

## The Relationship between Reef Fish with Habitat Structure at Yao Islands, Phang Nga Province.

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### ABSTRACT

The relationships between reef fish and their habitat were investigated at Yao islands, Phang Nga Province. The aims of this study were to illustrate the diversity of coral reef fish and their relationships with habitat structure. The samples were collected on five stations around Yao islands. The data of reef fishes was corrected by Video Census while habitat data using Photo Belt Transect. Five replicates of 30 meters long transect were randomly laid on the reef slope of each station. For habitat data, 0.5x0.5 m<sup>2</sup> quadrat was allocated along the transect. There were 93 species of reef fish from 23 families recorded. Pomacentridae (25 species) was a dominant reef fish family at Yao islands followed by Labridae (20 species). The twin demoiselle (*Neopomacentrus sororius*) was a predominant species of Yao islands. For the reef habitat, Merulinidae and Acroporidae were the most dominant corals family. In terms of area cover, *Galaxea astreata* had the highest coverage of coral species. The relationship between reef fishes and their habitat, species richness of fishes was positively correlated with dead coral cover ( $r^2 = 0.98$ ,  $P < 0.05$ ) and species richness of coral ( $r^2 = 0.9$ ,  $P < 0.05$ ). The geographic position and turbidity were the most influential factors structuring the reef habitats and their associated reef fishes.

*Keywords:* coral reef fish, habitat structures, coral reef, Yao island, Phang Nga

### INTRODUCTION

Yao islands are located in the Andaman sea of Thailand which had high biodiversity and famous tourism activities. The reef area of Yao islands is approximately 9,860,800 sqm, with 3-5 meters of turbid water (Marine and Coastal Resources Research and Development Institute, 2015). There are shallow coral

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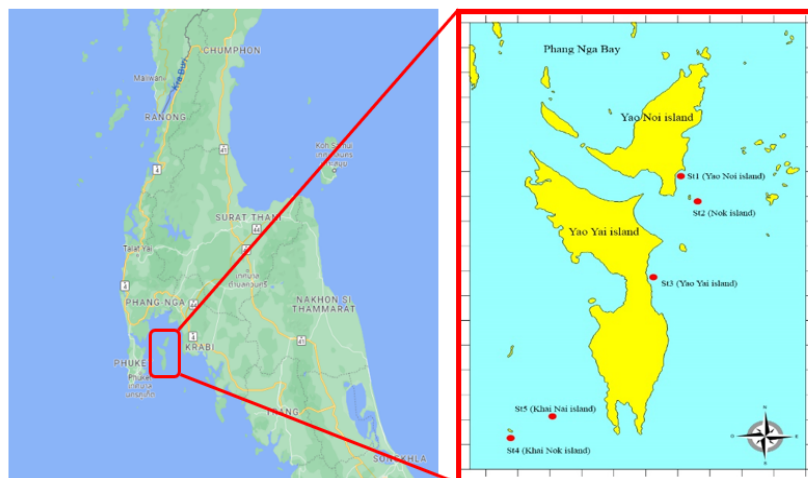
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reefs surrounding the island. Most coral reefs developed along the eastern coast because of they received less disturbance from the Southwest monsoon. In general, the Andaman Sea had less influence of sediment dispersing from land which allowing the development of coral assemblages and reefs in this area. Then, coral assemblages in this area can be found at 20-30 meters depth. The different in shape and size of corals and other reef structure provided a suitable habitat for the marine organism to use as food sources and nurseries (Munday *et al*, 2008). The reef habitat degradation both from human activities and natural phenomena, especially global warming, are the main treat for coral reef ecosystem. The degradation of reef habitat had the direct impact of reef organisms, especially coral reef fishes which live associate with corals such as coral goby (*Gobiodon* spp.) that live in *Acropora* sp. only (Munday *et al*, 1997). This means that the loss of *Acropora* had a direct impact on the populations of coral goby. (Hobbs *et al*, 2004). Therefore, the degradation or the loss of reef habitat should be the case to lost of the diversity of inhabitant reef fishes.

The objectives of this study were to illustrated the relationship between reef fishes and reef habitat structure at Yao islands, Phang Nga Province. The diversity of coral reef fish and the condition of the reef structure were also evaluated. The knowledge from this study can be used to supported for conservation of coral reef at the Yao islands.

## METHODOLOG

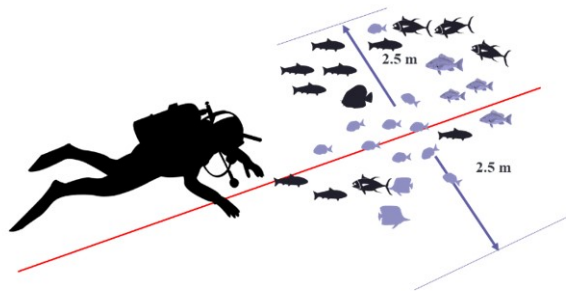
The data of reef fish and habitat structure were collected on five station at Yao island are St1 (Yao Noi island), St2 (Nok island), St3 (Yao Yai island), St4 (Khai Nok island), and St5 (Khai Nai island)(Figure 1). SCUBA diving was performed along the survey line 30 meters, with 5 replicates on each station.



**Figure 1** Study area at Yao islands, Phang Nga province, Thailand. (Google map, 2022)

## Reef fish

Reef fish data were collected using the Video Census method modified from Hill & Wilkinson (2004). The field of view on each census line was 5 meters along the 30 meters census line, then, the total sampling area of each station was 750 squamates. (Figure 2). Video data of reef fish was carried out in the laboratory. The identification of fishes was carried out using comparing photographs with documents by Burgess *et al*, (1988), Allen (1991), Allen (1999), and the Fish base (Froese & Pauly, 2021).



**Figure 2** Reef fish data were collected using the Video Census method (Hill & Wilkinson, 2004)

## Habitat structure

The data was collected on the same transect line of reef fishes. Photo Belt transect method was adapted from the Tropical Resources Survey of English *et al*, (1997). A quadrat-sized of 0.5x0.5 squamates was employed along the transect line. The picture of each quadrat was analyzed using CPCe (Coral Point Count with Excel Extensions) program (Kohler & Gill, 2006). The components of reef habitat structures were live coral, dead coral, sand, rock, macroalgae, and others living organisms. The program is assigned randomly by *Stratified Random* point, one point on five rows and columns, with 25 points in each picture. (Figure 3). The classification of coral species was comparing photographs with documents by Veron (2000).



**Figure 3** Habitat structures analyze by CPCe (Coral Point Count with Excel Extensions) **Data Analytics**

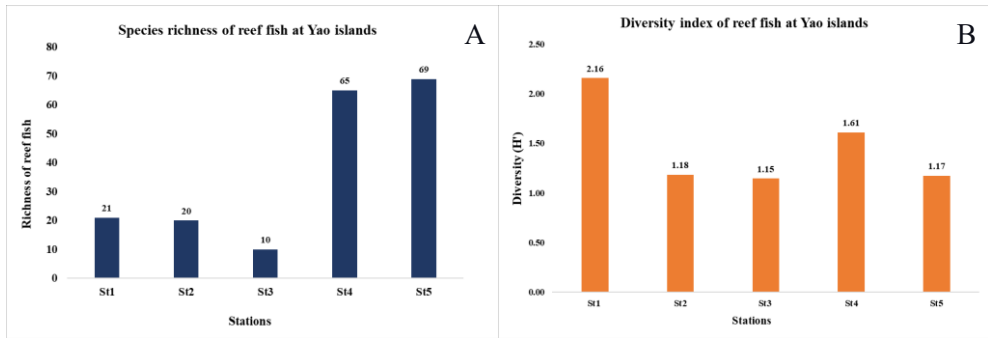
The field data of reef fish and habitat structures were analyzed for the Species richness and diversity index by the Shannon-wiener index diversity index ( $H'$ ) method. The main composition of the coral reefs, coral, gorgonians, sponges, zoanthids, macroalgae, tunicates, dead corals, sand, and rocks was recorded. The relationships between reef fishes and habitat structures were analyzed using Spearman's rank correlation. Then, perform a regression analysis for any significant pair. Principal Component Analysis (PCA) and Cluster Analysis (CA). (Quinn & Keough, 2002) were performed for displayed the species composition of the coral reef fishes.

## RESULTS AND DISCUSSION

### Species and diversity of reef fish

There were 19,006 reef fishes found in 3,750 squamates. It from 93 species and 23 families which accounted for 9.5% of Andaman reef fish (Satapoomin, 2011). The Marine and Coastal Resources Research and Development Institute (2015) reported the diversity of reef fishes in Yao islands were 18 species from 15 families. Pomacentridae and Labridae were the predominant families which found 25 and 20 species respectively. Considering the abundance of reef fish species, Twin demoiselle (*Neopomacentrus sororius*) was a dominant species, with 9,516 fishes (50.1%) islands, followed by Silver demoiselle (*Neopomacentrus anabatoides*), 4,758 fish (25.0%). Species richness and diversity index of reef fish at Yao islands was found highest at Khai Nai island (St5) as 69 species, while Yao Yai island (St3) had lowest species

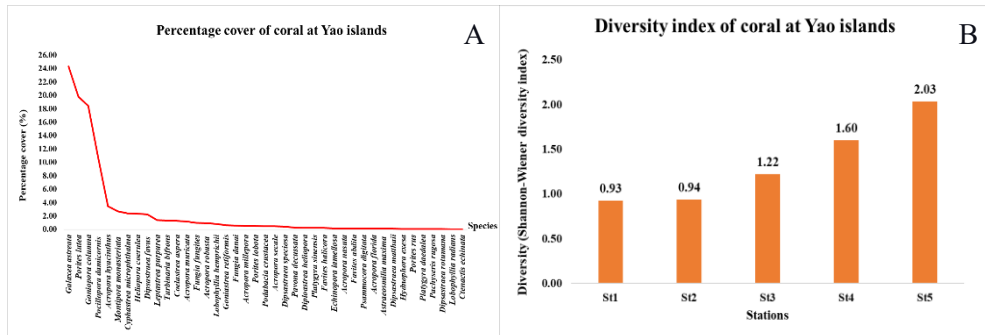
richness, found 10 species (Figure 4A). Considering the diversity index, Yao Noi island (St1) had the highest diversity (2.16), while Yao Yai island (St3) was the lowest (1.15) (Figure 4B)



**Figure 4** (A) Species richness (B) Diversity index of reef fish at Yao islands

### Habitat structure on coral reefs

There were 41 species from 14 families of hard corals found in Yao islands. Merulinidae was the most diverse family (14 species) and followed by Acroporidae (8 species). Considering the coverage of coral species, the *Galaxea astreata* was the most abundance coral species (24.3%) which can be found on all stations of Yao islands. Marine and Coastal Resources Research and Development Institute (2015), in contrast, reported that *Porites lutea* is a predominant coral species with wide distribution. This different result may come from the size of the sampling area in which the Marine and Coastal Resources Research and Development Institute surveyed 9.86 square kilometers while this study has only 3,750 square meters. However, *Porites lutea* had 19.3% covering all living coral areas of Yao islands (Figure 5A). However, when considering the diversity index of corals of each station, it was found that Khai Nai island (St5) had the highest diversity, 2.0, followed by Khai Nok island (St4) 1.6, while Yao Noi island (St1) is the lowest station, 0.93 (Figure 5B).



**Figure 5** (A) Percentage cover of coral species (B) Diversity index of coral at Yao islands

Considering the habitat structures, live coral had the highest coverage at Nok island (St2), with a live coral coverage of 34.14%. On the other hand, the station with the lowest live coral coverage were Yao Yai island (St3) had 6.1%. (Table 1). For dead coral, Khai Nai island (St5) (65.7%) had the highest dead coral cover and was followed by Khai Nok island (St4) at 64.5%. The geographic position was the main effect that Khai Nai island and Khi Nok island are located outside Phang Nga Bay which espoused to strong wind and waves especially during South–West monsoon. This had direct impact on branching corals as they are broke and may die.

### Relationships between reef fish with habitat structures

The results from the Spearman Rank Correlation indicated that species richness of reef fish had a significant positive correlation with dead coral cover ( $P < 0.05$ ,  $r^2 = 0.98$ ) and species richness of coral ( $P < 0.05$ ,  $r^2 = 0.94$ ) (Table 2). That means both death coral coverage and richness of coral increased then the richness of reef fish increases. (Figures 6A and 6B). However, dead coral cover was related to reef fish community changes as a result of changes in fish diet. Pratchett *et al*, (2011) reported that in coral reefs with high dead coral cover, the abundance of herbivorous fish in that coral reefs were also high. This was because of dead corals increases in the early stages then the abundance of fishes decreases. However, when the dead cover increases to approximately 40% of the total reef area, the abundance of reef fish increases (Mantrachitra, 1998). However, in this study (Figure 4A), the abundance of reef fishes was highest at Khai Nok island (St4) and Khai Nai island (St5).

**Table 1** Percent cover (%) of habitat structures on coral reef at Yao islands.

Station /	St1	St2	St3	(St4)	(St5)
Reef Structures (%)	(Yao Noi)	(Nok)	(Yao Yai)	(Khai Nok)	(Khai Nai)
Corals	20.9	34.1	6.1	28.7	11.1
Gorgonians	0.3	0.2	Rare*	0.0	0.0
Sponges	0.1	0.0	0.1	0.5	Rare*
Zoanthids	0.1	2.6	0.0	0.0	0.1
Macroalgae	Rare*	0.0	20.3	0.0	0.0
Tunicates	0.0	1.8	0.0	6.4	0.1
Dead coral	45.1	48.5	43.8	64.5	65.7
Sand, Rock	33.4	12.8	29.8	Rare*	23.0

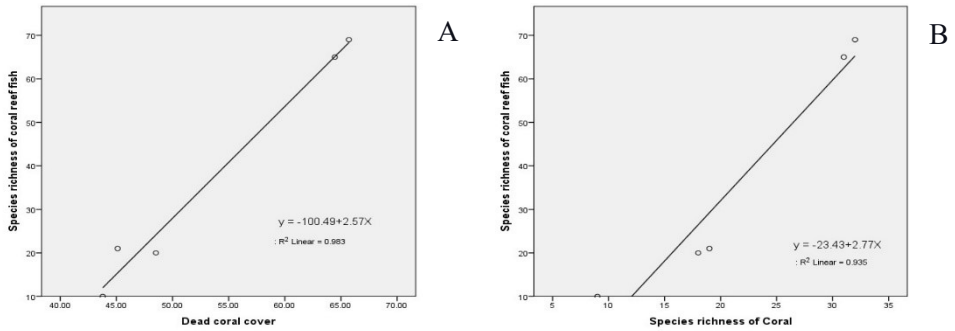
\*Rare =>0.01%

**Table 2** Spearman Rank Correlation between species richness and diversity index of reef fish with habitat structures on coral reef

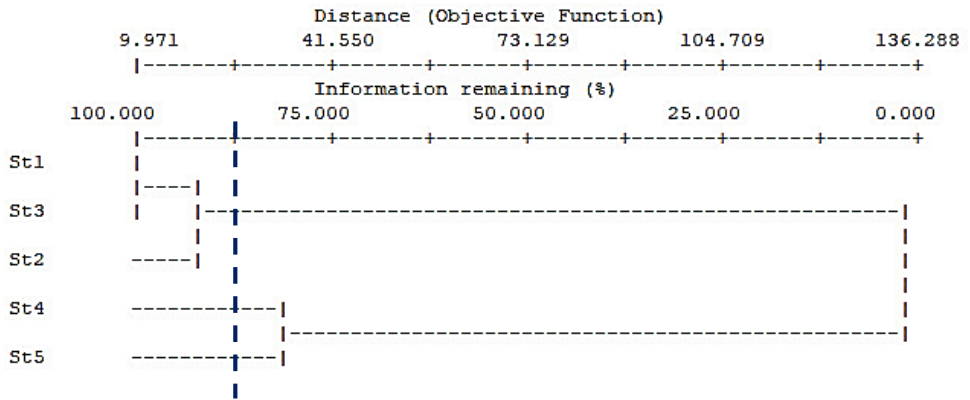
Habitat structures	C(S)	C(H)	LC	Gor	Spo	Zo	Mac	Tuni	DC	S&R
Richness of reef fish	.98*	.70	.10	-.56	.20	-.05	-.67	.41	.90*	-.30
Diversity of reef fish	.41	-.30	.60	.41	.50	.36	-.22	.21	.10	.00

\*Correlation is significant at the 0.05 level (2-tailed)., C(S): coral species richness, C(H): diversity index of coral, LC: Live coral, Gor: Gorgonians, Spo: Sponges, Zo: Zoanthids, Mac: Macroalgae, Tuni: Tunicate, DC: Dead coral, and S&R: Sand and Rock

Considering the geography of Yao islands (Figure 1), Khai Nok island and Khai Nai island are outer margin of Yao islands which most of the reefs are covered by small pieces of dead coral and turf algae. This is suitable for small herbivorous reef fish to live and feed on this turf algae. The results of cluster analysis (CA) and Principal Component Analysis (PCA) showed that the species composition of reef fishes depends on the geographic position. The reef fishes could be divided into three groups as 1) the inner part of the islands is Yao Noi island (St1), Nok island (St2), and Yao Yai island (St3). 2) Khai Nok island (St4) and 3) Khai Nai island (St5) (Figures 7 and 8). Yao Noi island (St1), Nok island (St2), and Yao Yai island (St3) received an influenced by sediments from the Phang Nga Bay. The sea floor of this area is sandy and muddy and then causes high turbidity. The coral reefs on the outer part of Yao islands are Khai Nok island (St4) and Khai Nai island (St5), that had less influenced by sediments from mangroves and urban than Yao Noi island (St1), Nok island (St2), and Yao Yai island (St3). Chansang *et al*, (1999) indicated that coral reefs are well developed in clear water and covered by staghorn corals.

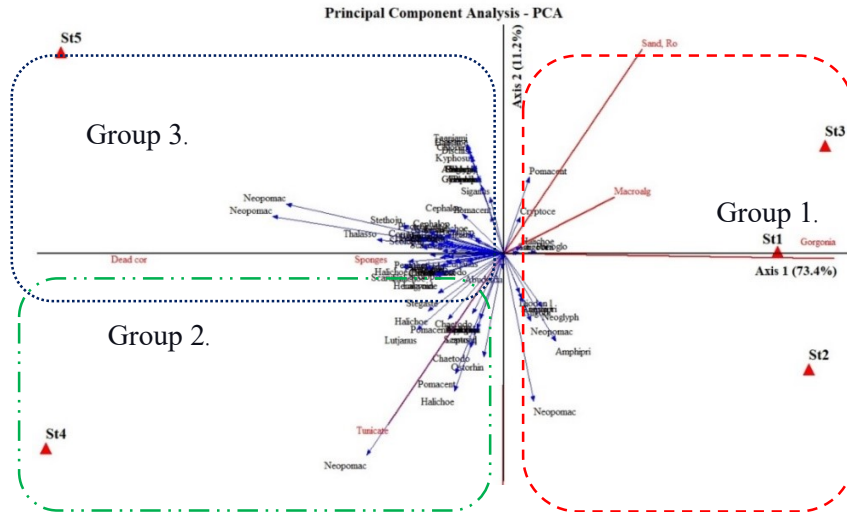


**Figure 6** Relationship between species richness of reef fish with (A) Dead coral cover, (B) Species richness of coral



**Figure 7** Cluster Analysis (CA) of reef fish communities at Yao islands





**Figure 8** Principal Component Analysis (PCA) of reef fish communities at Yao islands

## CONCLUSION

The relationship between reef fish and habitat structure at Yao islands, Phang Nga Province, were investigated. There were 93 species from 23 families of reef fish be recorded. Pomacentridae was a dominant reef fish family at Yao islands, followed by Labridae. The twin demoiselle (*Neopomacentrus sororius*) was a predominant species of Yao islands. The dominant hard coral family, when considering the percent cover, was Merulinidae and Acroporidae. The most dominant coral species was *Galaxea astreata*. For the relationship between reef fish and their habitat, there were positive ( $P < 0.05$ ) correlation between the species richness of reef fish and dead coral cover ( $r^2 = 0.98$ ) and species richness of coral ( $r^2 = 0.94$ ). This study found that the death coral area provides feeding area for herbivorous fishes which provide a changes of coral reef fish community by the domination of herbivorous fishes.

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