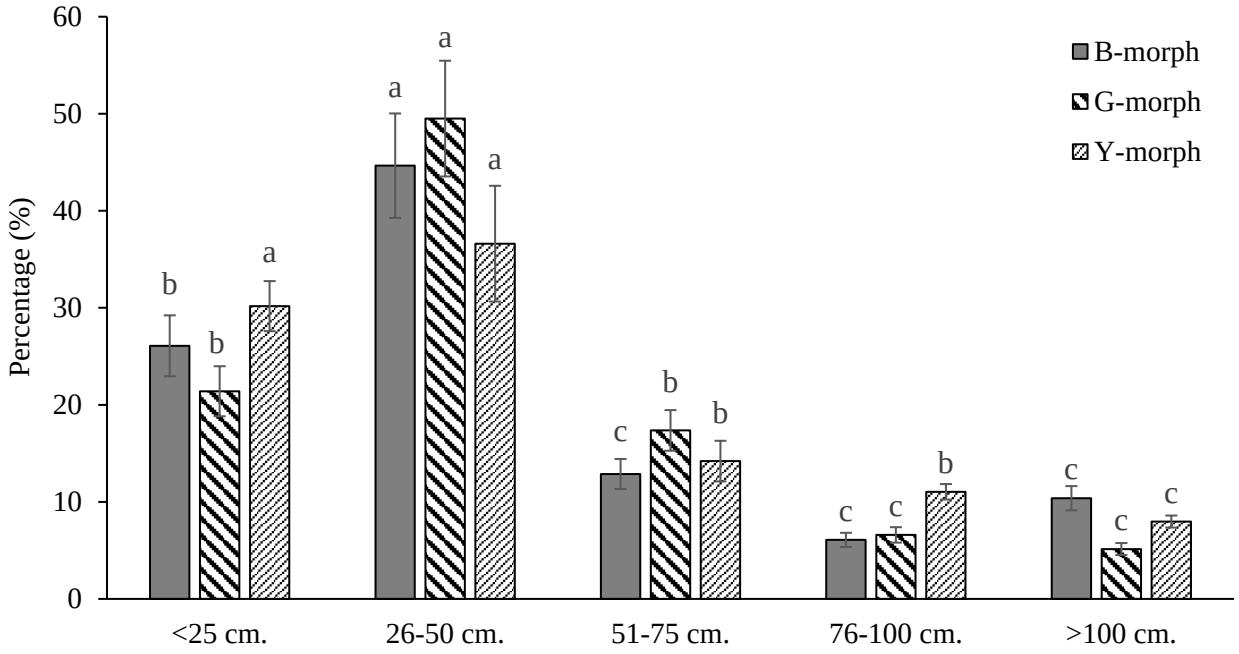


**Figure 6.** Size class distribution of colored different *P. lutea* in the Gulf of Thailand

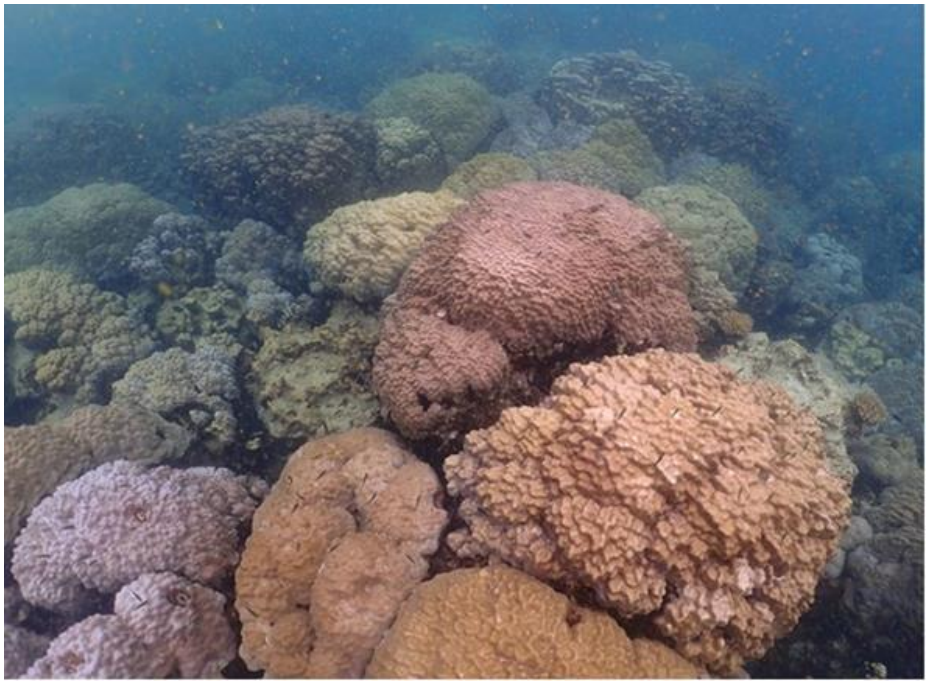

**Figure 7.** Underwater photograph showing the different colors of *P. lutea*

## 4. Discussion

The sediment plays an important role in environmental factors that influence the abundance and distribution of corals in the Gulf of Thailand. The corals that are adaptable in an environment have high sediment. We need to have the ability to eliminate the sediment. Moreover, the corals are adaptable in an environment that has low light intensity due to high solid suspended in the water column (Loya, 1976; Brown and Howard, 1985; Tomascik and Sander, 1987; Rogers, 1990; Van Katwijk et al., 1993, Gleason 1998 & Yeemin et al., 2013). Our results revealed that the tolerance of colored different *P. lutea* from sediments are different. The brown *P. lutea* showed the most resistance to sediment, whereas the green *P. lutea* showed low resistance. Gleason 1998 was reported that the ability to eliminate sediment of the brown *Porites astreoides* is greater than the green *P. astreoides*. In addition,

the mortality of the brown *P. astreoides* from sedimentation is lower than the green ones.

These results showed the brown *P. lutea* is high tolerance and can grow under bad environmental conditions in the Gulf of Thailand, such as high sediment and other stressful conditions. The large colonies of brown *P. lutea* were found at Koh Sam Sao and Mu Koh Ang Thong in the western Gulf of Thailand that are suitable for being the coral breeder of the coral restoration project by using the method of selecting coral breeder species again in the coral nursery. In addition, the important characteristics of coral will be considered, such as low partial mortality, high growth rates, bleaching and diseases tolerance, and high sexual reproduction (Baums et al., 2019).

The corallite of the green P. lutea differed from the brown and yellow P. lutea, its corallite variable making classification confused. The study of ultrastructure from Porites lobata from Galapagos, Easter Island, Tahiti, Fiji, Rarotonga, and Australia found that the ultrastructure analysis is effective for species classification of genus Porites corallite variable within species with 95% for *P. lobata* and *Porites evermanni* classification (Forsman et al., 2015).

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