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Abundance and diversity of fish larval assemblages in Iranian waters of the Oman Sea

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Abstract: A survey on the abundance and diversity of fish larvae along the Iranian waters of the Oman Sea, extending from Hormuz Strait to Gowatr Bay, was carried out in 2009 (before and post monsoon). Fish larva were collected by a Bongo net (300 µ mesh size) and temperature, salinity, dissolved oxygen, pH, chlorophyll-a, clarity, nitrate, nitrite, silicate and sulfate by oceanic data recorder (CTD) and Rosette oceanography instrument were measured. In total, 26 fish families were identified and their abundance calculated as 768 individuals per m^2. In pre-monsoon, 9 families were identified with Pomacentridae as dominant taxon. But in post-monsoon, 23 families were identified in which Myctophidae was dominant. The Shannon index was calculated as 0.583 ± 0.31 in pre-monsoon and 0.865 ± 0.73 in post-monsoon. The result of Principle Component Analysis (PCA) revealed a higher diversity among ichthyoplankton in post-monsoon compared to that of pre-monsoon. The abundance of fish larva was correlated with chlorophyll-a in post-monsoon, whereas samples from pre-monsoon were more positively correlated with in nutrients.

Keywords: Monsoon, Principle Component Analyses.

Introduction

Many fish species spend their early life stages in pelagic coastal waters as ichthyoplankton, and their dispersal, abundance, growth and development are effected by various abiotic and biotic factors along with physiological condition of fish larva (Hernández-Miranda et al. 2003; Abu El-Regal1 et al. 2008). Little information is available about the ichthyoplankton fauna of the northern Oman Sea (Thangaraja et al. 1987, 1989, 1991; Thangaraja & Al-Aisry 2001; Rabbaniha et al. 2005). Hence, this study aimed to investigate the diversity and abundance of fish larva in the northern Oman Sea before, during and after monsoon season to evaluate the affecting factors on these two parameters.

Materials and methods

Study area: The study area was ranged from Hormuz Strait (Hormozgan Province, Iran) to Gowater Bay (Sistan & Baluchestan Province, Iran) (24°40´ to 27°00'N and 56°30´ to 61°00'E (Fig. 1). Sampling were carried out at 10 transects each with two stations, one in coastal and other one in offshore waters. Sampling was performed in early summer (pre-monsoon), and mid-autumn (post-monsoon), using a 300 µ mesh size Bongo net (Smith & Richardson 1977), towed by a boat running at 1 1.852 km per hour for 10 minutes. Samples were fixed in 5% formalin in seawater immediately and transferred into 70% ethanol in laboratory. Abiotic factors including depth, transparency, temperature and salinity were measured by CTD, and sea water samples were collected by Rosette Sampler bottles for measuring nutrients. Fish larvae identification was based on Leis & Rennis (1983), Leis & Transky (1989), Olivar et al. (1999) and Richards (2006).

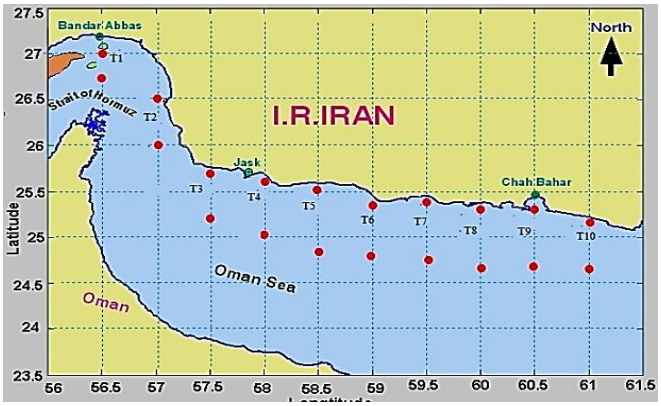

Fig.1. Map of sampling stations on opted transacts in Oman Sea (Ebrahimi et al. 2006).

Data Analysis: Fish Larval abundance was standardized to the number of larvae per 10 m^2 (Smith & 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 larval abundance between transects and t-test between the monsoon periods ($p<0.05$). Shannon–Wiener diversity index (H′) (Ludwig & Reynolds 1988) was used for calculation of species diversity. To evaluate the relationships between fish larva (dependent continuous variables) and different physico-chemical factors (independent variables), Principal Component Analysis (PCA) with supplementary variables was applied in FactoMine"R" package (Styleshout 2008). For applying PCA, fish families with relative larval abundance more than 1% were selected.

Results

Hydrological conditions: Table 1 represents the average, maximum and minimum values of the measured hydrological factors during pre-monson and post-monson sampling periods, showing that some factors have changed considerably during post monsoon.

Fish larva: In total, ichthyoplankton species belonging to 26 families were identified, with an overall average abundance of 768 individuals per m^2.

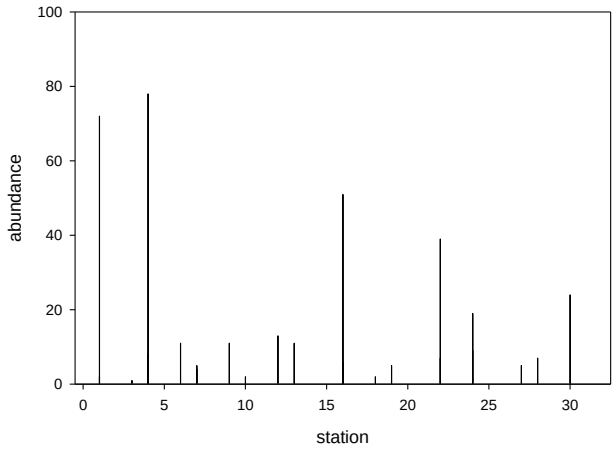

Fig.2. The fish larval abundance in sampling stations in the Oman Sea.

Fig. 2 shows the overall abundance of fish larva in all sampling stations. Myctophidae, Engraulidae and Pomacentridae were the dominant families comprising 56.7% of the total abundance (Table 2). Families Clupeidae, Gerreiodae, Nomeidae, Pomacentridae and Scombridae were present in both sampling periods. The larvae were more abundance in two sampling stations near the Hormuz Strait compared to other stations. The results of T-test ($p<0.05$), showed no significant differences between pre and post monsoon fish larval abundances. ANOVA also revealed no significant differences between stations in the abundance of fish larvae ($p<0.05$).

Pre-monsoon period: In this period, an average of 145 individuals of fish larvae per cubic meter belonging to nine families, including Bothidae, Clupeidae, Gerreidae, Hemirhamphidae, Lutjanidae, Nomeidae, Pomacentridae, Scombridae, and Terapontidae were identified (Table 2). Among these, Pomacentridae, Hemirhamphidae and Clupeidae were dominant. The Shanoon index was estimated as 0.583 ± 0.31. The result of PCA showed that dimdesc axes 1 and 2 covered 63.68% of the abundance variation (Fig. 3). There was not any correlation between the response and independent variables in this period. The coordination of fish

Table 1. The average, minimum and maximum of measured hydrological factors in the study area, Oman Sea.

Period	Factor	Temperature (c°)	Salinity (ppt)	O_2 (ppm)	pH	Chlorophyll (mg/m^3)	Clarity (m)	No_2 (µg/l)	No_3 (µg/l)	Si (µg/l)	Po_4 (µg/l)
pre-onsoon	Average	25.7	36.7	5.0	8.3	0.73	1.76	11.2	80.8	87.69	13.4
	Min.	23.9	36.5	4.2	8.1	0.27	0.54	8.1	20.8	70.55	4.5
	Max.	26.4	36.8	5.8	8.5	1.8	3.81	15.9	118.46	157.68	21.95
post-onsoon	Average	25.3	36.8	4.5	7.9	1.15	1.98	8.0	105.3	68.29	30.3
	Min.	24.2	36.5	3.6	7.8	0.49	0.35	2.0	73.18	35.3	24.9
	Max	26.7	37.5	5.1	8.0	2.7	6.3	13.38	140.3	108.2	38.2

Table 2. The relative abundance of larvae of different fish families collected during pre and post- monsoon in the Oman Sea.

Family	Relative abundance	Premonsoon	Post monsoon	Family	Relative abundance	Premonsoon	Post monsoon
Apogonidae	1.04		*	Nemipteridae	0.52		*
Bothidae	0.52	*		Nomeidae	2.08	*	*
Bregmacerotidae	1.30		*	Ophidiidae	2.60		*
Callionymidae	0.52		*	Parapelidae	1.82		*
Carangidae	2.34		*	Platycephalidae	1.56		*
Clupeidae	5.73	*	*	Pomacentridae	15.63	*	*
Cynoglossidae	0.26		*	Sciaenidae	1.04		*
Engraulidae	18.49		*	Scombridae	3.39	*	*
Gerreidae	3.13	*	*	Soleidae	0.26		*
Hemirhamphidae	11.72	*		Sphyraenidae	0.26		*
Leiognathidae	1.04		*	Synodontidae	1.30		*
Lutjanidae	0.52	*		Terapontidae	0.52	*	
Myctophidae	22.14		*	Tripterygiidae	0.26		*

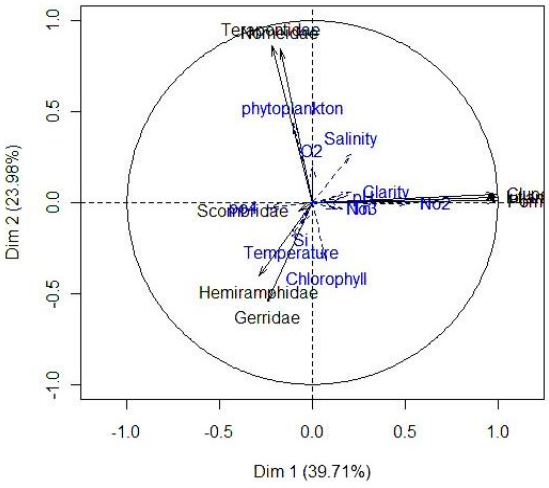

Fig.3. PCA plot in pre-monsoon period in the Oman Sea.

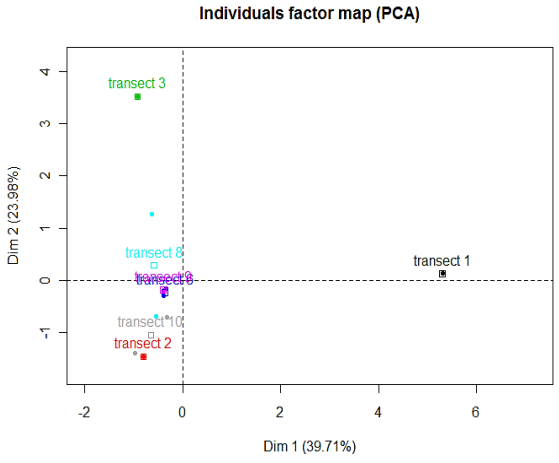

Fig.4. The transects coordination in pre-monsoon period in the Oman Sea with axis.

larval transects are shown in Fig. 4. Transect 1 had 5.30% coordination with dimdesc one, which differs from other transects, and transect 3 with dimdesc two (3.51%). The fish larval distribution is shown in Fig. 5.

Post-monsoon period: In this period, an average of

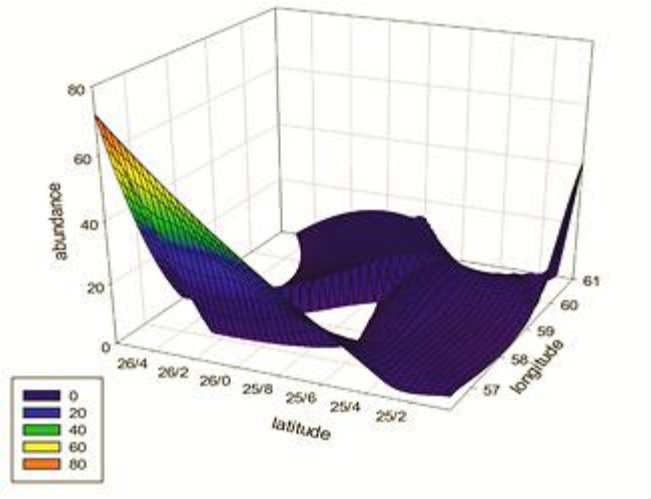

Fig.5. The distribution pattern of fish larvae in pre-monsoon period in the Oman Sea.

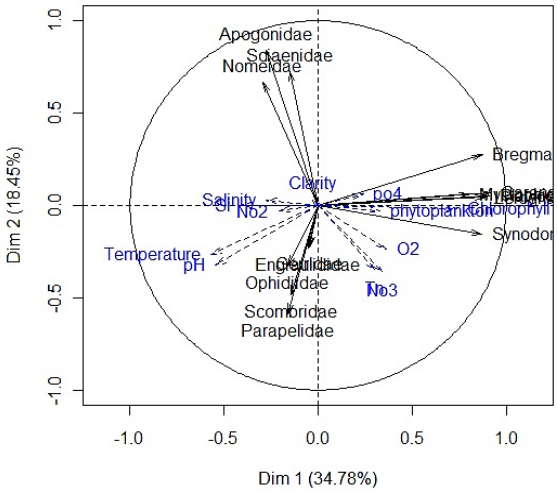

Fig.6. PCA plot in the post-monsoon period in the Oman Sea.

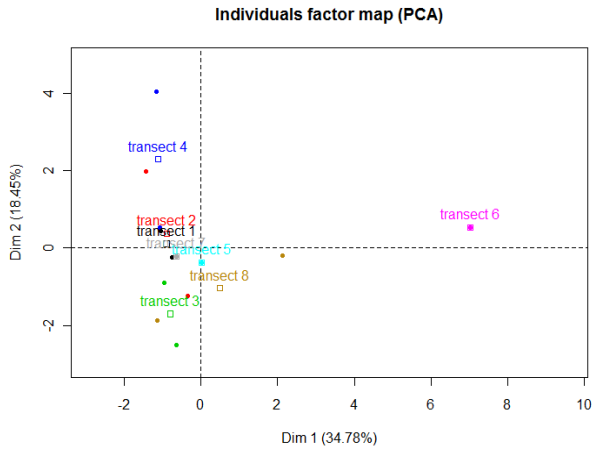

Fig.7. The transects coordination in post-monsoon period in the Oman Sea with axis.

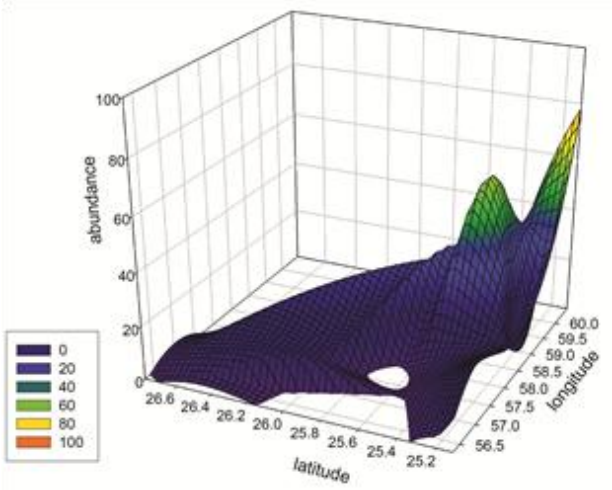

Fig.8. The distribution pattern of fish larva in post-monsoon period in the Oman Sea.

228 individuals of fish larvae per cubic meter belonging to 23 families including Apogonidae, Bothidae, Bregmacerotidae, Callionymidae, Clupeidae, Cynoglossidae, Engraulididae, Carangidae, Gerreidae, Myctophidae, Leiognathidae, Nemipteridae, Nomeidae, Ophidiidae, Parapelidae, Platycephalidae, Pomacentridae, Sciaenidae, Scombridae, Soleidae, Sphyraenidae, Synodontidae, and Tripterygiidae were identified (Table 2). Dominant families were Myctophidae and Engraulidae. The Shanoon index was 0.865 ± 0.73. The result of PCA showed that dimdesc axes 1 and 2 covered 68% of the abundance variation (Fig. 6), and only chlorophyll-a was the affecting factor on fish larval abundance and assemblage (73%). The coordination of transect 6 was different from other transects, and its coordination with dimdesc one was 7.03% (Fig. 7). Fish larval dispersal pattern is illustrated in Fig. 8.

Discussion

The relative number of fish larvae and the number of identified fish families increased after the monsoon phenomena. The dominant families were Myctophidae, Engraulidae and Pomacentridae which

is similar to those recorded by Chesalina et al. (2013) from south-western part of the Oman Sea. Thangaraja & Al-Aisry (2001) studied the ichthyoplankton of the Sultanate of Oman waters, and recognized Myctophidae (*Benthosema pterota*) as dominant family followed by Engraulidae (*Stolephorus* sp.). Rabbaniha et al. (2014,) identified Engraulidae as dominant family in the Gowatr Bay. Rabbaniha et al. (2014) identified meso-plagic larvae of three genera of *Benthosema*, *Diaphus* and *Lampadena* from this region. Houde et al. (1968) also reported the lantern fishes *Benthosema pterotum* and *Notolychus valdiviae* from western parts of the Persian Gulf.

In this study the biodiversity index of the fish larvae was 0.724. Thangaraja & Al-Aisry (2001) reported Shannon index value of 0.76 from the Sultanate of Oman waters (Chesalina et al. 2013). Among the factors investigated, chlorophyll-a was the only factor affecting the fish larval abundance and assemblage in post-monsoon period, indicating an increase in nutrients and subsequent increase in primary production and more available food. Ebrahimi et al. (2006) recorded 0.7 mg/m^3 of chlorophyll-a in summer and 1.3 mg/m^3 in winter in shallow waters (1-15 m) of the Oman Sea. Sheppard et al. (1992) reported the average range of chlorophyll-a in the surface layers of the Oman Sea as 2-20 mg/m^3 after monsoon period.

Conclusion

Study on the abundance and diversity of fish larvae along the Iranian waters of the Oman Sea showed monsoon as the main affecting phenomenon on fish larvae assemblages. We found more fish larval family with higher diversity in post-monsoon than in pre-monsoon period and chlorophyll-a was the most effective factor in the post-monsoon.

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