The Relationship between Coral Reef Fish and Habitat Structure on Coral Reefs at Kut Islands, Trat Province.

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ABSTRACT

The relationships between coral reef fishes and habitat structure on coral reefs at Kut islands, Trat province, were carried out on 10 stations during June 2019. The average area covers of living and dead corals were 42.4% and 26.2% respectively. The most dominant coral species was *Porites lutea* (55.8%). There were 138 species from 32 families of coral reef fishes be recorded. Spearman's rank correlation revealed that fish diversity has negative relationships with living coral cover ($r = - 0.86$, $P <0.05$). The species richness of fishes, on the other hand, had a positive relationship with dead coral cover ($r = 0.75$, $P <0.05$). Sand and rocks, however, were not correlate with coral reef fishes. The relationships between reef fishes and reef habitat structure remains varies. However, this study found a trend that fish species composition may different according to the structure of reefs habitat. Therefore, the species composition of coral reef fish and coral species on a wider area with different environment factors, especially salinity, should be investigated.

INTRODUCTION

Coral reef ecosystem are ecosystems with high biodiversity of both flora and fauna. Fishes, especially, about 4,000 out of more than 16,000 species of marine fishes are found living on the coral reefs (Songploy, 2006). The species of reef fishes in the Gulf of Thailand were approximately 375 species from 61 families. (Satapoomin, 2000). The earlier work on coral reef fishes in Thailand, Thongtham & Manthachitra, 1992), categorized reef fishes into three groups. They are target species, indicator species and major families. Target species are economic fishes such as Serranidae, Carangidae, Lutjanidae, etc. The indicator species are fishes that consume coral polyps which Chaetodontidae is the main group. Major families, the last group, are common fishes those can be found on the reef such as Pomacentridae, Labridae and Apogonidae. According to fish life cycle, however, they can be

divided into two groups. The first is permanent residence, which they spend most of their life in the reef. The second group is temporary resident which the fishes spend some part of their life related to coral reefs, especially for feeding and/or mating such Caragidae (Songploy, 2006).   For corals, there were 90 species from 14 families had been reported in the Gulf of Thailand (Jiravat, 1985). *Porites lutea* is the most abundance species while Faviidae are the most diverse coral family in this area (Chantarung, 2002).   In general, coral reefs with diverse coral species are usually had many lifeforms which indicate the high complexity from these structures. These structures are as habitat for reef organisms those are suitable for sheltering, feeding, and nursery of coral reef fish. (Munday, *et al.,* 2008). Currently, global warming has a strong effect on corals to die and then decrease coral community and reefs condition. Furthermore, during 2010, sea surface temperature in Thai waters had increased and then coral bleaching occurred on coral reefs in Chonburi, Chumphon, Prachuap Khiri Khan, and Surat Thani (Department Marine and coastal resource, 2014). Coral bleaching had direct effect on corals and reef habitats that impact all reef organisms, especially coral reef fishes (Munday, *et al.,* 2008). The loss of reef habitats means a decrease in reef fish diversity (Coker, *et al.,* 2014).   Butterflyfish (Chaetodontidae), for example, they eat corals polyp (Corallivore) of Acroporidae and their juvenile and subadult used these coral colony/structure as shelter.

The objective of this study was to assess the current status of coral reef fish and coral reefs habitat at Kut Islands, Trat province. The relationships between coral reef fishes and their habitat were also investigated. These results will be used as information for the conservation of the coral reef in the Kut Islands.

METHODOLOGY

The data of coral reef fish and habitat structure were collected from 12 stations around Kut islands (Figure 1). SCUBA diving was performed on 30 meters long transect at the upper reef slope. There were 5 replicates on each station. Fish data were collected using the Video Census method adapted from Hill & Wilkinson (2004). The field of view on each census line was 5 meters. Then, the total survey area of each station was 750 m.^{2}. The video data of coral reef fish were carried out in the laboratory.   The photo identification was performed by comparing photographs with documents by Allen & Swainton (1988), Allen (1991), Allen (1999), Burgess, *et al.*, (1988), and the Fish base, electronic database. (Froese & Pauly, 2019). For habitat structure, data of benthic component were collected on the same transect line and sampling scheme with the fish survey. Photo Belt transect on a quadrat-sized of 0.25x0.25 m.^{2}, adapted from the Tropical Resources Survey (English, *et al.*, 1997), was applied. Picture of each quadrat was analyzed using CPCe (Coral Point Count with Excel Extensions) program (Kohler & Gill, 2006). The program was set up by specifying the stratified points, assigned to random five rows and columns, twenty points in each picture. The classification of coral species was carried out according to Veron (2000). The field data of coral reef fishes and benthic components were analyzed for the Shannon-Weaver species diversity index. The relationships between reef fishes and habitat components were analyzed using

Spearman's rank correlation. Then, perform regression analysis for any significant pair. To evaluated the reef health, the criteria proposed by the Department of Fisheries (Chansang, *et al.,* 1999) was applied

Figure 1 Station survey at Kut islands, Trat province, Thailand.

RESULTS AND DISCUSSION

1) Abundance and diversity of Coral reef fish

There were 138 species from 32 families of coral reef fish found at Kut island. Pomacentridae and Labridae were predominant families which found 23 and 21 species respectively. They are also a prominent family in the Gulf of Thailand (Songploy, *et al,* 2006; Songploy & Yeemin, 2007). At Kut Island, the abundance of fishes on each station was as following, Ao Kra Ting S (KKUT2) had the highest species richness as 67 species, Ao Yai Kerd (KKUT9) 59 species and Laem Phak Wean (KKUT8) 39 species (Figure 2-A). Considering the diversity index, it is found that the KKUT4 (Ao Noi) had the highest diversity (2.49), followed by Ao Kra Ting (N) (KKUT3) (2.30) while Laem Phak Waen (KKUT8) is lowest (0.58) (Figure 2-B).
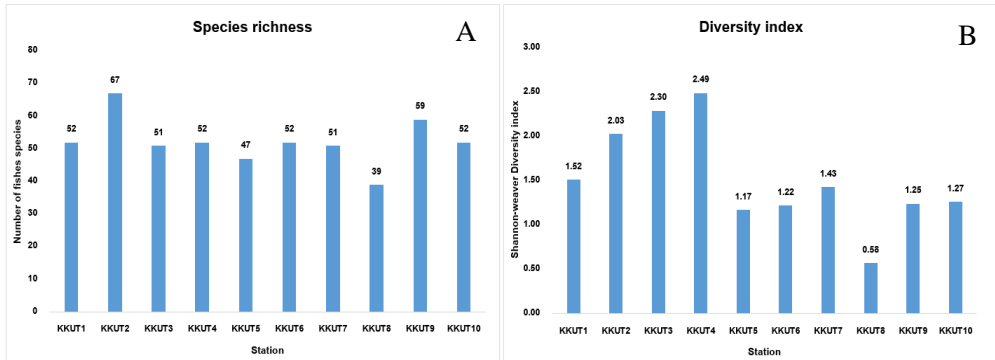
Figure 2 A: Species richness of coral reef fish, **B:** Diversity index of coral reef fish

2) Abundance and diversity of Corals

There were 54 species from 11 families of corals be found at Kut Island. Faviidae was the most dominant coral family and be found 19 species. Faviidae is also the most prominent family in the Gulf of Thailand. (Chantarung, 2002) and followed by Fungiidae (7 species). In term of area cover, however, the most dominant family Poritidae, especially, *Porites lutea* was a dominant coral species which cover 55.8% of the total sampling area. The species richness of coral was highest at Ao Yai (KKUT10) found 43 species, followed by Ao Noi (KKUT6) found 40 species. While Ao Kra Ting (S) (KKUT2) and Ao Kra Ting (N) (KKUT3)) are the lowest (20 species) (Figure 3-A). Considering the diversity index, Ao Noi (KKUT6) had the highest diversity (2.63) and followed by Ao Yai (KKUT1, 2.30). The lowest diversity index was at Laem Phak Waen (KKUT8, 0.81) (Figure 3-B).
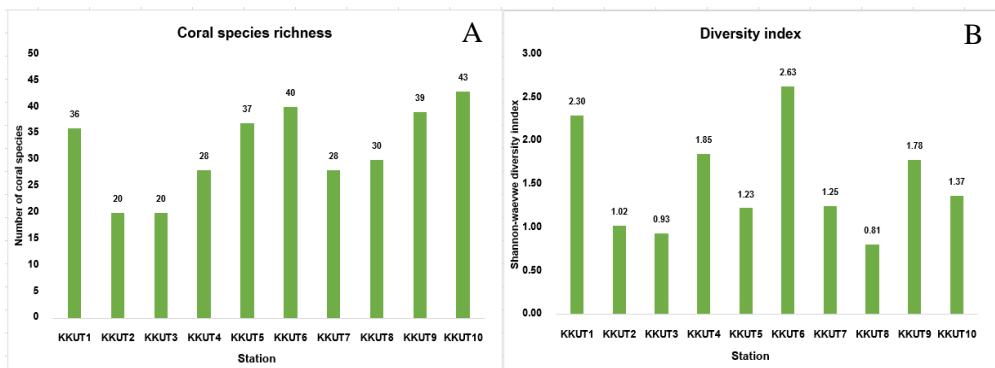

Figure 3 A: Species richness of coral species, **B:** Diversity index of coral species

3) Habitat structure on coral reefs

In general, the status of coral reefs at Kut Islands was in good condition. It had an average cover of living coral 42.4% and 26.2% of dead coral. Considering at each station, Laem Phak Waen (KKUT8) had the highest living corals (82.2%), followed by Ao Klong Chao (KKUT5) (70.2%) and the lowest at Ao Phrao (KKUT4) (12.9%). Ao Kra Ting (S) (KKUT2), however, had the highest dead coral cover (47.0%). The highest coverage area of sand (42.8%), was at Ao Kra Ting N (KKUT3). For rock, the highest cover (62.8%) was found at Ao Phrao (KKUT4) (Table 1)

Table 1 An area cover of habitat structure of coral reefs at Kut islands

Station / Life from	Live coral (%)	Dead coral (%)	Sand (%)	Rock (%)	Other (%)
KKUT1	43.6	24.4	29.8	0.2	2.2
KKUT2	28.9	47.0	23.6	0.0	0.5
KKUT3	14.7	42.0	42.8	0.1	0.4
KKUT4	12.9	18.3	5.2	62.8	0.8
KKUT5	72.0	9.2	7.2	11.1	0.6
KKUT6	40.1	43.3	15.1	0.9	0.7
KKUT7	38.6	11.2	7.5	42.0	0.7
KKUT8	82.2	4.7	8.5	0.8	3.8
KKUT9	39.0	34.5	25.6	0.1	0.5
KKUT10	51.3	27.7	19.6	0.0	1.3

4) Relationship between reef fish and reef habitat structure

The relationships between coral reef fish and habitat structures (living coral, dead coral, rock, and sand) were analyzed by using Spearman's rank correlation. (Table 2). It was found that the diversity of coral reef fish had a significant negatively relationship with living coral cover ($r^2 = 0.86$, $P <0.05$). While species richness of reef fish had a significant positive relationship with dead coral cover. To illustrated the type of this relationships, regression analysis was applied. The relationships between living coral cover and the diversity of reef fish was y = 2.547 - 2.41 x ($r^2 = 0.74$, $P <0.05$) (Figure 4-A). The relationships between dead coral cover and coral reef fish was y = 43.007+ 35.09x. ($r^2 = 0.56$, $P <0.05$) (Figure 4-B). Sand and rock, however, did not have any relationship with species richness and diversity of coral reef fish.

Considering the role of living coral on coral reef fish, living coral provide both shelter and also food for some species of fish, especially corallivorous butterfly fish (Chaetodontidae). For dead coral, it is only providing shelter for some groups of fish unless there were algae cover on which will attract herbivorous fish to the area. Then different structures had different roles for different groups of fish. Living corals, however, should be considered as the most dominant component as they

provide and maintain hard structure for coral reef habitat.   In this study, however, station that had high living coral cover but had lower species richness and diversity than the stations with low living coral cover (Figure 2 and Table 1). This is because the resulting from the differences in the utilization of reef fish. The shape of the coral around Kud Islands is not diverse as *Porites lutea* be the dominant species with highest coverage area. This provided solid structure that fish can use. The more complex structure such as branching corals (*Acropora* spp.) can provide shelter for fish like, *Amblyglyphidodon curacao* and *Dascyllus trimaculatus*, etc. On the other hand, the coral reef that had high living coral cover but less sand, fishes those utilized this sand habitats especially for food, such as goby fish and Threadfin bream should have low abundance.

Table 2 Spearman's correlation of coral reef fish with habitat structure on coral reef (*significant $P<0.05$ (2-tailed), ns = not significant, n = 10)

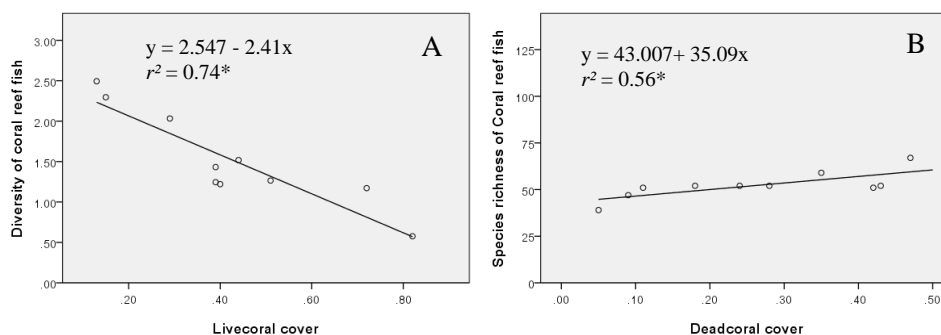| Fishes / Life forms	Living coral	Dead coral	Sand	Rock
Diversity of coral reef fish	- 0.86*	0.35^{ns}	0.24^{ns}	- 0.10^{ns}
Species richness of coral reef fish	- 0.48^{ns}	0.75*	0.37^{ns}	- 0.47^{ns}

Figure 4 Regression analysis **A**: Diversity of reef fish with live coral cover, **B**: Species richness of coral reef fish with dead coral cover

Therefore, the habitat characteristics have diverse roles on the distribution of coral reef fish, especially fish with specific habitat like on living corals. Which this habitat can provide both shelter and diet. For example, *Chaetodon octofasciatus* is the fish that feed on the polyp of coral. And the coral goby (*Gobiodon histrio*) is the fish that living in between the braces of A*cropora* sp., (Munday *et al,* 1997). Therefore, if there is disturbance like coral reef bleaching, and cause staghorn coral mortality. This means that the habitat of goby fish is deteriorate and lead to the disappearance of both coral and goby. The changing of habitat structure, therefore, can change the coral reef fish community. (Pratchett *et al,* 2011; Komyakova e*t al,* 2013)

CONCLUSION

The relationships between coral reef fishes and habitat structure on coral reefs at Kut islands demonstrate the linkage between the structure of coral reef habitat and the reef fish community. However, the relationship between reef fish and reef habitat structure remains unclear, and then difficult to pinpoint the relationship. However, there is some reveals trends of the fish community that different according to their habitat. Therefore, the long term study on the relationships between reef organisms and their habitats on the coral reefs at Kut islands should be performed. The knowledge of the relationships between fishes and their habitats will provide the information for conservation and management of coral reef in Thailand.

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