ORIGINAL ARTICLE

Diversity of fishes associated with artificial reefs off the coast of Sathing Pra, Songkhla

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Abstract. The fish compositions were presented in this study under artificial reefs monitoring program at Sathing Pra, Songkhla coast. Nondestructive method as record of frequency percentage was done during 2 seasonal collections. Our results showed that jack fishes in family Carangidae were the most diverse group, which was marked 5 species: *Alepes djedaba*, *A. vari*, *Atule mate*, *Caranx ignobilis*, and *Selaroides leptolepis*. While rabbitfishes, *Siganus javus*, and snappers, *Lutjanus lutjanus* and *L. russelli* were the dominant groups in all study sites. The former species of artificial reef fishes were observed in both periods, resulting to similar species richness among seasons. Those indicated several residences living in this artificial reef. Moreover, resident fishes mainly composed by economic species, hence it implies that this artificial reef can be an effective habitat for local fishery utilization.

Keywords: Gulf of Thailand, fish community, artificial reef, southern coast.

1. Introduction

The study of fish assemblage is a common tool for monitoring after the installation of artificial structures. Habitat utilization by fishes can evaluate the suitability of artificial reef as marine resource management (Strelcheck et al. 2005; Arena et al. 2007; Hackradt et al. 2011). Generally, fishes living in artificial reef have been found several groups according to their behaviors, i.e., attaching species prefer being in a refuge such as holes, crevices, and complex structure, etc. (Serranidae, Scorpaenidae, Pseudochromidae, Blennidae), cryptic species hiding closed to reef structure (Diodontidae, Apogonidae, Monacanthudae, Ostraciidae, Tetraodontidae), associated species swimming throughout structure (Lutjanidae, Leiognathidae, Chaetodontidae, Pomacanthidae, Balistidae, Acanthuridae), benthic species dwelling to the sea bottom or slow moving around structure base (Mullidae, Nemipteridae, Lethrinidae, Mugiloididae, Synodontidae, Rachycentirdae), and pelagic fishes (Caesionidae, Ephippidae, Sphyraenidae, Engraulidae, Hemiramphidae, Myliobatidae) (Satapoomin 1994).

Fishes use artificial reefs as the sites for mating, spawning, feeding, and being shelter against their predators (Leitão et al. 2007; Bortone et al. 2011). The size and complexity of artificial reef were mentioned to positively influence species richness and abundance of reef fishes. (Abelson and Shlesinger 2002). Square or encircled pattern was suggested for artificial reef installation being a nursery habitat and fishery conservative area (Suphongphan and Singtothong 1992).

The artificial reefs were established at coastal Sathing Pra, Songkhla Province under a project of "Habitat establishment for aquatic organisms at Songkhla coast" belonging to Charoen Pokphand Group Co., Ltd. and True Corporation in order to enhance local fishing resources by providing an additional habitat. Therefore, it was a good opportunity to monitor the development of reef fish communities at the beginning of artificial reef.

2. Materials and Methods

2.1 Study site

The artificial reefs were installed since November 2017, at 6 km away from coastal area, in north-south direction: AR1 (7°30'58.7"N 100° 29'28.5"E), AR2 (7°30'31.0"N 100°29'39.2"E), and AR3 (7°29'30.4"N 100°29'58.4"E) as shown in Figure 1 Cubic shape, 1.5x1.5x1.5 m, was designed in pattern of hollow cube artificial reef. Each was constructed using reinforced concrete, which was the most favored reef material (Baine 2001). Each group of 70-80 concrete cubes was placed and arranged on the sea floor of each study site covering about 600 m^2 of reef area. The average depth of the study sites was 13.1±0.2 m below mean sea level. The reefs were in turbid water so the visibility was limited as < 5 m. This area located in tropical climate affected by two seasons: summer season covering from mid-February to the mid-May and rainy season dominated by Southwest Monsoon (mid-May to mid-October) and Northeast Monsoon (mid-October to mid-February).

2.2 Data collection and analysis

Assessment of reef fish community composition was held twice according to seasons. The first survey was organized between May 2018 when the artificial reefs were installed for 6 months ("6M"). Another was done between October 2018 when the artificial reefs were installed for 11 months ("11M"). Visual census method was applied to both surveys. SCUBA diver slowly swam 50-60 minutes above and through the structures for each study site. The occurrence of each fish in each minute was recorded separately. Then, frequency occurrence percentage (%F) was calculated as following:

$$\text{Frequency percentage of species i } (\%F_i) = \frac{\text{Number of minutes species i exist}}{\text{Total minute}}$$

The frequency percentage was categorized into ACFOR groups (Kent 2011) as;

%F > 75% = A, abundant
50% < %F ≤ 75% = C, common
25% < %F ≤ 50% = F, frequent
5% < %F ≤ 25% = O, occasional
0% < %F ≤ 5% = R, rare including fishes were not found by investigator but found by other divers.

Moreover, other physical parameters as seawater temperature and light intensity were collected during both surveys using HOBO Pendant® Temperature/Light 64K Data Logger (Onset Computer Corporation, USA). The temperature was randomly measured at the depth of the artificial reef while the light intensity was recorded along vertical profile from sea surface to sea bottom for each study site.

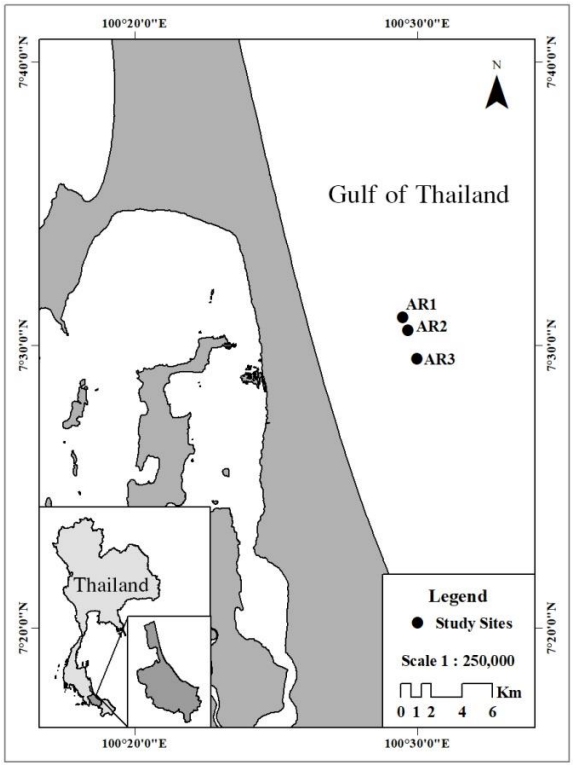

Figure 1. Location of artificial reefs, coast of Sathing Pra, Songkhla

3. Results

According to the surveys, reef fish community of the artificial reefs off the coast of Sathing Pra was relatively diverse. There were 32 species from 19 families of the artificial reef fishes recorded in this study (Table 1). The greatest family in terms of species number was Carangidae which included 5 species, i.e., *Alepes djedaba*, *A. vari*, *Atule mate*, *Caranx ignobilis*, and *Selaroides leptolepis*. The second and the third diverse families were Lutjanidae and Serranidae that found 4 species (*Lutjanus russelli*, *L. monostigma*, *L. lutjanus*, and *L. vitta*) and 3

species (*Cephalopholis boenak*, *C. formosa*, and *Epinephelus coioides*), respectively.

Reef fish species richness observed at 6M and 11M were comparable. There were 31 species from 18 families observed in the 6M reefs whereas there were 30 species from 18 families observed at the 11M reef. The composition of fishes in the reefs found at 6M and 11M were also similar to each other. Total 29 species from 17 families were found in both surveys. However, there were a few species that were observed in only one survey, e.g., Gon's cardinalfish *Archamia bleekeri* (Apogonidae) and herring scad *Alepes vari* (Carangidae) that were found only at 6M, and redbelly yellowtail fusilier *Caesio cunning* (Caesionidae) that was found only at 11M.

Quantitative information of the fishes also exhibited similar result between surveys. For both 6M and 11M surveys, three species were classified as abundant based on frequency occurrence. The mentioned abundant species included streaked spinefoot *Siganus javus* (Siganidae), Russell's snapper *Lutjanus russelli* (Lutjanidae) and bigeye snapper *L. lutjanus* (Lutjanidae). And so on, the rest fish species were found at 6M and 11M in the similar occurrence.

In situ physical parameters presented in Figure 3 and 4 indicating similar temperature among study sites even in different periods. However, light intensity penetrated to underwater was obviously higher in summer. This was the only considerable different of physical condition between these two seasons.

Table 1. A checklist and quantitative information of fishes found in the artificial reefs off the coast of Sathing Pra, Songkhla, Thailand, during summer and rainy season 2018 (6 months and 11 months after reef installation). Quantitative information: A = abundant, C = common, F = frequent, O = occasional, and R = rare)

Family	Species	6M			11M		
		AR1	AR2	AR3	AR1	AR2	AR3
Hemiscylliidae	*Chiloscyllium griseum* Müller & Henle, 1838	O	O	O	R	O	O
	Chiloscyllium hasseltii Bleeker, 1852	O			R		
Dasyatidae	*Taeniura lymma* (Forsskål, 1775)		O			O	
Plotosidae	*Paraplotosus albilabris* (Valenciennes, 1840)	F	O	O	O	O	O
Serranidae	*Cephalopholis boenak* (Bloch, 1790)	O	O	O	F	O	O
	Cephalopholis formosa (Shaw, 1812)	O	R	O	O	R	O
	Epinephelus coioides (Hamilton, 1822)	O	O	O	O	O	O
Apogonidae	*Archamia bleekeri* (Günther, 1859)			R			
Carangidae	*Alepes djedaba* (Forsskål, 1775)	R	O		R	O	O
	Alepes vari (Cuvier, 1833)			O			
	Atule mate (Cuvier, 1833)	F	O	F	F	O	C
	Caranx ignobilis (Forsskål, 1775)	F	O	O	O	O	O
	Selaroides leptolepis (Cuvier, 1833)	O	O	C	O	O	C
Lutjanidae	*Lutjanus russellii* (Bleeker, 1849)	A	C	F	A	C	C
	Lutjanus monostigma (Cuvier, 1828)	O	F	O			F
	Lutjanus lutjanus Bloch, 1790	A	C	C	A	C	F
	Lutjanus vitta (Quoy & Gaimard, 1824)	O	O	O	O	O	O
Caesionidae	*Caesio cuning* (Bloch, 1791)						O
Haemulidae	*Diagramma pictum* (Thunberg, 1792)	F	O	O	O	O	O
Lethrinidae	*Lethrinus lentjan* (Lacepède, 1802)	R			R		
Nemipteridae	*Scolopsis vosmeri* (Bloch, 1792)		R			R	
	Scolopsis monogramma (Cuvier, 1830)		R	O		R	O
Monodactylidae	*Monodactylus argenteus* (Linnaeus, 1758)		R			R	R
Pomacentridae	*Neopomacentrus cyanomos* (Bleeker, 1856)	O	O	O	C	O	O
	Abudefduf bengalensis (Bloch, 1787)		R			R	
Labridae	*Thalassoma lunare* (Linnaeus, 1758)		R			R	
Ephippidae	*Platax teira* (Forsskål, 1775)		F			F	F

Table 1. (Cont.)

Family	Species	6M			11M		
		AR1	AR2	AR3	AR1	AR2	AR3
Siganidae	*Siganus fuscescens* (Houttyn, 1782)		O			O	
	Siganus javus (Linnaeus, 1766)	C	A	A	A	A	A
Monacanthidae	*Monacanthus chinensis* (Osbeck, 1765)	O			R		
Ostraciidae	*Ostracion rhinorhynchos* Bleeker, 1851	R			R		
Tetraodontidae	*Arothron stellatus* (Anonymous, 1798)	O			O		
Total species		**21**	**24**	**18**	**20**	**23**	**20**
Grand total			**31**			**30**	

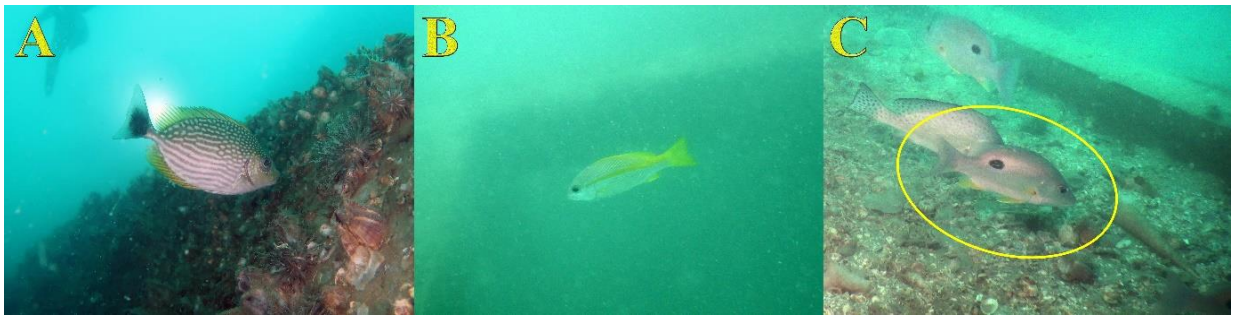

Figure 2. Fishes that were categorized as "abundant" in the artificial reefs off the coast of Sathing Pra: A = *Siganus javus*; B = *Lutjanus lutjanus*; C = *L. resselli*

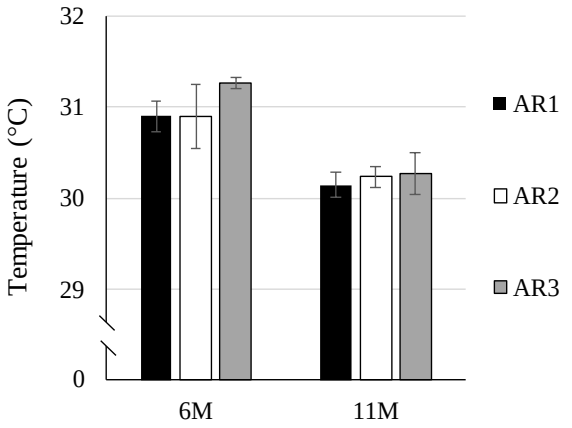

Figure 3. Seawater temperature (mean±SD) measuring in the artificial reefs off the coast of Sathing Pra at 6 and 11 months after reef installation.

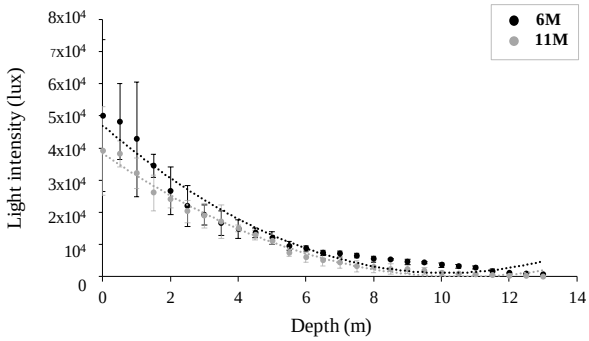

Figure 4. Vertical profile of light intensity (mean±SD) of the three artificial reefs off the coast of Sathing Pra at 6 and 11 months after reef installation.

4. Discussion

Variety of fishes associated with artificial reefs in Thai's Water in term of both diversity and abundance depends on numerous factors, especially transparency/visibility of seawater, location, structure complexity and installation period (Dehnendo 1991; Fujisawa et al. 1991; Department of Fisheries 2012; Pengchumrus et al. 2018). In this study, the information on physical factors including water temperature and water transparency, indicated by light intensity, showed comparable values between seasons. This is an ordinary conditions of tropical sea, physical conditions of seawater in the reefs were relatively stable (Ebeling and Hixon 1991). Therefore, seasonality would not be significant effect to dominate reef fish community in the area. Moreover, we at least compare our study with the previous one, carried out using similar conditions in Songkhla artificial reefs, which found the same conspicuous species as *Siganus javus* and *Lutjanus russelli* (Panichsuk et al. 1985).

Most of the fishes appeared in the reefs were in their juvenile stage. Considered of short time after installation, therefore, reef fish aggregation would be the attraction property of artificial reefs rather than production (Bohnsack

1989). However, equilibrium of fish community was mentioned to be usually achieved within one to a maximum of five years. A pattern of initial overshoot in number of fish species to a new artificial reef was observed with an eventual leveling off at some equilibrium level (Dance et al. 2011).

Based on the result, diversity of fishes in the artificial reefs off the coast of Sathing Pra at 6M and 11M were not distinctly different. Corresponding to the monitoring at Rayong artificial reefs, identical species and richness were observed among both periods (twice a year) although the study methods were different (Ingsrisawang 1996). However, the appearance of diverse fish communities indicated that those reefs were able to attract and concentrate marine fishes (Pickering and Whitmarsh 1997). Furthermore, most of the members of fish community were indicated as juvenile and immature fishes suggesting a developing and effective habitat of these reef fish communities that will support local fishery in the future.

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References

Abelson A, Shlesinger Y (2002) Comparison of the development of coral and fish communities on rock-aggregated artificial reefs in Eilat, Red Sea. ICES J Mar Sci 59: S122–S126

Arena PT, Jordan LKB, Spieler RE (2007) Fish assemblages on sunken vessels and natural reefs in southeast Florida, USA. Hydrobiologia 580: 157–171

Baine M (2001) Artificial reefs: A review of their design, application, management and performance. Ocean Coast Manag 44: 241–259

Bohnsack JA (1989) Are high densities of fishes at artificial reefs the result of habitat limitation or behavioral preference? Bull Mar Sci 44: 631–645

Bortone AS, Brandini FP, Fabi G, Otake S (2011) Artificial reefs in fisheries management. CRC Press, Boca Raton, Florida

Dance MA, Patterson WF, Addis DT (2011) Fish community and trophic structure at artificial reef sites in the northeastern Gulf of Mexico. Bull Mar Sci 87: 301–324

Dehnendo MN (1991) A review of artificial reefs development and use of fish aggregating devices (FADs) in the ASEAN region. In: Pietersz VLC (ed) Symposium on Artificial Reefs and Fish Aggregating Devices as Tools for the Management and Enhancement of Marine Fishery Resources. pp 116-141

Department of Fisheries (2012) Fish species in artificial reef under the Royal Development Projects Board (RDPB) for restoration of coastal marine resources at Pattani and Narathiwat Provinces in 2002 - 2012. Deep Sea Fishery Technology Research and Development Institute, Marine Fisheries Research and Development Division, Department of Fisheries. In Thai

Ebeling AW, Hixon MA (1991) Tropical and temperate reef fishes:comparison of community structures. In: Sale P (ed) The ecology of fishes on coral reefs, San Diego, California: Academic Press. pp 509-563

Fujisawa W, Munprasit A, Sungthong S, Ananpongsuk S, Sawatpreera S, Sae-ung S (1991) The Artificial Reefs Experiment in Thailand. Training Department Southeast Asia Fisheries Development Center, Bangkok

Hackradt CW, Félix-Hackradt FC, García-Charton JA (2011) Influence of habitat structure on fish assemblage of an artificial reef in southern Brazil. Mar Environ Res 72:235–247

Ingsrisawang W (1996) Monitoring and analysis of results from artificial reef constuction using fishing trap at Chanthaburi Province. Technical Paper No.62/2539, Eastern Gulf Fisheries Research and Development Center,

Marine Fisheries Division, Department of Fisheries. In Thai

Kent M (2011) Vegetation description and data analysis: A practical approach. John Wiley & Sons, Ltd.

Leitão F, Santos MN, Monteiro CC (2007) Contribution of artificial reefs to the diet of the white sea bream (*Diplodus sargus*). ICES J Mar Sci 64: 473–478

Panichsuk P, Tanwilai D, Predalumpabut Y (1985) Experiment of artificial reef constuction in front of the Institute of Coastal Aquaculture, Songkhla, Technical Paper No.12/2528, Institute of Coastal Aquaculture, Songkhla, Department of Fisheries. In Thai

Pengchumrus W, Thongtham N, Klongsamut M (2018) Species composition and abundance of fish on the artificial reefs and natural reefs at Phi-Phi Leh Island, Krabi Province. Proceedings of the 6th Marine Science Conference, Bangsean Heritage Hotel, Chonburi. pp 730-739. In Thai

Pickering H, Whitmarsh D (1997) Artificial reefs and fisheries exploitation: A review of the "attraction versus production" debate, the influence of design and its significance for policy. Fish Res 31: 39–59

Satapoomin U (1994) Fish aggregation at the artificial reefs. In The effect of artificial reef installation on the bioscioeconomics of small-scale fisheries in Ranong Province, Thailand, the Bay of Bengal Programme (BOBP), Abhiramapuram, Madras, India. pp 29-49

Strelcheck AJ, Cowan JH, Shah A (2005) Influence of reef location on artificial-reef fish assemblages in the northcentral Gulf of Mexico. Bull Mar Sci 77: 425–440

Suphongphan S, Singtothong U (1992) Natural reef and artificial reef. Thai Fisheries Gazette 45: 999-1010. In Thai