Distribution pattern of coral & non coralline fish larvae in Khark & Kharko (Persian Gulf)

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Abstract
Khark and Kharko Islands are located at far northern point of fringing coral reefs in the Iranian coast of the Persian Gulf. These coralline are the habitats of the wildlife refuge with total area of 2400ha and located in the territory of Bushehr province. The present study was carried out from July 2006 to June 2007 over 12 stations. Sampling was conducted obliquely from bottom using Bongo-net plankton sampler with 500µm of mesh size. In total, 1808 specimens, both in pre and post flexion stages were collected and examined. They were belonging to 45 families from different ecological groups (21 coralline and 24 non coralline fish larvae families). 96% of examined fish larvae were in preflexion stage. Some families are new ones from the area. Among identified families, Clupeidae, Blenniidae, Sillaginidae, Atherinidae and Tripterygiidae; were dominant families in studied area and the peaks were estimated in spring. The mean abundance of total fish larvae was 18.71 per 10m² of sea surface. The most abundant families were Clupeidae, Sillaginidae, Blenniidae, Atherinidae and Tripterygiidae in which comprised 65% of fish larvae. Abundance in spring showed significant difference with other seasons. The distribution pattern of fish larvae changed seasonally in both groups, increasing in east coasts of Khark Island and in three coastal stations during summer and autumn and in west coast of Khark in spring. The distribution of fish larvae seemed to be correlated to sea currents.

Keywords: Coralline fish larvae, Abundance, Khark and Kharko Islands, Persian Gulf, Iran

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**Introduction**

The study on life cycle, spatial and temporal distributions of larval stages of commercial fishes are important in marine biology and fishery management subjects.

Ichthyoplankton survey addition to increase knowledge of early life history inclusive growth, behavior, food requirement and others information help to explore for new resource and locating spawning concentrations of important stocks.

Few studies on ichthyoplankton were carried out in the Persian Gulf. Nellen (1973) sampled larval fishes in the northern and eastern sides of the Persian Gulf as part of Indian Ocean survey. His study provided useful information, however, samples were only taken during a single cruise and the survey was conducted in limited area of the Iranian waters (31 stations). Houde (1986) studied Kuwait waters, and collected 214 ichthyoplankton samples by Bongo-net with 333µ mesh size and 61cm in diameter. In last two decades, surveys on ichthyoplanktons were conducted in the Iranian waters by the Iranian Fisheries Research Organization. These studies were performed in the coastal waters of Khouzestan (Dehghan *et al.*, 2000), Bushehr (Owfi & Bakhtiary, 1999; Owfi & Mohamadnejad, 2000), and Hormouzgan (Jokar & Saraji, 2002) provinces. The present study, focused on coralline sites of Bushehr waters, including Khark & Kharko Islands, which being environmentally protected since 1967 (Danekar, 1999). This was designated as a preserved wildlife area in 1975 and is composed of two islands named of Khark & Kharko. The total area of the Islands are 2398ha which located 4km away from each other in the north part of the Persian Gulf territory of Bushehr province. The aims of the present study were to identify different fish larvae, to determine their abundance and temporal and spatial distribution in the studied areas.

**Materials and methods**

Khark & Kharko coralline Islands are located in the northern part of the Iranian side of the Persian Gulf, in Bushehr province waters. Nine stations around islands and 3 stations toward coastal waters were selected for sampling and the study was conducted during July 2006 to June 2007 (Fig. 1).
Figure 1: Sampling stations in the present study, including Khark & Kharko islands (Ropme, 2004, Google earth).

Fish larvae were collected monthly from July 2006 to June 2007, during daylight hours using a Bongo-net plankton sampler, with 61cm of mouth diameter (Smith & Richardson, 1977) equipped with 500µ-mesh size net and flow meter. Oblique tows were made from near bottom to sea surface. Length of towing wire was calculated based on station depth (Smith & Richardson, 1977). The time of towing for each station was 10 min while the boat speed was approximately 1 knot. Samples fixed in 5% formalin in seawater immediately after towing.

Samples were transferred to the marine biology laboratory of Shrimp Research Center, and the fixative solution was changed from formalin to 10% ethanol. Morphometric and meristic parameters were measured using stereomicroscope equipped with micrometer.

In order to identify, selected specimens were cleared and stained with Alcian blue and Alizarin (Balon, 1985). Fish larvae were identified according to Leis and Rennis (1983); Leis (1983,1989) and Leis and Transky (1989).

The raw data of larvae at each station were converted to numbers per cubic meter of filtered water based on flow meter revolution number. The data were also standardized to numbers in 10m² of sea surface by the method given in Smith & Richardson (1977) and Houde et al. (1986). To compare means and average of abundance indices were tested with K independent sample between stations & seasons.
Results
In total, 1808 fish larvae were collected from 12 stations, including 45 families. The larvae were in different stages and two main ecological groups, including 21 coralline and 24 non coralline were determined (Tables 1 and 2). The coralline fish larvae percent was 39% in the study area and was changed with ecological type of station, for example; in coralline station such as Kharko Jetty, the percent of coralline fish larvae increased up to 66%. Data showed that Clupeidae, Blenniidae, Sillaginidae, Atherinidae and Tripterygiidae were dominant families, which included 65% of total fish larvae abundance.

The relative abundance of preflexion fish larvae was 96%. The mean abundance of total fish larvae; coralline and non coralline fish larvae were 18.7, 6.9 and 11 larvae per 10m² of sea surface, respectively. The maximum abundance was 59.13 larvae per 10m² of sea surface in the Khark Pelaj and the minimum was 4.9 larvae per 10m² in the west of Kharko (Table 3). The fish larvae abundance were differ in the studied area seasonally, the maximum was in spring with significant difference with others seasons (P<0.05) (Fig. 3).

The distribution pattern of fish larvae is showed in Figures 3, 4 and 5. The change of fish larvae distribution in two groups; coralline and non coralline were the same. In summer, the most abundance of fish larvae was in east stations of island and stations of coastal area and in spring the most distribution of fish larvae on west stations of island, especially in west of Khark.

Table 1: Number and abundance of coralline fish larval families, in Khark & Kharko Islands (northern part of the Persian Gulf)

<table>
<thead>
<tr>
<th>Family</th>
<th>Number (per sample)</th>
<th>Mean abundance (N/10 m²)</th>
<th>Family</th>
<th>Number (per sample)</th>
<th>Mean abundance (N/10 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apogonidae</td>
<td>2</td>
<td>0.0113</td>
<td>Lutjanidae</td>
<td>5</td>
<td>0.0257</td>
</tr>
<tr>
<td>Atherinidae</td>
<td>131</td>
<td>1.3329</td>
<td>Mugiloididae</td>
<td>2</td>
<td>0.0205</td>
</tr>
<tr>
<td>Blenniidae</td>
<td>152</td>
<td>2.1532</td>
<td>Mullidae</td>
<td>57</td>
<td>0.6183</td>
</tr>
<tr>
<td>Bregmacerotidae</td>
<td>3</td>
<td>0.0234</td>
<td>Nemipteridae</td>
<td>9</td>
<td>0.0795</td>
</tr>
<tr>
<td>Chaetodontidae</td>
<td>3</td>
<td>0.0245</td>
<td>Platyecephalidae</td>
<td>5</td>
<td>0.0689</td>
</tr>
<tr>
<td>Creediidae</td>
<td>1</td>
<td>0.0118</td>
<td>Pomacenteridae</td>
<td>26</td>
<td>0.4985</td>
</tr>
<tr>
<td>Gerreidae</td>
<td>22</td>
<td>0.2059</td>
<td>Scorpaenidae</td>
<td>2</td>
<td>0.0572</td>
</tr>
<tr>
<td>Gobiidae</td>
<td>109</td>
<td>0.7023</td>
<td>Siganidae</td>
<td>1</td>
<td>0.0271</td>
</tr>
<tr>
<td>Haemulidae</td>
<td>1</td>
<td>0.0028</td>
<td>Sphyraenidae</td>
<td>30</td>
<td>0.2168</td>
</tr>
<tr>
<td>Labridae</td>
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<td>0.0118</td>
<td>Tetraodontidae</td>
<td>2</td>
<td>0.0294</td>
</tr>
<tr>
<td>Lethrinidae</td>
<td>6</td>
<td>0.0545</td>
<td>Tripterygiidae</td>
<td>91</td>
<td>0.8673</td>
</tr>
</tbody>
</table>
Table 2: Number and abundance of non coralline fish larval families, in Khark & Kharko Islands (northern part of the Persian Gulf)

<table>
<thead>
<tr>
<th>Family</th>
<th>Number (per sample)</th>
<th>Mean abundance (N/10 m²)</th>
<th>Family</th>
<th>Number (per sample)</th>
<th>Mean abundance (N/10 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belonidae</td>
<td>1</td>
<td>0.0312</td>
<td>Sciaenidae</td>
<td>1</td>
<td>0.0105</td>
</tr>
<tr>
<td>Bothidae</td>
<td>24</td>
<td>0.2821</td>
<td>Scomberidae</td>
<td>35</td>
<td>0.3725</td>
</tr>
<tr>
<td>Callionymidae</td>
<td>14</td>
<td>0.1163</td>
<td>Sillaginidae</td>
<td>384</td>
<td>2.2911</td>
</tr>
<tr>
<td>Carangidae</td>
<td>49</td>
<td>0.5040</td>
<td>Soleidae</td>
<td>13</td>
<td>0.0788</td>
</tr>
<tr>
<td>Cepolidae</td>
<td>23</td>
<td>0.1493</td>
<td>Sparidae</td>
<td>35</td>
<td>0.2814</td>
</tr>
<tr>
<td>Clinidae</td>
<td>1</td>
<td>0.0057</td>
<td>Syngnathidae</td>
<td>2</td>
<td>0.0280</td>
</tr>
<tr>
<td>Clupeidae</td>
<td>368</td>
<td>5.4801</td>
<td>Synodontidae</td>
<td>1</td>
<td>0.0143</td>
</tr>
<tr>
<td>Clupeiform</td>
<td>18</td>
<td>0.2458</td>
<td>Terapontidae</td>
<td>47</td>
<td>0.4878</td>
</tr>
<tr>
<td>Cynoglossidae</td>
<td>4</td>
<td>0.0287</td>
<td>Triacanthidae</td>
<td>12</td>
<td>0.0958</td>
</tr>
<tr>
<td>Engraulididae</td>
<td>23</td>
<td>0.2672</td>
<td>Triglidae</td>
<td>4</td>
<td>0.0186</td>
</tr>
<tr>
<td>Exocoitidae</td>
<td>5</td>
<td>0.0615</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: The abundance of fish larvae in the study area

<table>
<thead>
<tr>
<th>Station</th>
<th>Fish Larvae</th>
<th>Coralline</th>
<th>Non Coralline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Terminal</td>
<td>19.9030</td>
<td>14.4063</td>
<td>6.3874</td>
</tr>
<tr>
<td>Chemical Terminal</td>
<td>9.1482</td>
<td>2.3406</td>
<td>7.5093</td>
</tr>
<tr>
<td>Gas Terminal</td>
<td>11.0874</td>
<td>6.8892</td>
<td>5.3747</td>
</tr>
<tr>
<td>Khark Pelaj</td>
<td>59.1295</td>
<td>10.8037</td>
<td>43.6616</td>
</tr>
<tr>
<td>Khark Jetty</td>
<td>34.7060</td>
<td>15.8974</td>
<td>16.2382</td>
</tr>
<tr>
<td>Khark-Kharko Canal</td>
<td>13.1132</td>
<td>5.1329</td>
<td>8.0422</td>
</tr>
<tr>
<td>Kharko Jetty</td>
<td>15.2668</td>
<td>10.3005</td>
<td>4.9663</td>
</tr>
<tr>
<td>West of Kharko</td>
<td>4.9208</td>
<td>2.1668</td>
<td>2.5482</td>
</tr>
<tr>
<td>North of Kharko</td>
<td>13.7322</td>
<td>1.4469</td>
<td>11.8481</td>
</tr>
<tr>
<td>Marine 1</td>
<td>12.9407</td>
<td>4.1378</td>
<td>8.1923</td>
</tr>
<tr>
<td>Marine 2</td>
<td>23.3888</td>
<td>8.9229</td>
<td>15.3297</td>
</tr>
<tr>
<td>Doobe Creek</td>
<td>7.1632</td>
<td>3.7317</td>
<td>3.3354</td>
</tr>
<tr>
<td>Mean</td>
<td>18.7083</td>
<td>7.1814</td>
<td>11.0177</td>
</tr>
</tbody>
</table>

Figure 2: Seasonal variation in coralline & non coralline fish larvae abundance, in Khark and Kharko Islands (northern part of the Persian Gulf)
Figure 3: Seasonal distribution pattern of fish larvae (no. per 10m²) in Khark And Kharko area (northern part of the Persian Gulf), ▲ (station), *(port), a) summer, b) autumn, c) winter, d) spring.
**Figure 4:** Seasonal distribution pattern of coralline fish larvae (no. per 10 m²) in khark and kharko larvae (no. per 10 m²) in Khark And Kharko area (northern part of the Persian Gulf), ▲ (station), * (port), a) summer, b) autumn, c) winter, d) spring.
Figure 6: Seasonal distribution pattern of non coralline fish larvae larvae (no. per 10m²) in Khark And Kharko area (northern part of the Persian Gulf), ▲ (station), *(port), a) summer, b) autumn, c) winter, d) spring.
Discussion

Among 45 families identified in the present study, families Clupeidae, Sillaginidae, Blenniidae, Atherinidae and Tripterygiidae were dominant with 65% of total abundance. Previous studies, reported families Clupeidae, Gobidae and Sillaginidae comprise 90% of total identified specimens in Bushehr creek (Owfi & Bakhtiary, 1999) and 80% of fish larvae in Frakeh–Genaveh Region were belong to families Clupeidae, Gobidae, Sillaginidae and Engraulidae (Rabbaniha, 2002).

The highest abundance of Clupeidae larvae was observed in spring, however in Nayband it was in late summer (Rabbaniha, 1998), in Bushehr Creeks, it was during autumn (Owfi & Bakhtiary, 1999), and in Frakeh Bay-Genaveh Region it was during spring to summer (Rabbaniha, 2002) and in Khouzestan Creeks was in spring. In costal waters of Kuwait, Clupeid larvae have two increasing periods, including April to Jun and then August to October (Houde et al., 1986). The highest abundance of Sillaginid larva was assessed in Jun, July and November. In Bushehr Creeks, it was in April and December (Owfi & Bakhtiary, 1999), in Frakeh Bay-Genaveh Region, it was in August (Rabbaniha, 2002), and in Khouzestan Creeks, it was during July to September.

Occurrence of Blenniid larvae depends on the coral rocks and tides. The tiny fish lives in the bed of sea with more density around the island (Leis & Rennis, 1983). The highest abundance of Blenniidae larvae was collected in August in the present study, and previously in Nayband Bay, in May and August (Rabbaniha, 1998). In Bushehr Creeks (Owfi & Bakhtiary, 1999) and Frakeh bay- Genaveh Region no larvae of Blenniid was caught, however, in costal waters of Kuwait the most abundance of Blenniid larvae were reported during spring and summer.

The family Atherinidae belongs to shallow waters and lives close to the coral rocks (Leis & Rennis, 1983). Among larval studied, Atherinidae larvae have been recorded from Nayband Bay (Rabbaniha, 1998) and Khark and Kharko in the Persian Gulf with high abundance in the spring. Tripterygiide was demersal and lived near the coral and tide area that was first record from the Iranian waters of the Persian Gulf.

Some families, including Labridae, Apogonidae, Chaetodontidae and Mullidae, were only reported from Khark and Kharko islands and Clinidae, Creediidae and Tripterygiidae were the benthic fish of coralline habitat and were first report from the Persian Gulf. The increased ichthyoplankton types in this area must be largely a consequence of increased habitat divert in the study area; coralline, marine and shore waters.

The mean abundance in Nayband Bay, a very diverse habitat was 28.47 larvae under 10m² of sea surface and the dominated families were Clupeidae, Sphyraenidae, Lutjanidae. This area includes several habitats, such as creek, estuary, and mangrove forest (Rabbaniha, 1998). The mean abundance of fish larvae from Ziarat to Asalouyeh (southern creek of Bushehr City) was 43.67 larvae under 10m² of sea surface and the dominated families were Gobiidae, Engraulidae and Clupeidae (Owfi & Mohamadnejad, 2000). The mean abundance of central Bushehr creek fish larvae was 30.23 larvae under 10m² of sea surface and the dominated families were Gobiidae, Sillaginidae and Clupeidae (Owfi & Bakhtiary,
Vosuoghi et al. (1999) which were main ecosystems of this area is creek and estuary. The mean abundance of fish larvae from the creek-estuary Bushehr to Genave (northern part of Bushahr coastal waters) was 7.87 larvae under 10m² of sea surface and the dominated families were Gobiidae, Clupeidae, Sillaginidae, Sparidae (Rabbaniha, 2002). Comparing to the mean abundance between these areas showed that the highest abundance is in Central Bushehr creek, because the creeks of this area are sheltered creeks (pond shape and deep canal creeks). Also, the abundance of fish larvae in Khark and Kharko Islands is more than northern creeks of Bushehr, because the most of stations in northern creeks of Bushehr were located in open sea and they do not have shelter area. Therefore, it seems that the fish larvae distributed with currents.

The habitat diversity of Khark and Kharko, is one of the main reasons for species diversity of fish larvae and Clupeidae dominancy is related to the main habitat, the coralline fish larvae as same as Sphyraenidae, Lutjanidae, Blenniidae, Atherinidae, Tripterygiidae are presents. The mean abundance of Khouzestan coastal waters province (northern part of the Persian Gulf) were 59.11 larvae under 10m² of sea surface and Gobiidae, Clupeidae, Engraulididae dominated fish larval family and so Leiognathidae and Sciaenidae reported in limited area. Creek is main habitat of Khouzestan province.

Nellen (1973) collected larval fishes in 71 net tows at 65 stations off the Iranian side of the Persian Gulf in two week period (31 March to 14 April 1965) using 500µm mesh. In this study, the predominant fish larvae were Pomadasyidae (Haemulidae), Clupeidae, Gobiidae and Apogonidae. Houde et al. (1986) sampled fish larvae from September 1979 to August 1980 from Kuwait waters and two cruises from Saudi Arabia (southern part of the Persian Gulf). The mean abundance was 71m⁻² and dominant families were Engraulididae, Gobiidae and Clupeidae.

Although a lots of researcher such as Laevastu and Hela (1970) believed that climate and oceanographic changes are linked to fish larve abundance and distribution, but in this study coefficient correlation assessment revealed no distinct relationship between fish larva abundance and a biotic factors of water temperature, salinity and depth. The result showed that fish larvae abundance was highest in spring to early summer.

The mean abundance of fish larvae in Pelaj station was higher than in other stations due to a deeper coralline habitat, which can be as a stable and safe area for fish larvae.

The distribution pattern of fish larvae changed seasonally in two groups in summer and autumn the abundance of all families increased in east coasts of Khark Island and in three coastal stations (Figs. 5 and 6) in case, it was changed in spring and the most abundance was in west coast of Khark. It seems that the distribution of fish larvae was correlated to sea currents, the main current of the Persian Gulf (anti clockwise current) cause the water moved from south-east to north-west, therefore, fish larvae had high abundance in east of Khark and in winter and spring with increased of northwest wind (especially in coast of Bushehr province), the sea current was changed and produce clockwise current, that cause high abundance of fish larvae in east coast.

Sea current distribution and type/ location of stations (path coral habitats) are the main
causes for the richness increase and abundance of the fish larvae decrease in this area. Also, their spatial distribution pattern will be changed under effect of mentioned phenomenon.

Acknowledgements
We wish to thanks Dr. Edward D. Houde (Maryland University) and Dr. Jeffrey Lies (New South Wales University) for their help in confirm of identification and calculation methods of fish larvae, and also, expert colleagues of Shrimp Research Center, Bushehr for their cooperative in cruise sampling and laboratory surveys.

References
Smith, P.E. and Richardson, S.L., 1977. Standard techniques for pelagic fish eggs and larvae survey. FAO, Rome, Italy. 110P.
الگوی پراکنش لارو ماهیان مرجانی و گیر مرجانی در ناحیه جزایر خارک و خارکو (خليج فارس)

غلامحسین وثوقی؛ محمد رضا فاطمی؛ مهناز ربانیها.1،2*\nشها جمیلی؛ کامیار غرا و محسن نوری نژاد\n
تاریخ دریافت: آبان ۱۳۸۷\nتاریخ پذیرش: آذر ۱۳۸۷\nچکیده\nژایی مرجانی خارک و خارکو در منتهی‌الیه منطقه مرجانی می‌باشد که در سال ۱۳۵۴ از نظر رده‌بندی حفاظتی در لیست بناهای حیات و عشق پرور عرفان ایمین تحقیق از تیم‌های ۱۳۸۵ صورت گرفت که طی آن علاوه بر ۹ این‌ستگاه در اطراف جزایر، ۳ این‌ستگاه ساحلی و دریایی نیز در نظر گرفته شد. جمعیت آوری نمونه‌ها در هربار توسط نوع Bongo (۵ میکرون) تصویر کشت مرجانی از کف به سطح انجام گردید. طی این بررسی ۱۸۰۸ عدد لارو Flexion (پرفلاکسیون) جمع آوری که در مقاطع لاروی پیش مرحله تشکیل صفحه دمی (Preflexion) و پس مرحله تشکیل صفحه دمی (Post) و در ۴۵ خانواده شناسایی گردید د کد و شماره مرجانی (۳۷ خانواده) و غیر مرجانی (۴۴ خانواده) را شامل می‌شود. با جمع‌آوری درصد لارو ماهیان جمع آوری شده در مرحله Preflexion، ۴۶ درصد لارو مرجانی؛ میانگین فراوانی لارو در منطقه ۱۸۷۱ عدد در ۲۰ هفت میلی‌سیم بود که خارکو‌های بینی‌شیرین فراوانی را داشته و جمعاً ۶۵ درصد کل فراوانی لاروی را شامل می‌شود. لاروی در تمامی طول سال در منطقه و جو به داشتن دریاچه‌های آب و قارچی آب‌های کاهش می‌یافت.

کلمات کلیدی: لارو ماهیان مرجانی، فراوانی لاروی، جزایر خارک و خارکو، خليج فارس

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