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Comparison of Larval Fish Density Between Seagrass Beds and Outside Seagrass Beds of the Southwestern Johor, Peninsular Malaysia

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ABSTRACT

Temporal variation of fish larval density and composition between seagrass and outside seagrass beds of the southwestern Johor, Malaysia were investigated between October 2007 and September 2008. Fish larvae were sampled monthly by using a bongo net with 500 μm mesh size and 30 min sub-surface tow. *In situ* environmental variables were also recorded during the sampling works. The fish larval assemblage comprised of 20 families from the seagrass beds and 16 families recorded from the outside seagrass beds station. In total, 3738 larvae (2,801 from seagrass and 937 from non-seagrass area) were collected. Total larva density was at 79 individuals per 100 m^3 and 34 individuals per 100 m^3 for seagrass beds and outside seagrass station respectively. Larval abundance varied significantly within monsoon and inter-monsoon seasons, with peaks in February-March and May-July. Top five families were Blenniidae, Clupeidae, Gobiidae, Sillaginidae and Terapontidae and they occurred consistently throughout the year. Larvae belonging to family Clupeidae (47.94% in seagrass and 42.03% in outside seagrass) and Terapontidae (17% in seagrass and 24% in outside seagrass) were the most abundant family in the study areas. The highest density of total larval fishes was recorded at the seagrass ecosystem. The spatial variations in larval density were not significantly ($p>0.05$) different between the seagrass beds and open sea station.

Key words: Fish larvae, density, abundance, seagrass habitat

INTRODUCTION

Spatial and temporal patterns of diversity, distribution and species composition of larval fishes are useful to examine factors influencing the structure of the larval fish community (Galactos *et al.*, 2004). Establishment of larval identification is essential not only to fisheries management purposes, but also in monitoring of the aquatic environment through inventory of the fish fauna or ichthyoplankton fauna in the target waters. As fishes are exposed to potentially high

mortality during egg and larval stages, study on larval diversity and survival rate of commercially important fishes is one of the main researches in fisheries science (Kawaguchi, 2002).

Various fish species especially their larval and juvenile stage inhabit in the seagrass beds for their survival and feeding. Merambong Shoal seagrass beds are among the most dense seagrass ecosystem in Peninsular Malaysia. Adult fish study was conducted in the Merambong seagrass beds by Jimmy (2007) but no specific study on the larval ecology has been conducted so far. The objectives of the present study were undertaken to compare the fish larval density and composition between seagrass beds and open sea of the southeastern coastal waters of Johor, Peninsular Malaysia.

MATERIALS AND METHODS

Study area and sampling: Fish larvae were sampled from the seagrass beds (N 01° 19.414'; E 103° 35.628') and outside seagrass beds (N 01° 18.799'; E 103° 35.246') of the southwestern part of Johor (Fig. 1). The outside station was fixed approximately 1 km apart from the margin of the seagrass beds. Monthly sampling was conducted between October, 2007 and September, 2008. Specimens of fish larvae were collected by using a bongo net (0.3 m mouth diameter, 1.3 m long, 500 μm mesh at the body and cod end) that was towed for 30 min. A flow meter (Hydro-Bios) was attached to the net in order to determine the volume of the water been filtered. At each sampling station, *in situ* temperature (°C), dissolved oxygen (mg L^{-1}), salinity (ppt), pH and conductivity (μS/cm) were recorded using YSI meter (556 MPS, USA).

Sample processing: After each tow, samples were immediately fixed in 5% formalin and transported to the laboratory. The fish larvae were sorted from the rest of the zooplankton and they are preserved in 75% alcohol. Individuals of fish larvae were identified to the family level

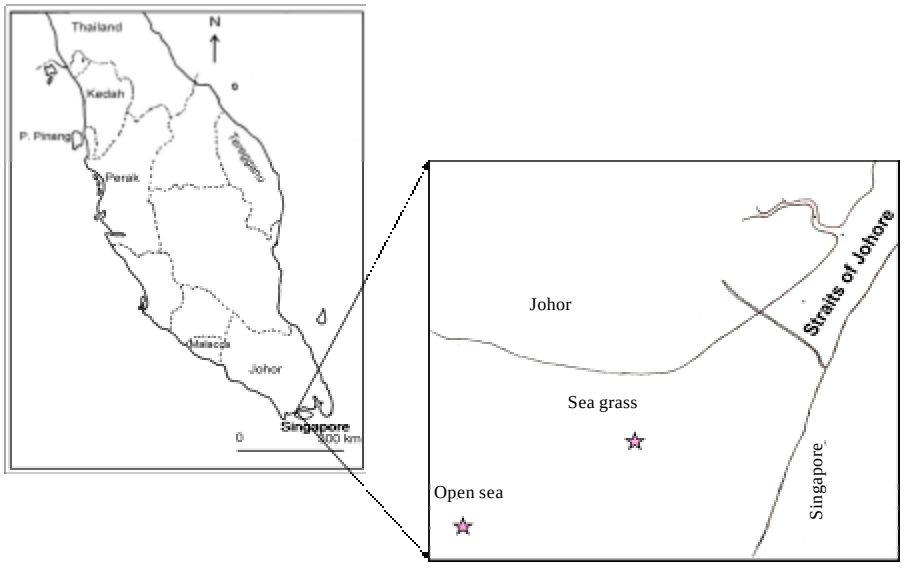

Fig. 1: Geographical location of the sampling stations (*) in the seagrass beds and outside seagrass beds of the southwestern coast of Johor, Peninsular Malaysia

using the appropriate literature (Leis and Ewart, 2000). Numbers of individuals per family were counted from the whole sample and then standardized to number of fish larvae per 100 m^3.

Data analysis: Between-station variations in temperature, salinity, DO, pH, conductivity and fish larval density were analyzed by independent samples t-test. All analyses were done using SPSS version 11.5.

RESULTS

Habitat characteristics: The physic-chemical parameters of the seagrass and open sea waters are summarized in Table 1. Annual mean temperature was recorded as 29.10 °C in the seagrass station and 28.62 °C in open sea station. The values fluctuated between 24.23 and 30.83 °C. Dissolved oxygen content ranged between 4.73 and 7.36 mgL^{-1} in the study area. The higher dissolved oxygen value was observed in the outside seagrass station than the seagrass habitat (Table 1). Salinity fluctuation was very low, recorded between 27.38 and 34.33 ppt. The pH and conductivity concentrations in outside seagrass habitat were higher than those in the seagrass beds habitat. However, none of the water parameters showed significant differences ($p>0.05$) between the two sites.

Fish larval composition: In total, 3738 larvae were collected for analysis from the study areas. Total density of the larvae was calculated as 79 and 34 per 100 m^3 from seagrass beds and outside seagrass waters, respectively. The larval fish assemblage of the study area consisted of 20 families, where all the 20 families were recorded in seagrass beds while 16 families were listed for the outside seagrass station (Table 2). Clupeidae was the most abundant family and it contributed 46.20% of total larva abundance. This was followed by other larval families, Teraponidae (18.86%), Gobiidae (8.69%), Sillaginidae (5.35%), Blenniidae (4.60%), Nemipteridae (3.75%), Mullidae (2.30%), Engraulidae (2.25%) and Ambassidae (1.72%). The majority of unidentified individuals (4.49% of the total catch) were 'yolk-sac larvae' (Table 2). The top five families, Blenniidae, Clupeidae, Gobiidae, Sillaginidae and Terapontidae occurred consistently throughout the year in the study areas (Fig. 2).

Temporal variation of total catches: Highest total density (293.08 individuals per 100 m^3) of larvae was recorded in February at the seagrass beds station and the lowest density of 0.35 individuals per 100 m^3 was observed in the month of April at the outside seagrass station (Fig. 3). The density of total fish larvae varied significantly ($p<0.05$) among the different sampling months. Total fish larval densities showed significant variation within monsoon and inter-monsoon seasons with peaks in the months of February-March and May-July (Fig. 3).

Table 1: Annual Mean±standard error, ranges (in bracket) of each physic-chemical water parameter in the seagrass and outside seagrass stations of the southwestern coast of Johor, Peninsular Malaysia

Parameters	Seagrass	Open sea	p
Temperature (°C)	29.10±0.34 (26.92-30.83)	28.62±0.49 (24.23-30.70)	>0.05
Dissolved oxygen (mg L^{-1})	05.79±0.20 (4.73-7.36)	06.21±0.17 (5.34-7.27)	>0.05
Salinity (ppt)	30.64±0.49 (27.38-33.68)	30.83±0.77 (28.11-34.33)	>0.05
pH	07.88±0.03 (7.61-8.06)	08.03±0.04 (7.61-8.19)	>0.05
Conductivity (µS cm^{-1})	82252.61±34727.26 (42823.50 - 464167.50)	882252.61±34727.26 (42823.50-464167.50)	>0.05

Table 2: Numerical composition of catches of larval fishes in the seagrass beds and outside seagrass beds of the southwestern coast of Johor, Peninsular Malaysia

		Number of total catches				Body length (mm)	
	Family	Seagrass	Outside	Total	%	Mean±SE	Range
1.	Ambassidae	42	22	64	1.72	2.49±0.07	1.75-3.95
2.	Blenniidae	141	31	172	4.60	2.71±0.09	2.03-4.96
3.	Carangidae	2	2	4	0.11	2.43±0.02	2.42-2.45
4.	Clupeidae	1343	384	1727	46.20	5.11±0.14	2.00-12.14
5.	Cynoglossidae	1	1	2	0.05	2.60±0.26	1.85-3.36
6.	Engraulidae	59	25	84	2.25	6.55±0.29	3.85-8.94
7.	Gobiidae	265	60	325	8.69	2.63± 0.09	1.68-3.90
8.	Hemiramphidae	1	-	1	0.03	-	-
9.	Leiognathidae	20	2	22	0.59	1.94 ±0.02	1.69-2.25
10.	Monacanthidae	6	-	6	0.16	2.19±0.17	1.64-2.71
11.	Monodactylidae	2	1	3	0.08	5.20±0.05	5.16-5.25
12.	Mullidae	28	58	86	2.30	2.96±0.10	2.18-3.72
13.	Nemipteridae	113	27	140	3.75	2.89±0.13	1.20-9.78
14.	Rachycentridae	4	-	4	0.11	2.35±0.14	2.07-2.55
15.	Samaridae	2	-	2	0.05	2.19±0.25	1.75-2.62
16.	Scatophagidae	3	5	8	0.21	13.21±0.62	11.31-15.52
17.	Sillaginidae	150	50	200	5.35	4.43±0.49	2.06-10.30
18.	Sphyraenidae	-	1	1	0.03	-	-
19.	Terapontidae	487	218	705	18.86	3.05±0.12	0.88-7.04
20.	Toxotidae	1	-	1	0.03	-	-
21.	Triacanthidae	10	3	13	0.35	3.71±0.36	2.17-15.52
22.	Unidentified	121	47	168	4.49	-	-
Total number		2801	937	3,738		3.74±0.19	2.68±6.00
Total family		20	16				
Total density /100 m^3		79.08	33.67				

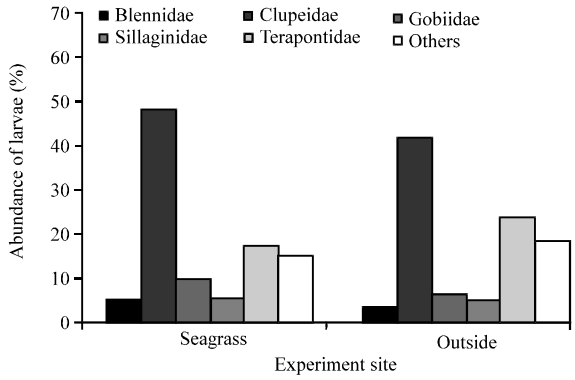

Fig.2: Spatial abundance of top five families in the seagrass beds and outside seagrass beds of the southwestern coast of Johor, Peninsular Malaysia

Larval fish diversity: Larval fish diversity indices of seagrass beds and outside seagrass waters are shown in Table 3. None of the ecological indices like as family diversity, evenness and richness showed significant variation ($p>0.05$) between the seagrass and outside seagrass waters. The family

Table 3: The fish larval diversities in the seagrass beds and outside seagrass habitats of the southwestern coast of Johor, Peninsular Malaysia; values are Mean±SE derived from 12 sampling cruises

Habitats	S	N	H'	J'	D'
Seagrass beds	20	2801	1.53±0.27	0.69±0.10	1.75±0.35
Outside seagrass	16	937	1.32±0.42	0.75±0.19	1.50±0.50

Notes: S: Number of families, N: Number of individuals, H': Shannon diversity index, J': Pielou's evenness index, D': Family richness

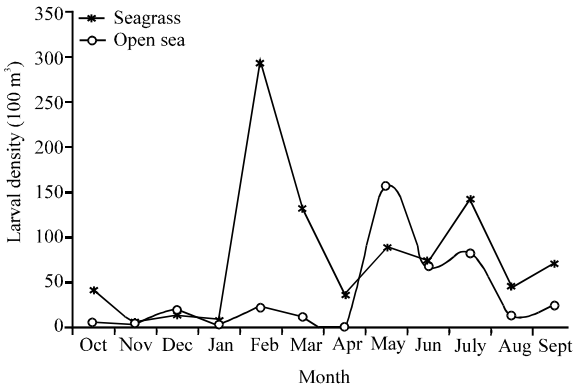

Fig. 3: Temporal variation of total fish larval density in the seagrass beds and outside seagrass beds of the southwestern coast of Johor, Peninsular Malaysia

diversity for seagrass beds was 1.53 and it was 1.32 for outside seagrass waters. The evenness indices were 0.69 and 0.75 for seagrass and outside seagrass waters, respectively. The family richness was higher in the seagrass beds but not significant.

DISCUSSION

Fish larvae belonging to family Clupeidae (48% in seagrass and 42% in outside seagrass) and Terapontidae (17% in seagrass and 24% in outside seagrass) were the most abundant in the study areas. Several studies show that Gobiidae are distributed widely in the coastal areas regardless of climate and factors such as seagrass composition, temperature and biological variables (Kwak and Klumpp, 2003). Schooling species showed clump, highly variable recruitment that presumably resulted from aggregative settlement and this can be related to the high occurrence of family Gobiidae (Anand and Pillai, 2005). Larval fish assemblage in the seagrass of Sungai Pulai estuary, has a common features with those found in many other seagrass fish population (Chavanich *et al*., 2004; Anand and Pillai, 2005; Mateo *et al*., 2006).

Total fish larval density in the seagrass beds was found to be 43% higher than that of the outside seagrass waters. The highest number of total larval fishes (293 larvae/100 m^3) was recorded from seagrass area in February and the lowest (0.35 larvae/100 m^3) was found at outside seagrass in November. Significant variation observed within monsoon and inter-monsoon seasons peaking in the months of February (293 larvae/100 m^3), March (132 larvae/100 m^3) and July (142 larvae/100 m^3). Seasonal patterns of abundance of fish larvae also linked to reproductive strategies of adult populations and their life cycles, which in turn are often associated with oceanographic and meteorological features (Hernandez-Miranda *et al*., 2002). Biotic factors are related to food availability and zooplankton abundance is sometimes related to larval fish abundance, namely the seasonality of abundance of larval fish can be strongly correlated with

densities of copepod nauplii (Mateo *et al*., 2006). Prey availability may also be an important factor influencing faunal abundance in tropical seagrass beds. High seagrass standing crop provides good shelter and food resources for small organisms such as epiphytic epifauna like amphipods, isopods and tanaids (Kwak and Klumpp, 2003).

Generally Shannon diversity index, evenness and family richness was considerable higher ($p = 0.06$) in the seagrass water than that of outside seagrass habitat but not significant. Comparing the two habitats, the number of family in the seagrass beds was found to be 20% higher than that of the outside seagrass habitat. Several environmental factors such as physicochemistry of the water quality, topographical, hydrological characteristics and habitat destruction could play important roles in species richness, diversity and survival in aquatic habitats (Johnson, 1967; Zakaria *et al*., 1999). From our study it has been proven that the physicochemical parameters were not significantly different between the seagrass and outside seagrass habitats. Therefore, the non-significant differences in terms of diversity indices between the two habitats may be related to the physicochemical properties of the seagrass and non-seagrass waters.

CONCLUSIONS

Fish larvae that are known to exist in the seagrass beds and nearby in the open waters of the southwestern part of Johor were listed for the establishment of the diversity record of ichthyological fauna of Johor Straits. The mean environmental parameters recorded during the sampling were not significantly different ($p>0.05$) between seagrass beds and outside seagrass site. In total, 20 different families of fish larvae were found in the study area. Among the 20 families, five families occurred consistently throughout the year. The highest number of larvae of 293 individuals/100 m^3 was recorded in the month February at the seagrass station.

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