

# THE EARLY ESTABLISHMENT OF FISH COMMUNITIES AT ARTIFICIAL REEF STRUCTURES IN SINGAPORE WATERS

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## ABSTRACT

Observations on the early development of fish communities at two types of artificial reef structures (vehicle tyres and concrete modules) showed that both attracted similar numbers of species but at different rates of increase. Larger-sized individuals favoured the concrete reef while smaller sized ones including fry and juvenile stages associated more with the tyre reef. The results of this initial investigation indicated the effectiveness of artificial reefs in the turbid water conditions of Singapore.

## INTRODUCTION

A pilot-scale artificial reef was established north of the patch reef, Terumbu Pempang Tengah, (fig.1) between mid-August and the end of September, 1989. It consisted of two sections, one of 50 pre-cast hollow concrete cubes ( $1 \text{ m}^3$ ), and the other of 20 pyramidal tyre modules (each module comprising 42 tyres). Both sections were spaced 10 m apart from each other on the seafloor and about 30 m from the patch reef, at depths of 12 to 15 m. The project was conducted to determine the effectiveness of artificial reefs at enhancing fish life in the turbid waters of Singapore, and also to evaluate which of the two materials used served the

purpose better. The site was selected based on the results of an earlier survey of possible areas (Chou & Hsu, 1987). Artificial reefs have been used extensively throughout the world (Chou, 1989) including Southeast Asia (White et al, 1990) with varying degrees of success in meeting different objectives. This paper gives the results of the fish communities observed at these structures within the first five weeks of the completed date of deployment.

## MATERIALS AND METHOD

The fish communities were assessed by underwater

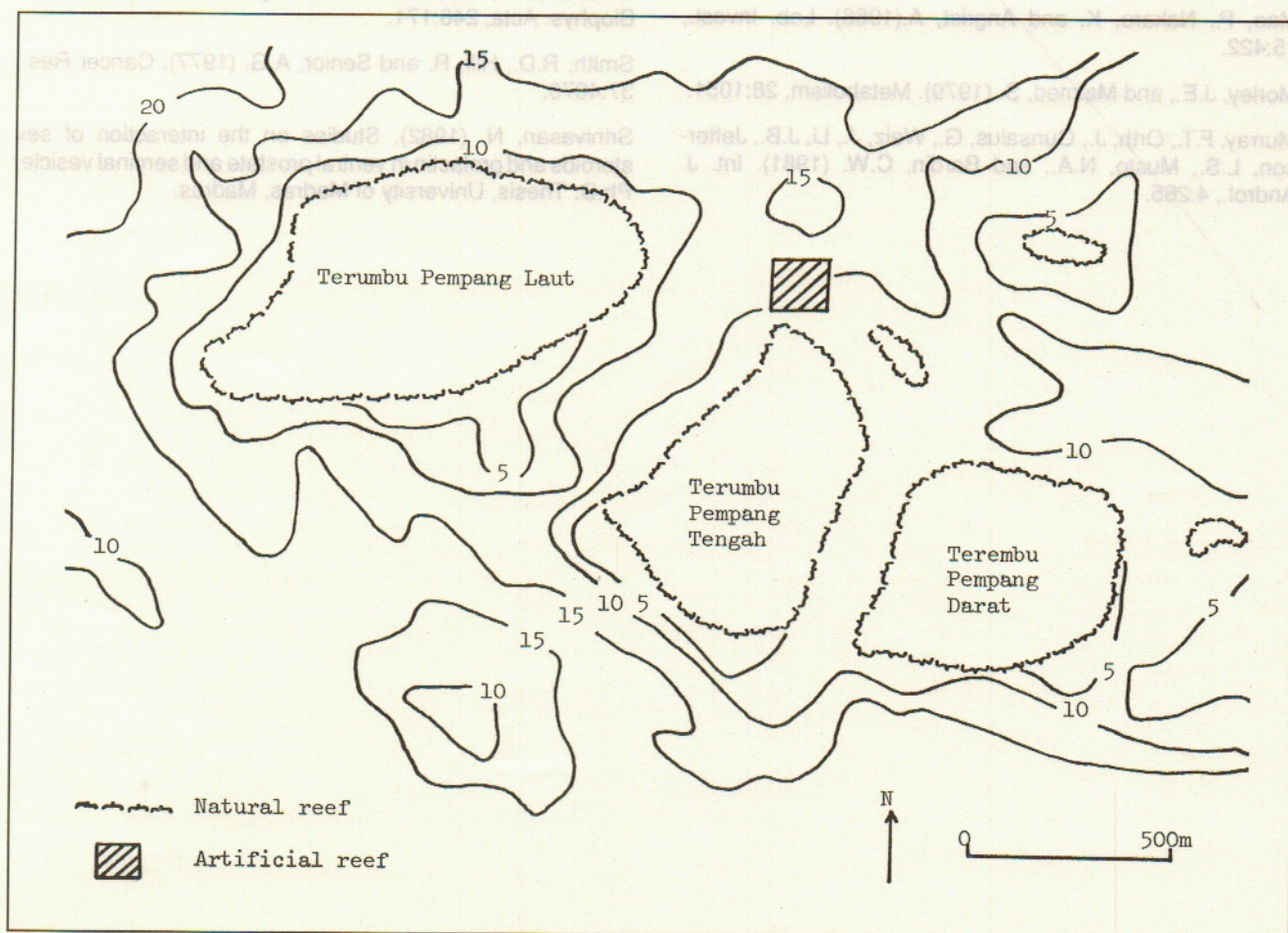


Fig. 1 Terumbu Pempang patch reefs with location of artificial reef indicated (depths shown in metres).



Table 1. Early development of the fish community at the tyre reef.

Family	Genus/species	Remarks	Date first sighted
APOGONIDAE	<i>Apogon</i> sp.1	school of juveniles	13/10/89
	<i>Apogon</i> sp.2	school of juveniles	13/10/89
CARANGIDAE	<i>Selaroides leptolepis</i> ?	school of juveniles	13/10/89
CHAETODONTIDAE	<i>Chelmon rostratus</i>	1-3 indiv.	15/09/89
	<i>Coradion chrysozonus</i>	1 indiv.	13/10/89
EPHIPPIDAE	<i>Platax orbicularis</i>	4 indiv. (adults, semi-adults, juveniles)	13/10/89
GRAMMISTIDAE	<i>Diploprion bifasciatus</i>	2-4 adults	13/10/89
HAEMULIDAE	<i>Plectorhynchus pictus</i> ?	2 indiv. (20,25cm)	13/10/89
LABRIDAE	<i>Choerodon anchorago</i>	2 indiv. (20,30cm)	7/11/89
	<i>Choerodon shoenleinii</i>	large (20-40cm) common	13/10/89
	<i>Halichoeres dussumieri</i>	small, common	7/11/89
	<i>Halichoeres scapularis</i> ?	small, common	13/10/89
LATIDAE	<i>Lates calcarifer</i>	1 indiv. (25cm)	25/10/89
LUTJANIDAE	<i>Lutjanus carponotatus</i>	4-6 indiv. (20-40cm)	13/10/89
MONOCANTHIDAE	<i>Monocanthus</i> sp.1	1 juvenile, 2 adults	13/10/89
NEMIPTERIDAE	<i>Scolopsis vosmeri</i>	1 indiv.	13/10/89
		unidentified sp.1	on seafloor prior to 21/08/89 reef establishment
POMACANTHIDAE	<i>Pomacanthus sexstriatus</i>	1-2 large indiv.	4/10/89
	<i>Chaetodontoplus mesoleucus</i>	5 indiv.	13/10/89
POMACENTRIDAE	<i>Neopomacentrus nemurus</i>	school of juveniles	4/10/89
SCARIDAE	<i>Scarus ghobban</i>	1-2 indiv. (25-30cm)	26/10/89
SIGANIDAE	<i>Siganus guttatus</i>	3 adults (30 cm)	27/10/89
SPHYRAENIDAE?		school of juveniles	13/10/89
Total number of families: 16			
Total number of genera/species: 23			

visual census using scuba equipment. Observations were made in the area prior to the establishment of the artificial reef as well as during the deployment phase. The observations were continued on a weekly basis from the time when all modules were well in place for a further period of five weeks (until 7 November 1989) to trace the early development of fish communities. Individuals were counted and identified in the field to species level wherever possible and size estimates were made of the food-important species.

## RESULTS

Observations prior to the establishment of the artificial reef structures indicated the area to be almost barren of fish. Only one unidentified nemipterid species appeared to be present, with individuals spending most of the time resting on the seafloor. No other pelagic or demersal species were seen.

Species recorded from observations during and after the

deployment of the artificial reef structures are shown in Table 1 for the tyre modules, and in Table 2 for the concrete modules. Both structures attracted 23 species each, with those at the tyre reef representing 16 families, and the concrete modules, 18 families. A good overlap was provided by 12 families common to both structures.

The communities of both types of structure included a high number of food-important species. The results did not indicate a significant difference in the diversity of such species between the tyre and the concrete reefs. Each community supported 7 species which are sold in markets. The tyre reef supported a further 7 edible species which are not commonly found in markets, while the concrete reef supported 5 edible species in this category.

More of the larger-sized individuals were sighted at the concrete reef. Species richness was low during the deployment of the modules and the week after complete deployment. The tyre reefs saw a large increase in species richness in the second week after complete deployment and smaller



**Table 2.** Early development of the fish community at the concrete reef.

Family	Genus/species	Remarks	Date first sighted
APOGONIDAE	<i>Apogon</i> sp.1	school of juveniles	13/10/89
	<i>Apogon</i> sp.2	school of juveniles	13/10/89
CARANGIDAE	<i>Selaroides leptolepis</i> ?	school of juveniles	27/10/89
DASYATIDIDAE	unidentified	1 indiv. (1m)	4/10/89
EPHIPPIDAE	<i>Platax orbicularis</i>	9 indiv. (adults,	7/09/89
GOBIIDAE	unidentified	small (5-10cm)	25/10/89
GRAMMISTIDAE	<i>Diploprion bifasciatus</i>	school of semi-adults	15/09/89
HAEMULIDAE	<i>Plectorhynchus pictus</i> ?	1 indiv. (40cm)	7/11/89
LABRIDAE	<i>Choerodon shoenleinii</i>	large (20-40cm), common	13/10/89
	<i>Halichoeres dussumieri</i>	small, common	7/11/89
	<i>Halichoeres scapularis</i>	small, common	13/10/89
LUTJANIDAE	<i>Lutjanus</i> sp.1	2 large indiv. (80cm), breeding size	4/10/89
	<i>Lutjanus carponotatus</i>	2-4 indiv. (20-40cm)	27/10/89
MULLIDAE	<i>Upeneus tragula</i>	(15cm), common	14/10/89
NEMIPTERIDAE	unidentified sp.1	on seafloor prior to reef establishment	21/08/89
PLOTOSIDAE	<i>Plotosus</i> sp.1	1 juvenile	25/10/89
POMACANTHIDAE	<i>Pomacanthus sexstriatus</i>	1 large indiv. (20cm)	25/10/89
POMACENTRIDAE	<i>Neopomacentrus nemurus</i>	school of juveniles	4/10/89
	<i>Pomacentrus albimaculus</i>	1 indiv.	13/10/89
SERRANIDAE	<i>Cephalopholis pachycentron</i>	1 indiv. (15cm)	25/10/89
SIGANIDAE	<i>Siganus guttatus</i>	3 adults (30cm)	27/10/89
TETRAODONTIDAE	<i>Arothron</i> sp.1 ( <i>mappa</i> ?)	1 large indiv. (60cm)	7/11/89
SPHYRAENIDAE?		school of juveniles	13/10/89
Total number of families: 18			
Total number of genera/species: 23			

but constant increases in the final weeks of observation. The concrete reefs however, registered a constant increase in species richness of 6 to 7 with each series of observations, except for the last survey which added a further 3 species.

## DISCUSSION

The artificial reef structures served as an aggregating device by attracting fish from the vicinity. Many of the individuals were of sizes which indicated that they moved in from surrounding areas and repeated sightings indicate that some have taken residence at these reefs. The concrete reef modules appear to favour larger-sized individuals. Fry and juvenile stages of different species were observed to associate more with the tyre reefs, particularly in the later weeks of observation, indicating the preference of species in using the tyre reefs as a nursery.

These initial findings demonstrate the effectiveness of

artificial reefs in Singapore's turbid waters in attracting fish. The enhancement of fish life will be realised only when these artificial reefs support a large diversity of species which are permanently in residence or which return frequently, as well as their use as a nursery by the various species. Further monitoring is required and is being carried out to establish this. An effective comparison between the two types of artificial reefs also requires observation over a longer term.

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