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The effect of monsoon on fish larva assemblage changes in Gowatr Bay, North Oman Sea

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Abstract

The study and research of abundance and diversity variation of fish larva (Ichthyoplankton stages) was done in Gowatr Bay during autumn 2006 - summer 2007. Five stations were selected for sampling, and Bongo-Net with 300µ mesh size was towing from bottom to surface. During of survey, totally 531 larvae belong to 11 families were collected and identified. The mean abundance estimated 12.17 larvae per 10 m^2, which three fish larva family including: Gobiidae, Clupeidae and Engraulidae were dominant (86% of relative abundance). The result showed that there was significant differences between pre and post-monsoon fish larvae abundances ($p<.05$), and there were not significant differences between stations ($p>.05$). In pre-monsoon 4 families were identified of which Clupeidae introduced as indicator group, whereas in post-monsoon 10 families were identified and Gobiidae was indicator family, accompany with increase of diversity. PCA result was shown, temperature as the main factor affected on fish larvae assemblage was found with a significant decrease of 11.9 °C after monsoon phenomenon.

Keywords: Fish larva, Indicator family, PCA, Monsoon, Gowatr Bay, Oman Sea

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Introduction

The composition and structure of larval communities and their relation to the environment is so necessary to know about the profitable use of fishery resources (Veerappan and Balasubramanian, 2009).The abundance and the distribution of fish larva have direct relevance to the fishery potential of an area and have been studied extensively worldwide (Kidwai and Amjad, 2001). Climate and oceanography are linked to fish abundance and distribution (Laevastu and Hela, 1970). In addition, the physical environment, as well as food availability has been proposed as another major factor to determine the survival of early-stage larval fish and the success of population recruitment (Brain *et al.*, 1996).

Gowatr Bay which located in the north-east of Oman Sea is connected to the Indian Ocean via the Arabian Sea. Therefore, the effect of Indian monsoonal winds on this area is remarkable. The year is divided into periods of northeast (NE) monsoon, southwest (SW) monsoon, and its following inter-monsoon periods (post-south west monsoon (post-monsoon), and pre southwest monsoon (pre-monsoon) (Wyrtki, 1973; Wilson, 2000). In our area the southwest monsoon (in July-September) is stronger and more effective than North-east Monsoon. In Iranian waters o f the Oman Sea has been reported phytoplankton bloom after the SW monsoon (Iranian Fisheries Research Organization, 2009).

Larval survey in the Oman Sea was limited and we could refer to Thangaraja surveys on egg and fish larvae in the area (Thangaraja, 1989). The aims of present study were to introduce the hydrological conditions and factors that affected on distribution on fish larva with considering monsoon and creek – estuary habitats of Gowatr Bay.

Materials and methods

The study area is restricted to Gowatr Bay (Sistan- Baluchestan province, North-east of Oman Sea) with geographical position: 25° 01´ to 25° 12´ N, and 61° 24´ to 61° 27´ E (Fig.1) as the last fishing site in Iranian waters of the Oman Sea closed to the Pakistan border.

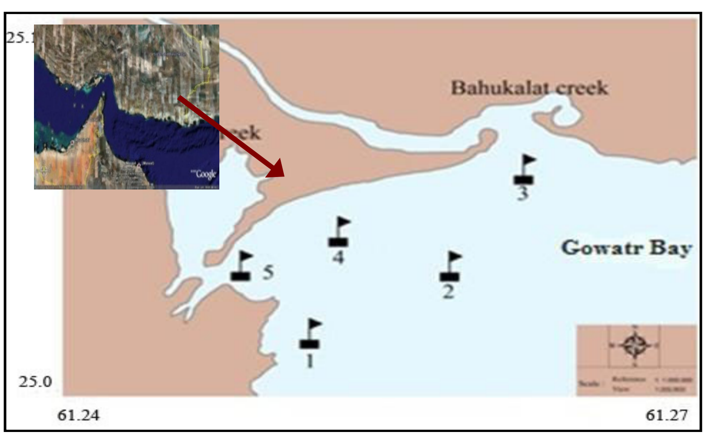

Figure 1: Location of Gowatr Bay and sampling stations

The seasonally sampling was done during autumn 2006 - summer 2007 in 5 selected stations (Fig.1). Sampling was conducted using a Bongo-Net with 300µ mesh size (Smith and Richardson, 1977). The duration of towing for each station takes 10 min with a speed boat approximately one knot. Samples were fixed in 5% formalin in seawater immediately after towing and were preserved in 10% ethanol in laboratory. The identification of Fish larvae was based on Leis and Rennis (1983), Leis (1983, 1989), Leis and Transky (1989). Main factors such as: depth, transparency, temperature and salinity also were measured with the CTD.

A cumulative graph was plotted based on the standardized salinity and temperature data for illustrating the hydrological pattern of study area. Seasonally variation of temperature and salinity and changes of depth and transparency in stations were plotted.

Fish Larvae abundance were standardized to the number of larvae per 10 m^2 (Smith and Richardson, 1977) and transformed by the formula, log(x+l), where x is the family abundance (number of larvae per 10 m^2 surface area). A data matrix was formed by these values for conducting the statistical analysis. ANOVA was performed for the comparison of the fish larvae abundance in all stations and t-test between the monsoon periods.

To find the indicator family in each hydrological condition (pre-monsoon and post-monsoon), an Indicator Value (InVal) was estimated (Anneville et al., 2002) and Shannon–Wiener diversity index (*H′*) and richness index (*R*) were used to calculate the species diversity and richness, respectively (Ludwig and Reynolds, 1988).

To evaluate the relationships between fish larva (Dependent continuous variables) and temperature, salinity, pH, depth and transparency (Independent variables); Principal Component Analysis (PCA) with supplementary variables was applied. For multivariate data analysis, FactoMine R (version,2.11.1) (Husson et al., 2008) was used, and comparisons between groups were done using MASS package in "R" statistical package (Adler, 2010).

Results

The mean sea surface temperature (SST) was 27.7±3.6 °C and the least temperature was measured in autumn just after the monsoon. The mean sea surface salinity (SSS) was 37.5±1.8 ppt with minimum as same as temperature in autumn (Figs. 2, 3). Transparency was changed between 43-77 cm and depth was changed from 2-6 m. Due to variation of two main factors temperature and salinity, the hydrological condition divided to two time period of pre- monsoon (spring and early summer) and post- monsoon (autumn and winter).

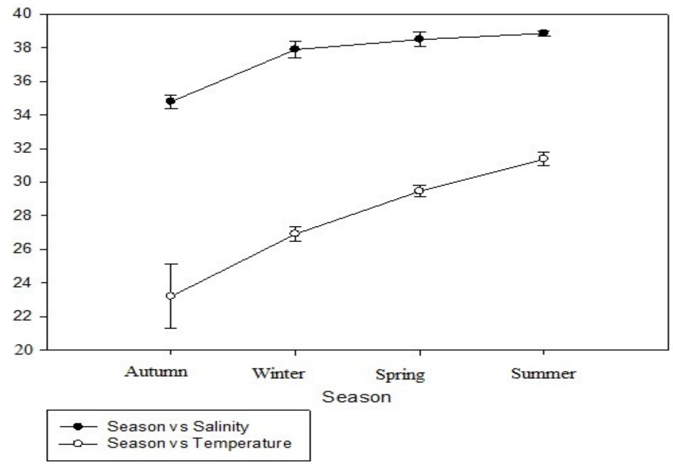

Figure 2: Seasonaly average and standard deviation (vertical bars) for temperature and salinity at the study area, Gowatr Bay

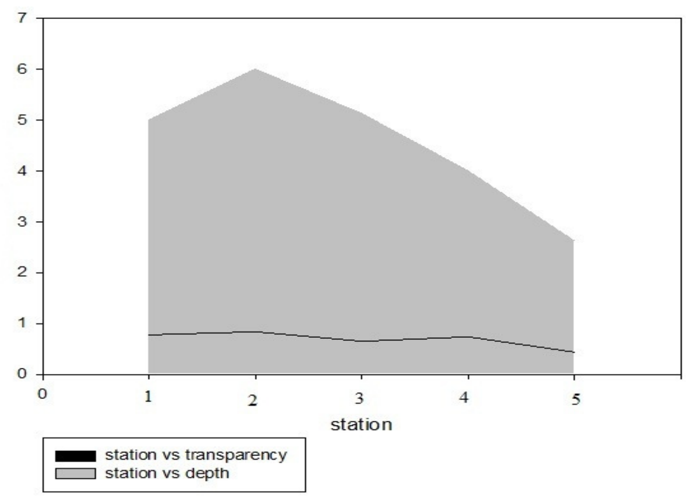

Figure 3: Seasonaly average of depth and transparency(m) in stations, Gowatr Bay

Totally, 531 fish larvae specimens were collected in which belong to 11 families. The mean abundance estimated 12.17 larvae per $10m^2$. Gobiidae, Clupeidae and Engraulidae were dominant families (86% of relative abundance) (Table1). The composition and variation of fish larva in base of stations and seasons were shown in Figures 4 and 5 and the measured factors were shown in Table2.

Table 1: Specimens Number (SN), Mean Abundance(MA) (Ind per 10 m^2), Standard Deviation (SD), Relative Abundance (RA, %) of fish larval, Gowatr Bay

Family	SN	MA	SD	RA
Gobiidae	288	7.312	4.27	60.1
Carangidae	1	0.025	0.05	0.2
Sparidae	19	0.193	0.17	1.6
Clupeidae	141	2.610	2.92	21.4
Sillaginidae	9	0.193	0.24	1.6
Hemiramphidae	7	0.047	0.09	0.4
Engraulidae	19	0.848	1.42	7.0
Blenniidae	27	0.461	0.19	3.8
Nemipteridae	6	0.145	0.10	1.2
Monacantidae	1	0.063	0.08	0.5
Callionymidae	1	0.018	0.04	0.1
Unkown	12	0.259	0.17	2.1

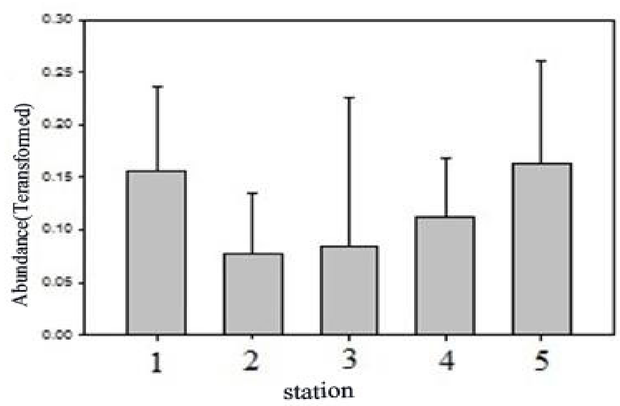

Figure 4: Mean Abundance ± SD for fish larvae (per 10 $m^{2)}$ in sampling stations, Gowatr Bay [Abundance transformed by the formula, log(x+l)]

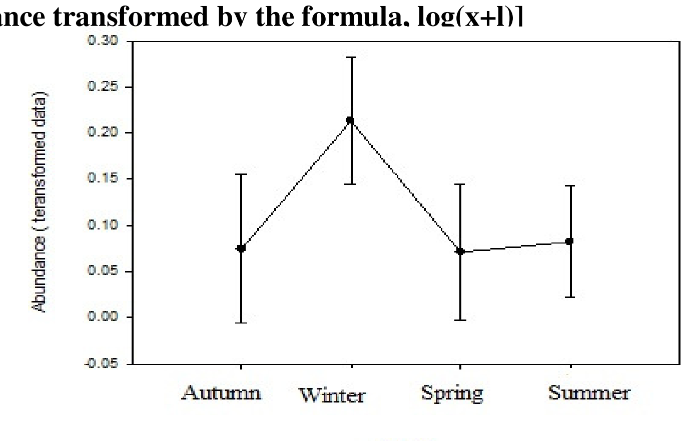

Figure 5: Mean Abundance ± SD for fish larvae (per 10 m²) seasonaly at the study area Gowatr Bay [Abundance transformed by the formula, log(x+l)]

Table 2: Specimens Number (SN), Family Number (FN), Mean Abundance (MA) (Ind per 10 m^2), Shannon-Index (H′) and Richness (R) of fish larva , Transparency (T), Depth (D) and Salinity (S) at pre-monsoon and post-monsoon, Gowatr Bay

Period	SN	FN	MA	H′	R	T	D	S
Pre-monsoon	201	4	7.133	0.739	0.732	0.95	3.5	36.35
Post-monsoon	330	10	15.765	1.086	1.185	0.437	5.8	34.83

There was significant differences between pre and post- monsoon fish larva abundances based on T-Test (p-value = 0.011,*p<.05*), but there were not significant differences in fish larva abundances between stations(1.000 = P, *p>.05*) based on Tukey HSD.

In pre-monsoon: only four families were identified; Clupeidae, Gobiidae, Sparidae and Blenniidae (Fig.6), and Clupeidae was introduces as indicator family. The result of PCA was shown that dimdesc axes 1 and 2 covered % 77.6 of abundance variation. Among estimated factors; temperature (0.486) and depth (-0.348) was related to the abundance than others factor.

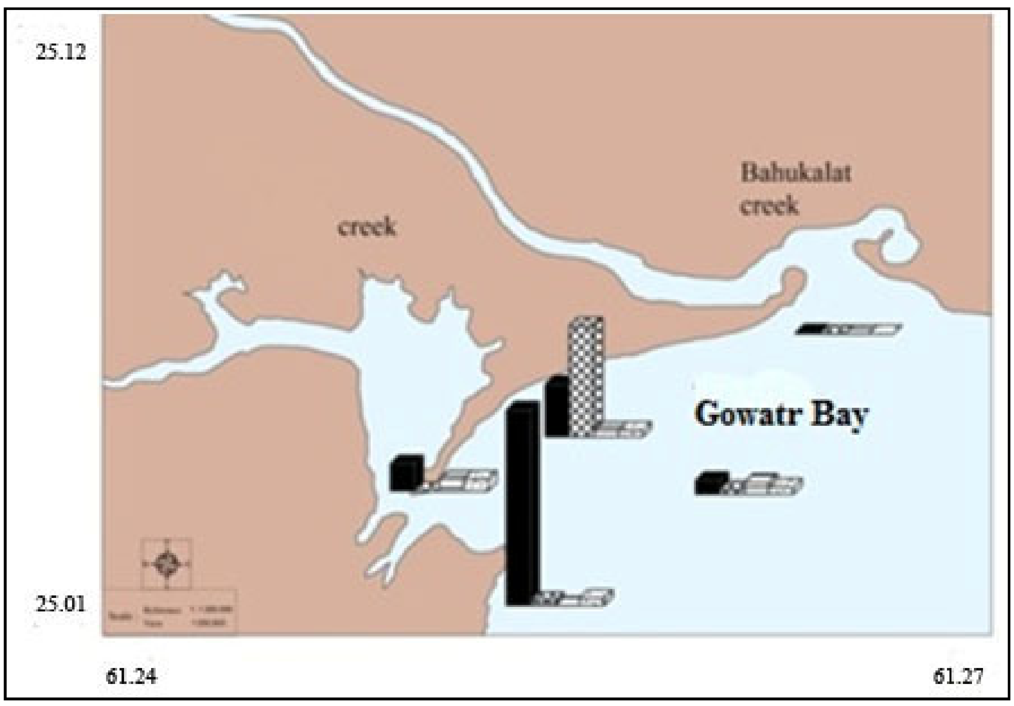

Figure 6: The composition of fish larva in pre-monsoon in study area, Gowatr Bay

In post monsoon: 10 fish larva families were identified including of: Carangidae, Gobiidae, Clupeidae, Sillaginidae, Hemiramphidae, Blenniidae, Engraulidae, Nemipteridae and Monacanthidae (Fig.7). Gobiidae was dominant family in this period and the two first dimdesc axces were covered %58.07of variation. In this period temperature (-0.407) and salinity (0.363) were identified affected factors on fish larvae abundance.

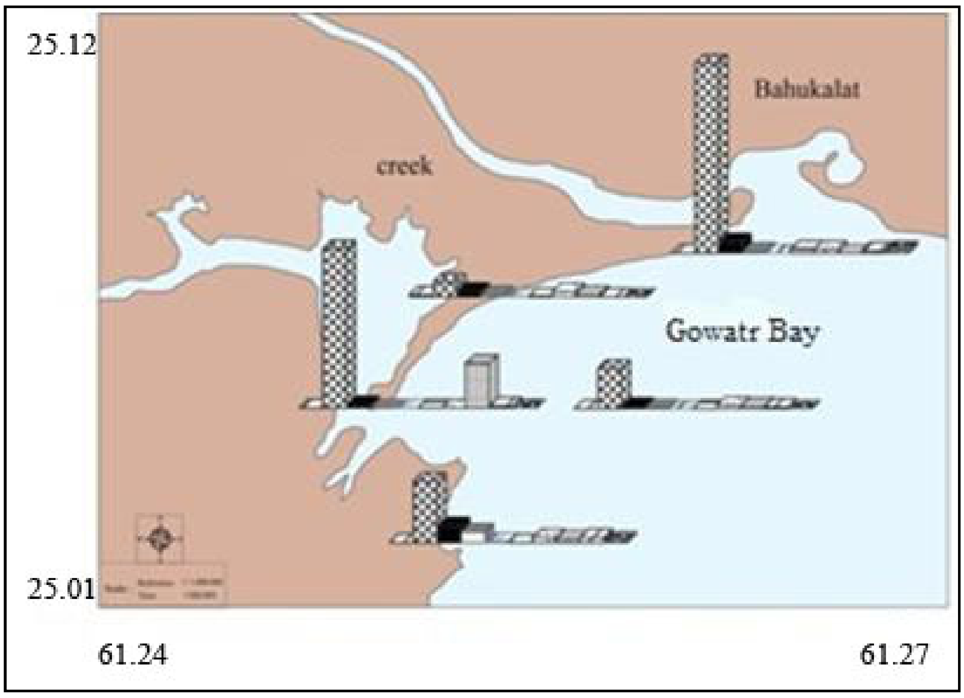

Figure7: The composition of fish larva in post-monsoon in Gowatr Bay

Discussion

As the results showed monsoons phenomenon play a major role in the existence and variation abundance of fish larvae in the study area. The diversity and richness of fish larva in autumn and early winter (post-monsoon) is more than spring and early summer (pre- monsoon) (Table 2). This result was consistent with other studies. Fazeli and Zare (2011) were found the increase of copepod in post-monsoon than per- monsoon in this area.

The surveys of fish larva in monsoon area in the world show the same result. The species diversity of larval fish showed significant spatial and temporal changes during the rise and fall of the northeasterly monsoon in Taiwan (Lo et al., 2010). Monsoon-driven coastal currents may influence the seasonal dispersal patterns of larval fish assemblages in the estuary and coastal waters of west coast of Taiwan, and the larval fish communities generally were more diverse in spring–autumn than in winter (Tzeng et al., 2002). On the study of fish eggs and larvae abundance in Sultanate of Oman waters, the peak abundance of both eggs and larva was found in summer. This result is quite similar to the findings of Thangaraja (1989) in Omani waters. This findings indicated that the peak spawning of fish in Omani waters was in summer (Thangaraja and Al-Aisry, 1998).

Composition and abundance of zooplankton (including copepods and fish larvae) in Taiwan Strait are closely related to oceanic variables, which, in turn, are heavily influenced by monsoons (Hsieh *et al.,* 2005). Several factors impact on fish larva distribution that included biological and abiotic factors. In present study we found the temperature as the main factor affect on fish larva. In pre- monsoon its range was 30.0-39.9 °C that it decreased to 28-31 °C after monsoon. With focus on Fig. 5, we noticed fish larva abundance increased and reached to maximum in winter also salinity variation was same and decreased after the monsoon from 38.7 g/lit to 36.35 g/lit averages. With the onset of the monsoon winds and torrential rains, the condition of coastal area was changed and temperature and salinity reduced. Owens et al. (1993) found temperatures off the coast of Oman during a southwest monsoon tend to be low (, also turbulence of monsoon cause to increase available nutrients for food web as was observed high fish larva abundance in winter. Panikkar and Aiyar (1939) observed that the breeding of marine fishes increased in December-January immediately succeeding the outbreak of the north-east monsoon. The fish larva was identified such as: Gobiidae, Sillaginidae and Clupeidae belong or related to inshore waters. This result matched to the other fish larva investigated in Iranian waters of the Persian Gulf and Oman Sea, (Rabbaniha,1998,2002; Owfi and Bakhtiary,1999; Dehghan et al., 2000; Owfi and Mohammadnejad, 2000; Jokar and Saraji, 2002), but the peak of abundance were different in each area.In other study the high abundance was in spring or early summer while in Gowatr area was in winter just follow the changes in the environment caused by monsoon. The peak of phytoplankton, zooplankton and benthos biomass were after monsoon in Gowatr Bay (Zarei, 1995).

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