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Artificial Seagrass: A Habitat for Marine Fishes

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ABSTRACT

Artificial seagrass plays an important role for the distribution of benthic organisms and fishes.
Based on this perspective a study was conducted in the Sepanggar Bay located in the Northern part
of Kota Kinabalu, Malaysia from November 2006 to February 2007 to determine the potentiality
of artificial seagrass as an alternative habitat for marine fishes. The artificial seagrass area is
located approximately 100 m from the coastline at the depth between 6 and 10 m and made up of
Dorken Advance Engineer Rubber which was tightened on a square 1 × 3 m metal mat. The
sampling process was done by capturing photos and video recording. The picture of the fishes was
taken as many as possible to increase the accuracy and precision of fish identification. A total of 497
fish species belong to 17 families were observed in 5 sampling periods throughout the study. Out
of 17 families, Pomacentridae was dominant with 25.55% (127 individuals) followed by caesionidae
with 22.13% (110 individuals). It was observed that *Caesio* sp. from a family Caesionidae was
dominant genus in the artificial seagrass area, followed by *Chromis* sp. and *Pomacentrus* sp. from
a family Pomacentridae. Overall Shannon diversity (H') value of 2.5315 indicates artificial sea
grass could play a vital role as a nutrient rich habitat for marine fishes.

Key words: Artificial seagrass, dorken AER system, fish habitat, species diversity, Sepanggar Bay

INTRODUCTION

The artificial seagrass is familiar as an alternative method to replace the destroyed natural
seagrass ecosystem in many countries. It has been widely used as a soft engineering method to
protect shoreline from erosion and as an alternative marine habitat for various marine organisms.
Besides the ability to prevent coastal erosion, it also provide nursery ground for juveniles, habitat
for small fishes, food for grazers and hiding place for small fishes thus playing major role in
maintaining balance in marine environment. They stabilize bottom sediments with their dense roots
and rhizomes that form a secure mat. This sediment stabilization and erosion prevention is
especially important during storms and hurricanes that often threaten the coastal areas (Fairhurst
and Graham, 2003).

Seagrass beds offer important feeding sites for fish (Weinstein and Heck, 1977; Heck and Orth,
1980) due to the high invertebrate biomass they support (De Troch *et al.*, 2003; Nakamura and

Sano, 2005). Seagrass fish assemblages are commonly dominated by fish that feed on abundant small crustaceans (Nakamura *et al.*, 2003). Food availability has been found to explain the distribution of fish within seagrass beds (Grenouillet *et al.*, 2002). Khalaf and Kochzius (2002) found that 79.9% of fish in seagrass area were planktivores, 5.5% fed on both fish and invertebrates, 5% were omnivorous and only 2.5% fed exclusively on invertebrates. Although several studies (e.g., Marasabessy and Hukom, 1989; Dolar, 1991) have reported on the diversity and abundance of seagrass fish assemblages within SE Asia their trophic structure remains undocumented. Furthermore it is also efficient in removing dissolved nutrients from waters that often enter coastal waters as a result of runoff from the land (Duffy, 2006). They trap fine sediments and particles from both land and water. The removal of sediments and nutrients from the water results in high water clarity and nutrient-poor waters required for the survival of coral reefs. Despite of playing important roles in marine environment, seagrass ecosystem has been degraded in many ways especially by human activities (Lee *et al.*, 2001; De Silva *et al.*, 1999). Nevertheless, some of the functions of natural seagrass cannot be established by artificial seagrass. Artificial seagrass cannot produce gases to increase the gas regulation in the water. Artificial seagrass does not have real roots as natural seagrass to absorb nutrients and consolidate the sand structure. The successiveness of seagrass to attract fish inside of it can play the vital role to increase the fish population in the area (Adams *et al.*, 2004). Among the fishes, the commercial fish also inhabits in the seagrass meadow area, indirectly boosting the local fishery economics.

Realizing the study on artificial seagrass in Malaysia is still scanty, this study was aimed to determine the effectiveness of artificial seagrass as a marine habitat towards the conservation of marine fishes.

MATERIALS AND METHODS

Sampling sites: This study has been conducted in Sepanggar Bay, Northern part of Kota Kinabalu (Fig. 1). The data was collected between November, 2006 and February, 2007. The artificial seagrass area located approximately 100 m offshore from the coastline. The depth at the artificial seagrass area varied between 6 and 10 m. The artificial seagrass units are made by Dorken Advance Engineer Rubber. They were tightened on a square 1 × 3 m metal mat. The metal mat was submerged with six heavy breaks surrounding. The length of each artificial seagrass unit was 1 m where the water absorption was less than 0.3% and it was non-toxic material.

During sampling, the weather and time were the vital factors to be concerned. The sampling was carried out during a sunny day between 9 o'clock in the morning until 3.00 o'clock in the afternoon. This period receives optimum sunlight and provides the best visibility as stated by other marine biologists (Sogard and Able, 1994; Bell *et al.*, 1985). The sampling process was done by capturing photo and video recording (Beck *et al.*, 2001; Heck *et al.*, 2003; Hemminga and Duarte, 2000). The picture of the fishes was taken as many as possible by Self Contained Underwater Breathing Apparatus (SCUBA) divers to increase the accuracy and precision of fish identification. Video recording was used to record the fish activities in the artificial seagrass area. The morphological characteristics (e.g., colour, body shape, fins shape, snout type) and the behavior of the fishes in the artificial seagrass area were recorded on underwater water-proof paper as followed the method (Barber *et al.*, 1979) and the diversity of fishes was analyzed using Shanon diversity (Shannon and Weaver, 1949).
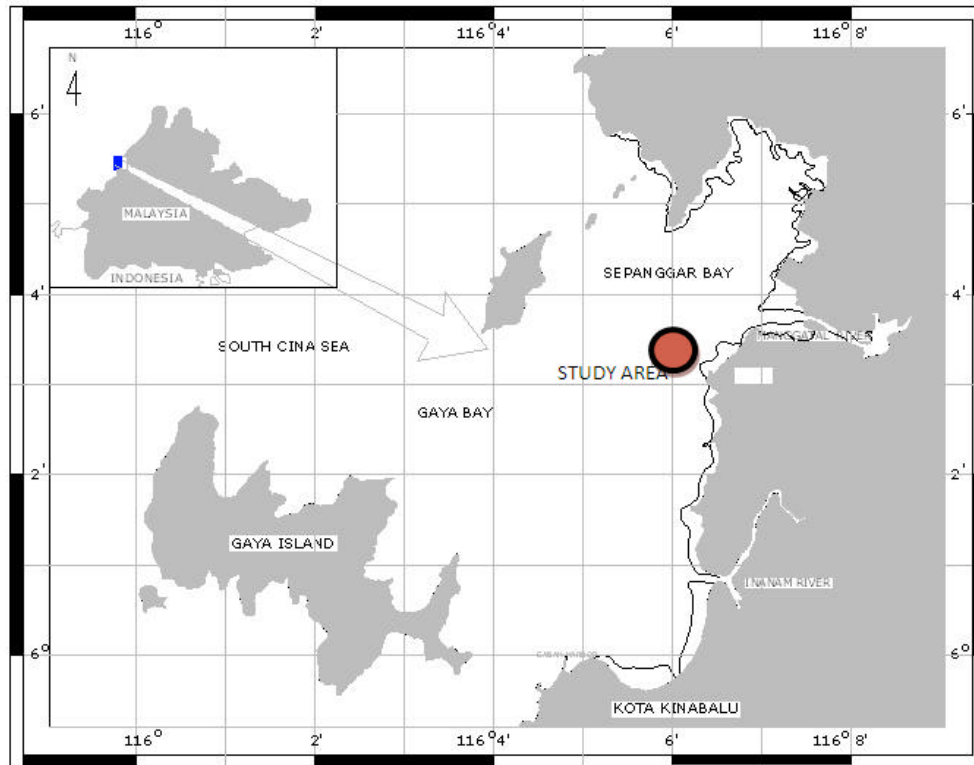
Fig. 1: Location of the study area

RESULTS

Fish distribution in the artificial seagrass area: Four hundred ninty individuals (25 genus) from 17 families were observed in 5 sampling periods throughout the study as shown in (Table 1). The identification of fishes in the artificial seagrass area was studied up to the genus level. The dominating family in the current study was Pomacentridae which occupied 25.55% of the whole area; whereas the second abundant family in the artificial seagrass area was Caesionidae which was 22.13%. Apogonidae fishes were the third dominant with representatives of *Apogon* sp. (9.64%) followed with Siganidae family (8.85%) and Centriscidae (8.25%). Three families were observed to be least dominant (Labridae, Lutjanidae and Nemeptiridae with 6.24, 5.63 and 5.63%, respectively) (Fig. 2). Perhaps this might indicate the artificial seagrass bed could play a significant role in attracting specific families of fishes such as Pomacentridae and Caesionidae for conservation purposes in the study area.

The dominant fish in the artificial seagrass area was *Caesio* sp. (family: Caesionidae) represented with 19.92% followed with *Chromis* sp. (Family: Pomacentridae) represented with 13.28% of the total percentage of fish observed in the study area. *Thallasoma* sp. (Family: Labridae), *Gymnothorax* sp. (Family: Muraenidae) and *Sphyraena* sp. (Family: Sphyraenidae) were less dominant fishes in the artificial seagrass area, each contributed with 0.2% of the total population. Shannon-Weiner index was applied to know the diversity index of fish in the artificial searass bed. The result showed that the study area quiet diverse with fish species. Out of 25 species the first 3 dominant species were *Casio* sp. (H' = 0.32) followed by *Chromis* sp. (H' = 0.28) and

Table 1: Percentage of individual fish abundance in artificial seagrass bed. (S1 - S5 = Sampling 1 to sampling 5)

| Family	Genus	No. of species observed					Total	Abundance (%)
		S1	S2	S3	S4	S5		
Apogonidae	*Apogon* sp.	9	25	-	5	8	47	9.46
Caesionidae	*Caesio* sp.	15	50	7	12	15	99	22.13
	Pterocaesio sp.	3	-	-	5	3	11	
Centriscidae	*Aeoliscus strigatus*	-	22	-	-	19	41	8.25
Gobiidae	*Gobiodon* sp.	-	-	-	1	1	2	0.40
Labridae	*Cheilinus* sp.	2	-	-	-	2	4	6.24
	Coris sp.	5	-	-	5	5	15	
	Halichoeres sp.	-	2	1	-	-	3	
	Labroides sp.	-	3	1	-	-	4	
	Lamroides demi	2	-	-	-	2	4	
	Thallasoma sp.	-	-	-	1	-	1	
Lethrinidae	*Lethrinus* sp.	-	-	-	-	5	5	1.01
Lutjanidae	*Lutjanus* sp.	-	6	-	9	13	28	5.63
Monacanthidae	*Monacanthus* sp.	1	-	1	1	1	4	0.80
Muraenidae	*Gymnothorax* sp.	-	-	-	-	1	1	0.20
Nemipteridae	*Scolopsis* sp.	7	5	3	6	7	28	5.63
Pomacentridae	*Chromis* sp.	-	40	-	13	13	66	25.55
	Pomacentrus sp.	8	15	2	21	15	61	
Scaridae	*Scarus* sp.	1	1	2	1	1	6	1.21
Scorpaenidae	*Pterois* sp.	1	-	-	-	1	2	0.40
Serranidae	*Epinephelus* sp.	5	2	-	2	4	13	2.62
Siganidae	*Siganus* sp.	11	2	-	13	18	44	8.85
Tetradontidae	*Arothron* sp.	-	-	1	1	-	2	1.41
	Canthigaster sp.	1	1	1	2	1	5	
Sphyraenidae	*Sphyraena* sp.	-	-	-	-	1	1	0.20
Total							497	
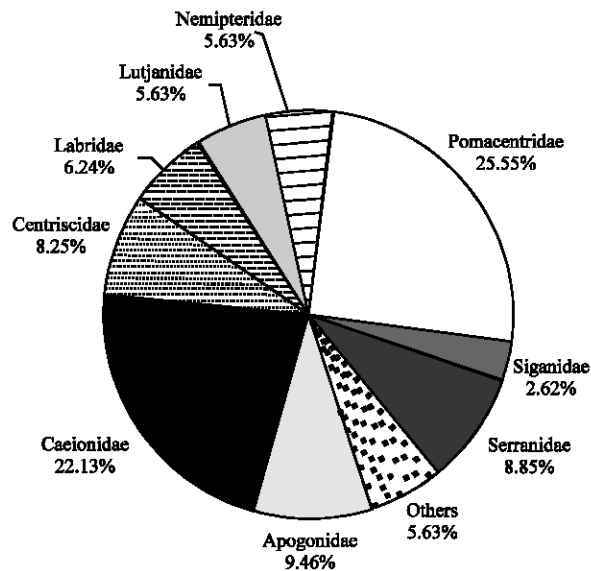
Fig. 2: Composition of the abundance of different fish families inhabited in artificial seagrass ecosystem

Table 2: Total number of species observed during the sampling period and individual species Shannon Weaver diversity Index (H') is represented

Genus	Total No. of species recorded	Shannon weaver diversity index (H')
Apogon sp.	47	0.2230
Caesio sp.	99	0.3213
Pterocaesio sp.	11	0.0842
Aeoliscus sp.	41	0.2058
Gobiodon sp.	2	0.0220
Cheilinus sp.	4	0.0386
Coris sp.	15	0.1057
Halichoeres sp.	3	0.0307
Labroides sp.	4	0.0386
Lamroides sp.	4	0.0386
Thallasoma sp.	1	0.0129
Lethrinus sp.	5	0.0468
Lutjanus sp.	28	0.1620
Monacanthus sp.	4	0.0386
Gymnothorax sp.	1	0.0129
Scolopsis sp.	28	0.1620
Chromis sp.	76	0.2871
Pomacentrus sp.	51	0.2336
Scarus sp.	6	0.0534
Pterois sp.	2	0.0221
Epinephelus sp.	13	0.0952
Siganus sp.	44	0.2146
Arothron sp.	2	0.0221
Canthigaster sp.	5	0.0468
Sphyraena sp.	1	0.0129
Total	497	2.5315

Pomacentrus sp. (H' = 0.23). The least dominant species were *Thallasoma* sp. *Gymnothorax* sp. and *Sphyraena* sp. with H' value of 0.01 (Table 2). The species diversity (H') in the sampling area was 2.5315 clearly indicates that artificial seagrass bed could provide unique shelter habitat for marine fish communities.

DISCUSSION

Habitat selection by organisms is influenced by several factors including food preference, habitat structure, chemical defense, predation and competition (Hacker and Steneck, 1990; Duffy and Hay, 1991). Among this, seagrass beds are among the most widespread and productive coastal ecosystem types worldwide and range from the tropics to boreal margins of every ocean (Hemminga and Duarte, 2000). Similar findings were observed in our study area which comprised highly diversified fishes. They provide physical structure on otherwise largely featureless sediment bottoms, enhancing community diversity, biomass, primary and secondary production. Seagrass community provide nursery areas for juvenile stages of commercially important species (Heck *et al.*, 2003) contributes significantly to the economic importance of estuarine fisheries (Anderson, 1989; Costanza *et al.*, 1997). As such, the observed high abundance of *Caesio* sp. in the artificial seagrass area might be due to their feeding habit. They feed primarily on benthic invertebrates and small fishes and grow up to 18 cm in size. Due to the abundance of aquatic invertebrates like bivalves

and gastropods in artificial seagrass bed might help in the feeding habit of *Caesio* sp. Meanwhile *Chromis* sp. which primarily feeds on zooplankton at offshore reefs can grow up to 8 cm (Fletcher and Fletcher, 1995). *Caesio* sp. and *Chromis* sp. those were found in the artificial seagrass area was fairly big in size (6 cm). This showed that artificial seagrass might be a suitable habitat even then the artificial seagrass area provides habitat, food and hiding place from predatory fishes (Borowitzka and Lethbridge, 1989). The genus of *Thallasoma* sp. (family: Labridae) *Gymnothorax* sp. (family: Muraenidae) and *Sphyraena* sp. (family Sphyraenidae) were least dominant fishes in the artificial seagrass area and each contributed only about 0.2 % to the total population. Similar finding was observed by Judy Upstona *et al.* (2003). He suggested that the least abundance of species belong to the families muraenidae and sphyraenidae in the artificial seagrass area proved that this habitat is not a conducive environment for their best survival. Even though some of the Muraenidae fishes can grow up to 1m and above as like Sphyraenidae fishes, however we could not generate any record proving their abundance in seagrass areas. These fishes generally prefer nearby coral reef ecosystem rather than seagrass beds. Hence we predict that artificial seagrass might not be as suitable as coral reef ecosystem for their better survival. It was also observed that they were found to be in the benthic realm shows their sluggish behavior around the artificial seagrass area.

The resulted Shannon-Weiner Diversity Index indicated that *Caesio* sp. (H' = 0.32) was the most dominant fish followed by *Chromis* sp. (H' = 0.29) and *Pomacentrus* sp. (H' = 0.23) in the artificial seagrass area. This might be due to floating seagrass blades expedite the growth of algae as food source for these fishes and helps in providing the suitable habitat for their survival. Overall Shannon diversity value of 2.5315 clearly demonstrated that artificial seagrass bed in Sepanggar Bay provide better habitat for various species of marine fishes.

The diverse faunal communities of seagrass beds throughout South East Asia are threatened by continued overexploitation of living marine resources such as fish (Kuriandewa *et al.*, 2003). Fish movements are utilized by local fishers across South East Asia who use Fyke nets (fish fences) set into tidal currents or between seagrass beds and reefs to catch fish. It is important for the future sustainable management of seagrass beds since it offers alternative natural habitat to sustain the marine fish communities (Parrish, 1989; Fortes, 1990).

CONCLUSION

The fish diversity in the artificial seagrass area was quite diverse based on the Shannon-Weiner Diversity Index. There were few species dominating the artificial seagrass area, which were *Caesio* sp., *Chromis* sp. and *Pomacentrus* sp. These fishes generally planktivorous feed primarily on phytoplankton and zooplankton, especially on the algae that grows on the artificial seagrass blades. Artificial seagrass blades can be applied to increase the abundance and the numbers of fish in a specific area. Because these structures might provide food for small fishes as algae can grow in these artificial grasses. Nevertheless the study has shown that the artificial seagrass can be used as a unique artificial habitat for marine fishes. Thus it can be utilized for the conservation of some important valued commercial fishes for the sustainable development of marine fishery resources.

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