Turkish Journal of Fisheries and Aquatic Sciences 11: 121-130 (2011)
www.trjfas.org
ISSN 1303-2712
DOI: 10.4194/trjfas.2011.0116

Temporal Changes in Ichthyoplankton Abundance and Composition of Babadıllimanı Bight: Western Entrance of Mersin Bay (Northeastern Mediterranean)

Dursun Avsar[1,]*, Sinan Mavruk[1]

[1] Cukurova University, Fisheries Faculty, 01330 Adana, Turkey.

* Corresponding Author: Tel.: +90.322 3386084-2065; Fax: +90.322 3386439;
E-mail: dursunav@cu.edu.tr

Received 30 March 2010
Accepted 09 January 2011

Abstract

In this study the temporal changes in ichthyoplankton abundance and composition of Babadıllimanı Bight (Northeastern Mediterranean) were identified and simultaneously the spawning periods of sampled teleost fishes were observed. Thus, monthly samplings were performed at nine stations by using Hensen Net with 300 µm mesh size during one year period between May 1999 and April 2000. Throughout the studying period, early life stages of 23 teleost fish species were observed. The mean egg and larval abundance were calculated as 46, and 20 individual 10 m^{-3} respectively. While the maximal egg abundance was observed in summer, larval abundance was the highest in early autumn. Only temporal changes in egg abundance ($P<0.01$) were significant; however spatial-temporal changes in larval abundance were not. Shannon-Wiener Diversity Index values were obtained as highest in summer for eggs, and in autumn for larvae as also being abundance.

Keywords: Fish egg, fish larvae, ichthyoplankton, spawning period, teleost fish.

Mersin Körfezi Batı Girişi Babadıllimanında (Kuzeydoğu Akdeniz): İhtiyoplankton Bolluğunun Kompozisyonu ve Zamansal Değişim ve

Özet

Bu çalışmada Babadıllimanı Körfezinde (Kuzeydoğu Akdeniz) ihtiyoplankton bolluk ve kompozisyonu değişiklikleri belirlendi, aynı anda teleost balıkların yumurtlama dönemleri gözlendi ve örnekleme yapıldı. Dokuz istasyonda Mayıs 1999 ve Nisan 2000 tarihleri arasında bir yıl boyunca 300 µm 'lik Hensen plankton ağı kullanarak aylık örnekleme yapıldı. Çalışma dönemi boyunca erken yaşam evrelerinde 23 teleost balık türü gözlendi. 10 m^3 hacimde ortalama yumurta ve larva bolluğu sırasıyla 46 adet ve 20 birey, olarak hesaplandı. Yumurta bolluğunda maksimal değer yaz aylarında gözlenirken, larval bolluk en yüksek erken sonbaharda bulundu. Yumurta bolluğu bakımından sadece zamansal değişiklikleri önemli ($P <0.01$) iken; larva bollukta mekan-zamansal değişiklikleri önemli değildi. Shannon-Wiener Çeşitlilik Endeks değerleri, yumurta için yaz aylarında ve larva için sonbaharda en yüksek bolluk miktarı elde edilmiştir.

Anahtar Kelimeler: Balık yumurtası, larva, ihtiyoplankton, üreme dönemi, teleost balık.

Introduction

Ichthyoplanktonology as a sub discipline of ichthyology concerns pelagic early life stages of fishes including eggs, larvae and partly juvenile stages (Yuksek and Gucu, 1994). The data about the early stages of fishes are informative on the ichthyology, fisheries oceanography, aquaculture and ecology in some respects such as the researching of fish communities, identifying of spawning times and localities, estimating of stock biomass, examining of recruitment (Demir and Southward, 1974; Reay, 1984; Palomera and Pertierra, 1993; Begg, 2005; Govoni, 2005). Thus, the importance of the ichthyoplankton surveys results from the fact that they can provide mentioned data faster, cheaper and reliable.

The ichthyoplankton surveys carried out by firstly Demir (1952) in Turkish Seas and most of the Black Sea, Marmara and Aegean Sea were researched up to now (Mater and Cihangir, 1990; Basar, 1996; Satılmıs, 2001; Alimoglu, 2002; Coker, 2003; Demirel, 2004; Coker and Mater, 2006). However, there were investigations only offshore the Mersin and Iskenderun Bay in the Mediterranean Sea (Ak, 2004; Ak and Uysal, 2007; Mavruk, 2009). Thus, it is clearly seen that considerable part of the northeastern Mediterranean coasts has not been investigated in respect of ichthyoplankton surveys yet. So Babadıllimanı Bight, the research area, is one of the mentioned uninvestigated areas located on the central Anatolian coasts of Mediterranean.

The coastal structure of Babadıllimanı Bight resembles typical Eastern Mediterranean type, with narrow continental shelf, straight hills on the shore and consequently rocky habitats in the coast (Miller, 1983; Avsar, 1999). The current characteristics are under the influence of west ward Asian Minor Current consisting some anticyclonic gyres, filaments and jets. So, mentioned current system exhibits some variations with time, depending on the changing regime of the Asian Minor Current (Ozsoy *et al*., 1989, 1991, 1993). Temperature and salinity of the studying area are high as also being in whole Levant Basin of the Mediterranean, (Miller, 1983). The ichthyofaunal structure is characterized by mostly Atlanto-Mediterranean and Indo-Pacific (Lessepsian) fishes, is also similar to that of whole Levant. As the clearly known, the fisheries income of the region is low, and this scarcity is explained mainly by narrow continental shelf and low nutrient concentration due to the absence of considerable river discharges (Ben-Tuvia, 1983). Therefore, the aim of this study is to clarify the temporal changes on the ichthyoplanktonic structure and related environmental parameters of the Babadıllimanı Bight for the first time. Besides, spawning periods of some teleost fishes have been investigated and Babadıllimanı Bight has been examined as a spawning area for fishes.

Material and Methods

This study was carried out by monthly intervals in between of May 1999-April 2000, at 9 stations that were localized in the area bordered 36°09'37″N-36°05'47″N and 33°25'51″E-33º32'39″E. However the samplings were performed at horizontal tows, the stations were clustered by considering depth contour intervals so that the environmental and ichthyofaunal changes depending on depth could be observed. Thus, five stations were chosen from coast to 50 m and three stations 50-100 m while only one station was selected at higher depth than 100 m (Figure 1). The reason of this heterogeneous clustering of the stations at different depth contour intervals was explained by reducing of variations in the ecological conditions by remaining horizontal distance from shore (Kocatas, 2003).

The sampling was performed horizontally at a vessel speed of 1.5-2 knots by using Hensen Net with 300 µm mesh size. The frame diameters of Hensen Net were 70 cm at the front and 120 cm at the behind. Flowmeter had been calibrated and was used while sampling so that straining water could be determined. The samples were fixed with %4 buffered formaldehyde solution and then the species were identified in laboratory. The quantities and percentages as individually of each species in the unit volume (ind/10m^3) had been determined. Mean quantities of each species sampled from the same depth range were calculated.

Temperature (T°C) and salinity (‰S) were measured by using a YSI 6600 model CTD and Secchi Depth (SD) were measured by using a Secchi Disc at each stations and mean values of same depth range were also calculated. The spatial and temporal changes of environmental parameters was tested by performing a two way ANOVA and significant variations were determined by Duncan Test (Elbek *et al*., 2006). Confidence intervals (%95) of each of the parameters were calculated.

The spawning period of each fish species was determined by using temporal modes of abundance. Mean abundance of total ichthyoplankton and

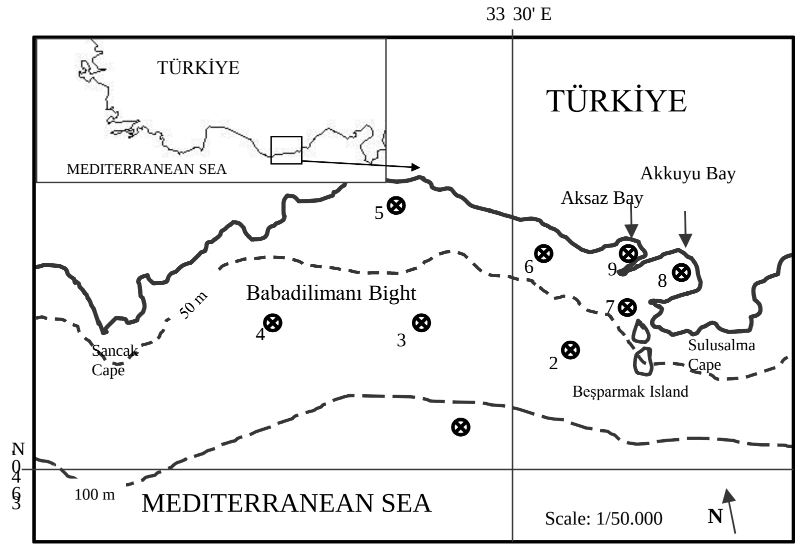

Figure 1. Studying area and the location of sampling stations.

standard deviations were calculated for each month and depth contours. The spatio-temporal changes in the egg and larval abundance were also tested by non-parametric Friedman Test (Gamgam and Altunkaynak, 2008). In the analysis, temporal scale was blocked by depth contours. The statistical considerations were performed with Minitab Statistical Software.

Shannon-Wiener Diversity Index (S-WSI) and its evenness component, Pielou's Evenness Index (PEI) were calculated with ln based equation for each month and station by using Primer V5 Program so that the diversity and evenness could be estimated and comparable data could be provided (Postel *et al.*, 2000).

Bray-Curtis Similarity Index (B-CSI) was calculated from the square root transformed data so that the importance of the highly abundant species could be down-weighted. Hierarchical agglomerative clustering with group average linking based on Bray-Curtis similarity index was applied by using Primer V5 Program, so the natural groupings of samples were estimated (Clarke and Warwick, 2001).

Results

Hydrological Conditions

Monthly variations of temperature (TºC), salinity (‰S) and Secchi Depth (SD) have been shown in Figure 2. Mean annual temperature was 21.77±0.10°C. Spatial variations of the temperature were not significant, whereas the temporal variations were ($P<0.01$). Mean annual ‰S was 36.26‰±0.14. As the temperature, monthly variations of ‰S also were significant ($P<0.01$) and spatial variations were not. Mean annual SD was measured 13.07±0.50m. Unlike to the T°C and ‰S, spatial and temporal variations of SD were found significant ($P<0.01$). So, mean annual SD values of 0-50, 50-100 and >100 m depth contours were 14.01±1.73, 10.03±1.73 and 15.17±1.73 m respectively.

Ichthyoplanktonic Results

Throughout the studying period, 23 teleost fish species belonging to 18 families were identified. Among them 20 species were found at 0-50 m, 19 50-100 m and 14 >100 m depth contours. Embryonic and larval stages of 8 species, only embryonic stages of 8 species and only larval stages of 7 species were observed (Appendix 1).

Monthly changes on the mean abundance of eggs and larvae sampled during the studying period were shown in Figure 3. It is clearly seen from Figure 3 that the egg abundance was increasing from March to July and a remarkable decrease occurred from July to September. Besides, considerable variations were not observed during the autumn and winter months. The mean abundance of eggs sampled throughout the studying period was 46±45 eggs/10 m^3 (Mean±STD). The minimum abundance was determined as 4 eggs/10 m^3 in March, whereas the maximum was 128 eggs/10 m^3 in June. When the significance of the egg abundance variations was considered, it is determined that the monthly changes of egg abundance were significant ($P<0.01$), however horizontally changes were not.

The mean abundance of larvae during the studying period was 20±22 ind/10 m^3 (Mean±STD). The fluctuations of the larvae abundance in spring and summer resembled with the egg abundance, however monthly egg abundance changes were more striking than those of larvae. But contrary to the egg abundance, a drastic increase occurred from August to September, and autumn and winter values fluctuated contrary directions (Figure 3). Unlikely to egg abundance, spatio-temporal larval abundance changes were not significant.

When spawning periods of identified fish species distributed in studying area were considered, early stages of 4, 6, 8 and 5 fish species were detected

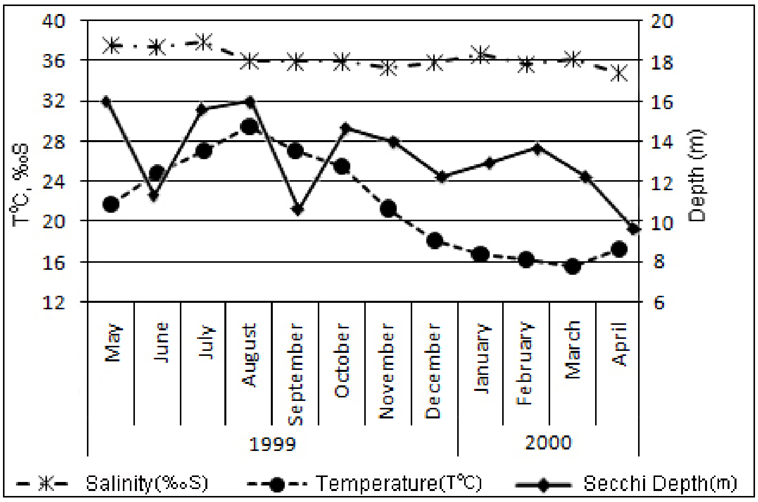

Figure 2. Temporal variations of salinity, temperature and secchi depth.

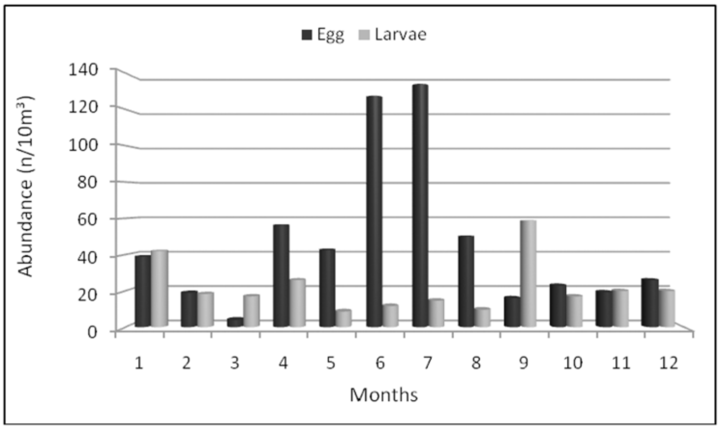

Figure 3. Monthly changes on the mean abundance of eggs and larvae identified during the studying period.

in Winter, Spring, Summer and Autumn respectively. The picks of early stage abundance of 5 species occurred more than 1 season (Appendix 1; Table 1).

Spatial and Temporal Changes

When temporal variations of S-WDI calculated for eggs are considered, it is clearly seen that the index values for winter and summer are higher than those of Spring and Autumn. Maximum species diversity observed in June at 50-100m depth contour, while minimum S-WDI values were observed as 0 for October at >100 m, in March and November at >50m depth contours (Table 2). The reason of observed minimum values was the sampling of eggs of only one species in mentioned months and depth contours except March, 50-100 m. In March, absence of any eggs at the surface of 50-100 m depth range was the reason of existed minimal diversity value.

Unlikely to the egg diversity, S-WDI calculated for larvae were observed highest for autumn. The maximum larval diversity was determined in September at the surface of 50-100 m. The minimum larval diversity values also were observed in different months and depth contour intervals (Table 2). As the egg diversity, the reasons of mentioned minimal values were the absence or presence of only one species' larval stages in the sample (Appendix 1).

As the results of the Bray-Curtis similarity index analyzes applied among the stations and months for identified pelagic eggs, 4 different groups were pointed out (Figure 4). When the results of index were considered for pelagic larval stages, 4 different groups were observed (Figure 5).

Discussion

High temperature and salinity values of Levant Basin were well documented by Ben-Tuvia (1966) and Gucu and Bingel (1994). Thus, throughout the studying period, monthly measured temperature values did not decrease under 15ºC even in the coldest month (March). Summer temperatures were also high and measurements reached up to 30ºC in the hottest month (August). However the climatic structure is typical sub-tropic type with intense seasonal fluctuations on environmental parameters (Golani, 1998). Variations of the both the salinity and temperature were not significant in horizontal scale, unlikely to the Secchi Depth. Horizontal variations of Secchi Depth were also statistically significant and unexpectedly mean Secchi Depth of 50-100 m contour was lower than that of shore. It is possible to explain this case by considering substrate structure of the Bight. So, substrate of the Bight is mainly formed by rocks and it may prevent the turbidity even when mixing occurs as a result of various factors.

When abundance fluctuations of total ichthyoplankton were considered, only temporal changes of total egg abundance were significant ($P<0.01$), however spatio-temporal changes of larval abundance were not. The clearly observed higher egg abundance in Spring and Summer months indicated a community structure mainly formed by Spring and Summer spawners.

The importance of coastal ecosystem as spawning and nursery grounds for many fish species was well documented (Koutrakis *et al*., 2004; Azeiteiro *et al*., 2006). In this respect it might be expected that egg and larval abundance should increase with decreasing depth, however a significant relation between depth and ichthyoplankton abundance could not be observed in this study. This result arisen from narrow continental shelf structure of considered area. Thus, the sudden depth increasing did not reflect the ichthyoplankton abundance in parallel with environmental parameters.

Diversity indices were discussed, index values calculated for eggs in summer and winter seemed higher than those of spring and autumn; however this situation was not valid in all months and depth contours. The mean reason of this case seemed to be the picks of some species at the mentioned time and station, due to the relatively low evenness values of lower diverse samples. On the other side, the highest diversities calculated in summer when the season

Table 1. Spawning periods of identified teleost fishes*

Species	Winter			Spring			Summer			Autumn		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Boops boops	-	**E**	**E**	E, L	-	-	-	-	-	-	-	-
Bothidae sp.	-	-	-	-	-	E	**E**	E	-	-	-	-
Callionymus lyra	-	-	-	-	-	-	-	-	E	-	-	-
Centracanthidae spp.	-	-	L	L	**L**	-	-	-	-	-	-	-
Chelidonichthys lucernus	E	**E**	E	E, L	-	-	**E**	-	-	-	-	-
Citharus linguatula	-	L	L	-	-	L	-	-	-	-	-	L
Conger conger	L	-	-	-	-	-	-	-	-	-	L	**E, L**
Cynoglossus sinusarabici	-	-	-	-	-	-	L	L	L	L	L	-
Diplodus annularis	E	-	**E**	E, L	L	-	-	-	-	-	-	-
Echelus myrus	-	-	-	-	-	-	-	-	-	**L**	-	-
Engraulis engrasicolus	-	-	-	-	-	-	-	-	-	**E, L**	L	-
Gobiidae sp.	-	-	-	-	-	-	-	-	L	-	-	-
Merluccius merluccius	-	-	-	-	-	-	-	-	-	E	-	-
Mullus barbatus	L	L	-	-	**E**	**E**	**E**	E	L	L	L	-
Mullus surmuletus	-	-	-	-	-	-	-	-	-	E	-	-
Muraena helena	-	-	E	-	**E**	-	-	-	-	-	-	-
Pagellus erythrinus	-	-	-	L	-	-	-	-	-	-	-	-
Saurida undosquamis	E	E, L	E	-	E	-	E	E	E	E, L	E	E, L
Scorpaena sp.	-	-	-	-	-	E	-	-	-	-	-	-
Solea solea	E	-	E	-	-	-	-	-	-	-	-	-
Syngnathus acus	-	-	-	-	-	-	L	-	-	-	-	-
Synodus saurus	-	-	-	-	**E**	-	**E**	**E**	**E**	E	E	-
Upeneus spp.	E	E	-	-	-	E	**E**	**E**	**E**	E, L	E	-

*Bold: Abundance picks; E: Egg, L: Larvae

Appendix 1. Abundance of Monthly Identified Ichthyoplankton Family and Species in Each Depth Range (Values in Paranthesis Represent the Larvae. n: Mean Number of the Eggs or Larva in 10 m^3)

Depth Range & Taxonomic Groups								
0-50m			50-100m			>100m		
Family and Species	Relative Abundance (n)	(%)	Family and Species	Relative Abundance (n)	(%)	Family and Species	Relative Abundance (n)	(%)
M A Y 1 9 9 9								
Bothidae			Bothidae			Bothidae		
Bothidae sp.	43	42.3	Bothidae sp.	17	62.2	Bothidae sp.	11	40.2
Citharidae			Mullidae			Mullidae		
C. linguatula	(26)	(26.7)	*M. barbatus*	10	37.8	*Upeneus* spp.	17	59.8
Mullidae		25.2						
M. barbatus	19	19.6						
Upeneus spp.	6	5.6						
Scorpaenidae								
Scorpaena sp.	5	5.5						
J U N E 1 9 9 9								
Bothidae			Bothidae			Bothidae		
Bothidae sp.	5	29.6	Bothidae sp.	55	29.8	Bothidae sp.	39	59.9
Cynoglossidae			Cynoglossidae			Mullidae		
C. sinusarabici	(18)	(10.5)	*C. sinusarabici*	(8)	(5.6)	*Upeneus* spp.	13	20
Mullidae		23.7	Mullidae		39.3	Synodontidae		
M. barbatus	18	10.5	*M. barbatus*	15	8.4	*S. undosquamis*	13	20
Upeneus spp.	22	13.1	*Upeneus* spp.	57	30.9			
Syngnathidae			Synodontidae		21.7			
S. *acus*	(9)	(5.3)	*S. undosquamis*	27	14.5			
Synodontidae		30.9	*S. saurus*	13	7.2			
S. undosquamis	43	25.6	Triglidae					
S. saurus	9	5.3	*C. lucernus*	9	4.6			

Appendix 1. Continued

Depth Range & Taxonomıc Groups								
0-50m			50-100 m			>100 m		
Family and Species	Relative Abundance (n)	(%)	Family and Species	Relative Abundance (n)	(%)	Family and Species	Relative Abundance (n)	(%)
			JULY 1999					
Bothidae			Bothidae			Bothidae		
Bothidae sp.	5	3.5	Bothidae sp.	12	6.8	Bothidae sp.	29	20.8
Cynoglossidae			Cynoglossidae			Cynoglossidae		
C. sinusarabici	(12)	(8.6)	*C. sinusarabici*	(14)	(8)	*C. sinusarabici*	(18)	(12.5)
Mullidae		78	Mullidae		60.9	Mullidae		50
M. barbatus	14	10.3	*M. barbatus*	17	9.8	*M. barbatus*	29	20.8
Synodontidae			Synodontidae		25.1	Synodontidae		
S. undosquamis	13	9.9	*S. undosquamis*	32	19.9	*S. undosquamis*	23	16.7
			S. saurus	9	5.2			
			AUGUST 1999					
Callionymidae			Mullidae			Cynoglossidae		
C. lyra	6	11.6	*Upeneus* spp.	31	59.8	*C. sinusarabici*	(9)	(12.9)
Gobiidae			Synodontidae		40.2	Mullidae		
Gobiidae sp.	(4)	(7.4)	*S. undosquamis*	17	31.7	*Upeneus* spp.	15	20.8
Cynoglossidae			*S. saurus*	5	8.5			
C. sinusarabici	(12)	(22.2)				Synodontidae		66.2
Mullidae		29.6				*S. undosquamis*	37	51.9
M. barbatus	(4)	(7.4)				*S. saurus*	11	14.3
Upeneus spp.	12	22.2						
Synodontidae		30.3						
S. undosquamis	13	25.9						
S. saurus	3	5.9						
			SEPTEMBER 1999					
Cynoglossidae			Cynoglossidae			Cynoglossidae		
C. sinusarabici	(12)	(21.7)	*C. sinusarabici*	(14)	(25.3)	*C. sinusarabici*	(4)	(21.5)
Engraulidae			Engraulidae			Engraulidae		
E. engrasicolus	5	9.8	*E. engrasicolus*	(1)	(17.6)	*E. engrasicolus*	5	25
Mullidae			Merlucciidae			Mullidae		
M. barbatus	(105)	(10.2)	*M. merluccius*	1	1.6	*Upeneus* spp.	4	18.9
M. surmuletus	3	4.3	Mullidae		29.9	Synodontidae		
Upeneus spp.	16	28.7	*M. barbatus*	(8)	(15.1)	*S. undosquamis*	8	35.7
Synodontidae			*Upeneus* spp.	(8)	(14.8)			
S. undosquamis	(7)	(12.7)	Ophichthidae					
			E. myrus	(4)	(7.1)			
			Synodontidae		18.6			
			S. undosquamis	(4)	(7.1)			
			S. saurus	6	11.5			
			OCTOBER 1999					
Congridae			Cynoglossidae			Cynoglossidae		
C. conger	(5)	(11.3)	*C. sinusarabici*	(11)	(20.3)	*C. sinusarabici*	(10)	(47)
Cynoglossidae			Engraulidae			Engraulidae		
C. sinusarabici	(7)	(16.3)	*E. engrasicolus*	(14)	(25.5)	*E. engrasicolus*	13	54
Mullidae		27	Mullidae					
M. barbatus	(4)	(9.1)	*Upeneus* spp.	5	8.3			
Upeneus spp.	7	17.9						
Synodontidae		45.4	Synodontidae		45.9			
S. undosquamis	14	33.3	*S. undosquamis*	15	26.6			
S. saurus	5	12.1	*S. saurus*	10	19.3			
			NOVEMBER 1999					
Citharidae			Citharidae			Citharidae		
C. linguatula	(5)	(13.1)	*C. linguatula*	(18)	(31.9)	*C. linguatula*	(13)	(60)
Congridae			Congridae			Synodontidae		
C. conger	18	45.9	*C. conger*	(8)	(17.8)	*S. undosquamis*	9	40
Synodontidae		40.9	Synodontidae					
S. undosquamis	9	22.3	*S. undosquamis*	22	38.9			
	(7)	(18.6)		(9)	(15.1)			

Appendix 1. Continued

Depth Range & Taxonomıc Groups								
0-50m			50-100m			>100m		
Family and Species	Relative Abundance (n)	(%)	Family and Species	Relative Abundance (n)	(%)	Family and Species	Relative Abundance (n)	(%)
D E C E M B E R 1 9 9 9								
Congridae			Mullidae			Mullidae		
C. conger	(1)	(1.7)	*Upeneus* spp.	9	33.2	*Upeneus* spp.	3	9
Mullidae			Soleidae			Soleidae		
M. barbatus	(4)	(13.6)	*S. solea*	3	8.9	*S. Solea*	5	18.1
Upeneus spp.	7	25.7						
Sparidae			Synodontidae			Sparidae		
D. annularis	6	22.6	*S. undosquamis*	9	32.7	*D. annularis*	16	55.7
Synodontidae			Sparidae			Synodontidae		
S. undosquamis	5	18.5	*D. annularis*	7	25.2	*S. undosquamis*	5	17.2
Triglidae								
C. lucernus	3	10.2						
J A N U A R Y 2 0 0 0								
Citharidae			Citharidae			Citharidae		
C. linguatula	(39)	(36.2)	*C. linguatula*	(38)	(55.4)	*C. linguatula*	(43)	(63.2)
Mullidae			Mullidae			Sparidae		
Upeneus spp.	5	4.5	*M. barbatus*	(3)	(4.1)	*B. boops*	21	30.4
Sparidae			Sparidae			Triglidae		
B. boops	48	44.8	*B. boops*	20	29.5	*C. lucernus*	4	6.3
Synodontidae			Synodontidae					
S.undosquamis	3	2.8	*S. undosquamis*	(3)	(4.4)			
Triglidae			Triglidae					
C. lucernus	12	11.7	*C. lucernus*	4	6.5			
F E B R U A R Y 2 0 0 0								
Centracanthidae			Centracanthidae			Centracanthidae		
Centracanthidae spp.	(16)	(47.9)	Centracanthidae spp.	(5)	(14.6)	Centracanthidae spp.	(9)	(21.1)
Citharidae			Citharidae			Citharidae		
C. linguatula	(9)	(17.3)	*C. linguatula*	(7)	(22.3)	*C. linguatula*	(9)	(21.1)
Muraenidae			Muraenidae			Soleidae		
M. helena	1	1.7	*M. helena*	6	18.7	*S. solea*	2	5.3
Soleidae			Soleidae			Sparidae		42.9
S. solea	1	0.2	*S. solea*	1	4.2	*B. boops*	15	37.6
Sparidae		25.3	Sparidae		32.9	*D. annularis*	2	5.3
B. boops	7	14.6	*B. boops*	7	22.6	Synodontidae		
D. annularis	5	10.7	*D. annularis*	3	10.3	*S. undosquamis*	2	5.3
Synodontidae			Synodontidae			Triglidae		
S. undosquamis	3	5.8	*S. undosquamis*	1	4.2	*C. lucernus*	2	4.2
Triglidae			Triglidae					
C. lucernus	1	1.9	*C. lucernus*	1	3.1			
M A R C H 2 0 0 0								
Centracanthidae			Centracanthidae			Centracanthidae		
Centracanthidae spp.	(13)	(59)	Centracanthidae spp.	(18)	(49.9)	Centracanthidae spp.	(5)	(42.8)
Sparidae		29.1	Sparidae		30.5	Sparidae		57.1
B. boops	3	11.8	*B. boops*	(5)	(14.7)	*B. boops*	5	42.8
D. annularis	3	11	*D. annularis*	(4)	(10.1)	*P. erythrinus*	(2)	(14.3)
P. erythrinus	(1)	(6.3)	*P. erythrinus*	(2)	(5.6)			
Triglidae								
C. lucernus	1	6.3						
	(1)	(6.3)						
A P R I L 2 0 0 0								
Centracanthidae			Centracanthidae			Centracanthidae		
Centracanthidae spp.	(23)	(42.7)	Centracanthidae spp.	(34)	(31)	Centracanthidae spp.	(17)	(19.8)
Mullidae			Mullidae			Mullidae		
M. barbatus	5	9.4	*M. barbatus*	33	28.3	*M. barbatus*	37	45
Sparidae			Synodontidae		24.5	Synodontidae		35.2
D. annularis	(4)	(6.8)	*S. undosquamis*	11	10.2	*S. undosquamis*	8	9.6
Synodontidae		41.1	*S. saurus*	15	14.3	*S. saurus*	21	25.6
S. undosquamis	17	31.8	Muraenidae					
S. saurus	5	9.3	*M. helena*	17	15.1			

Table 2. Shannon-Wiener Diversity (H') and Pileou's Evenness (J') indices in eggs and larvae calculated for each month and depth contour

Seasons and Months		Indices For Eggs						Indices For Larvae					
		0-50 m		50-100 m		>100 m		0-50 m		50-100 m		>100 m	
		H'	J'	H'	J'	H'	J'	H'	J'	H'	J'	H'	J'
Winter	Dec	1.34	0.97	1.32	0.95	1.17	0.84	0.50	0.72	0	-	0	-
	Jan	0.88	0.64	0.45	0.65	0.44	0.63	0	-	0.49	0.45	0	-
	Feb	1.37	0.77	1.49	0.83	1.13	0.70	0.65	0.94	0.68	0.98	0.69	1.00
Spring	Mar	1.00	0.91	0	-	0	-	0.49	0.44	1.06	0.76	0.60	0.86
	Apr	0.92	0.83	1.00	0.91	0.94	0.86	0.42	0.61	0	-	0	-
	May	1.05	0.76	0.66	0.95	0.67	0.97	0	-	0	-	0	-
Summer	June	1.45	0.90	1.57	0.87	0.95	0.86	0.64	0.92	0	-	0	-
	July	0.84	0.61	1.25	0.78	1.36	0.98	0	-	0	-	0	-
	Aug	1.26	0.91	0.90	0.82	0.96	0.87	1	0.9	0	-	0	-
Autumn	Sep	0.86	0.78	0.41	0.59	1.06	0.96	0.53	0.48	1.70	0.95	0	-
	Oct	1.00	0.91	1.01	0.92	0	-	1.07	0.98	0.69	0.99	0	-
	Nov	0.64	0.92	0	-	0	-	0.68	0.98	1.03	0.94	0	-

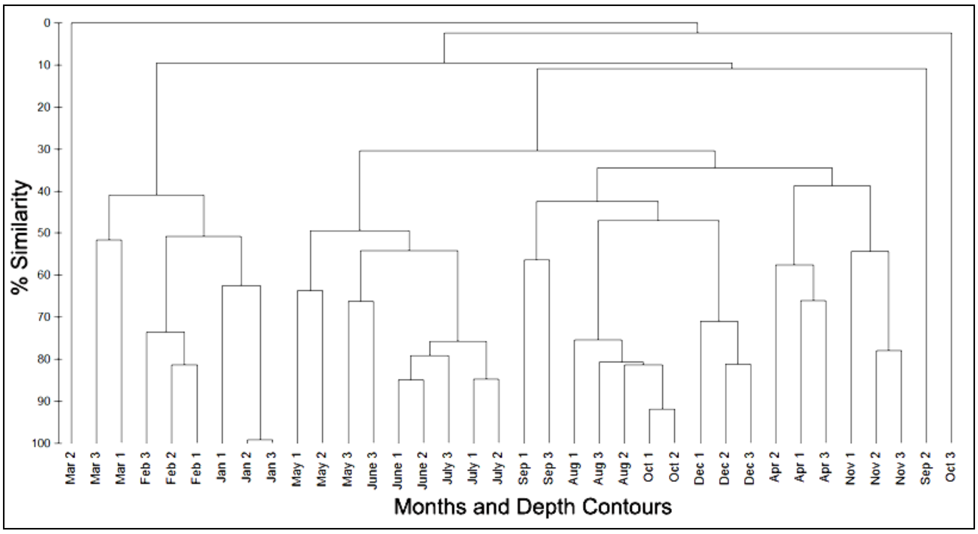

Figure 4. Dendrogram of Bray-Curtis index results applied among the months and depth contours for teleost fish eggs (1: 0-50 m; 2: 50-100 m; 3: >100m).

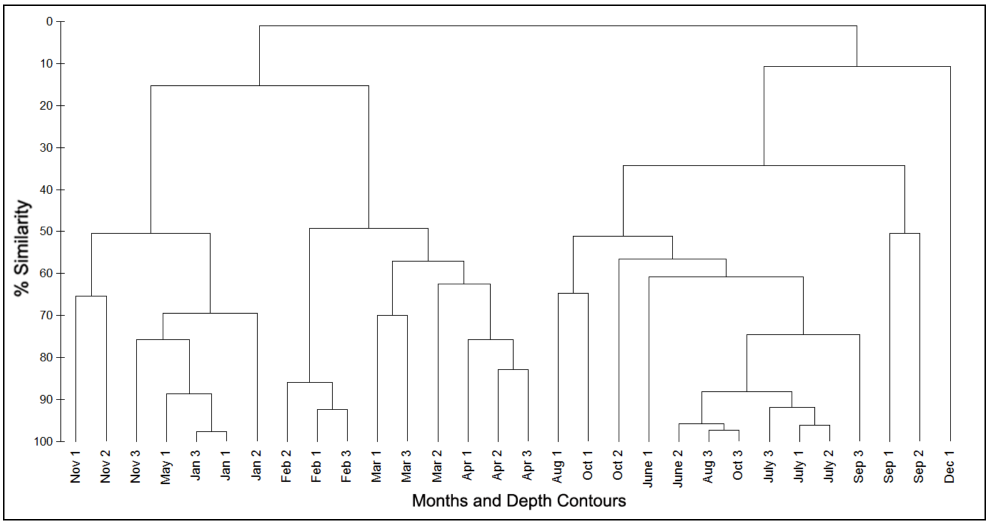

Figure 5. Dendrogram of Bray-Curtis index results applied among the months and depth contours for teleost fish larvae (1: 0-50m; 2: 50-100 m; 3: >100 m).

highest abundance and species number were determined. Minimal index values also seemed to be related to the abundance (Appendix 1; Figure 3). These reasons were valid for minimal and maximal larval diversities. When the larval diversity was taken into consideration, lower diversity values could be clearly seen than those of the eggs.

Four groups appeared for each of eggs and larvae among the similarity of different months and depth contours. When similarity calculated for eggs were discussed, normally, higher similarity rates were observed in same months. January, February and March formed a group characterized by winter spawned species. Similarly; May, June and July were another group consisted of summer spawned fishes. August, September, October and December jointly formed the other group. The cause of that December was included by this group, was due to the fact that fishes had long spawning time such as *Saurida undosquamis* and *Upeneus* spp. April and November jointly formed a different group because of the same reason. If the larval similarity is taken into the consideration, firstly a group formed by November, January and May appears. The cause of this unexpected grouping was also similar to the case of eggs. But, it was differently resulted from *Citharus linguatula*. February, March and April seemed to occur a natural grouping. June, July, August, September and October formed another group except for first and second depth contours of September. Mentioned sampling units jointly formed a different group with high abundance and species richness.

It could be inferred from the results of this investigation that Babadıllimanı Bight is one of the appropriate spawning and nursery ground for fishes in the North Eastern Mediterranean. The catching of early life stages of some highly economically important fish species such as *Mullus barbatus*, *Pagellus erythrinus* and *Solea solea* also showed the importance of the studying area in respect of economical fish stocks. However, the fisheries of the Northeastern Coasts of Mediterranean were not well developed due to the unsuitable conditions for trawling (Gucu and Bingel, 1994). Another important subject that should be necessarily discussed when Eastern Mediterranean fishes are considered is Lessepsian Phenomenon. It could be clearly seen from the findings of this study that the abundance and species number of Lessepsians are lower than those is eastern part of studying area. According to Gucu and Gucu (2002), this case occurs as a result of Posidonia meadows existence in the mentioned region.

As a conclusion, understanding the ichthyoplankton structure and dynamics of an area is important to comment on fish populations of there (Govoni, 2005). Therefore, it is thought that more specific and detailed investigations are required about the ichthyoplankton of the Northeastern Coasts of Mediterranean.

References

Ak, Y. 2004. The Abundance and Distribution of the Pelagic Eggs and Larvae of Some Teleost Fishes in off Erdemli, Mersin. PhD thesis. İzmir: Ege University.

Ak, Y. and Uysal, Z. 2007. Mersin Korfezi (Kuzeydogu Akdeniz) Ihtiyoplanktonu. Ulusal Su Gunleri Sempozyumu, Poster Sunumu. 16-18 April. Antalya. (in Turkish).

Alimoglu, S. 2002. Marmara Denizi'nin Kuzeydogusunda Kemikli Baliklarin Pelajik Yumurta ve Larvalarinin Dagilimi ve Bollugu. MsC thesis, Istanbul: Istanbul University, Deniz Bilimleri Enstitusu. (in Turkish).

Avsar, D. 1999. Physico-Chemical Characteristics of the Eastern Mediterranean in relation to distribution of the new Scyphomedusae (*Rhopilema nomadica*). Turkish Journal of Zoology, 23(2): 605-616. (in Turkish).

Azeiteiro, U.M., Nicolau, L.B., Resende, P., Goncalves, F. and Pereira, M.J. 2006. Larval Fish Distribution in Shallow Coastal Waters off North Western Iberia. Estuarine, Coastal and Shelf Science, 69: 554-566.

Basar, E. 1996. Seasonal Distribution of Pelagic Eggs and Larvae of Some Marine Teleost Fishes in Bay of Surmene. MSc thesis. Trabzon: Karadeniz Technical University, Graduate School of Natural and Applied Sciences. (in Turkish).

Begg, G.A. 2005. Life History Parameters. Stock Identification Methods, Applications in Fishery Science. Elsevier Academic Press. London: 119-150.

Ben-Tuvia, A. 1966. Red Sea Fishes Recently Found in the Mediterranean. Copeia, 2: 254-275.

Ben-Tuvia, A. 1983. The Mediterranean Sea. B. Biological Aspects. In: B.H. Ketchum (Ed.), Estuaries and Enclosed Seas. Elsevier, Amsterdam: 239-251.

Clarke, K.R. and Warwick, R.M. 2001. Change in Marine Communities, an Approach to Statistical Analysis and Interpretation. 2 Edn. Premier E: Plymouth, 177 pp.

Coker, T. 2003. The Morphology and Ecology of the Pelagic Eggs and Larvae of Teleost Fishes in Izmir Bay. PhD thesis. İzmir: Ege University, Graduate School of Natural and Applied Sciences. (in Turkish).

Coker, T. and Mater, S. 2006. Ichthyoplankton species in Izmir Bay (1974-2005). E.U. Journal of Fisheries and Aquatic Sciences, 23(3-4): 463-472.

Demir, N. 1952. Marmara'da yasayan berlam balığının (*Merluccius vulgaris* Flem'in) yumurta ve larvalarının morfolojileri ile ekolojileri hakkında. Istanbul Universitesi Fen Fakultesi Hidrobiyologi Arastirma Enstitusu Yayinlari. Istanbul, Hidrobiologi, 1(1):5-13.

Demir, N. and Southward, A.J. 1974. The Abundance and Distribution of eggs and Larvae of Teleost Fishes off Plymouth in 1969 and 1970. Journal of Marine Biological. Association U.K., 54: 333-353.

Demirel, N. 2004. Marmara Denizi'nde Bulunan Teleost Baliklarin Pelajik Yumurta ve Larvalarinin Dagilim ve Bollugu. MSc thesis. İstanbul: İstanbul University, Institute of Marine Sciences and Management. (in Turkish).

Elbek, A.G., Oktay, E. and Saygı, H. 2006. Su Urunlerinde Temel Istatistik. Ege Universitesi Yayinlari. Su Urunleri Fakultesi Yayin No: 19. Izmir, 308 pp.

Gamgam, H. and Altunkaynak, B. 2008. Parametrik Olmayan İstatistik Yöntemler. Gazi Kitabevi, Ankara, 496 pp. (in Turkish).

Golani, D. 1998. Impact of Red Sea Fish Migrants Trough the Suez Canal on the Aquatic Environment of the Eastern Mediterranean. Yale F and S Bulletin, 375-387.

Govoni, J.J. 2005. Fisheries Oceanography and the Ecology of Early Life Histories of Fishes: a Perspective Over Fifty Years. Scientia Marina, 69(1): 125-137.

Gucu, A.C. and Bingel, F. 1994. Trawlable Species Assemblages on the Continental Shelf of the Northeastern Levant Sea (Mediterranen) with an Emphasis on Lessepsian Migration. Acta Adriatica. 35(1/2): 83-100.

Gucu, A.C. and Gucu, G.M. 2002. Why lessepsian immigrants are so successful in colonising the Eastern Mediterranean Sea and who are the Defenders of the Native Ecosystem. In: B. Ozturk and N. Basusta (Eds.), Workshop on Lessepsian Migration, 20-21 July 2002, Gokceada: 62-70.

Kocatas, A. 2003. Ekoloji Cevre Biyolojisi. Ege Universitesi Basim Evi. VII. Baski. Bornova-Izmir, 597 pp.

Koutrakis, E.T., Kallianiotis, A.A. and Tsikliras, A.C. 2004. Temporal patterns of larval fish distribution and abundence in a coastal area of northern Greece. Scientia Marina., 68(4): 585-595.

Mater, S. and Cihangir, B. 1990. Karadeniz, Istanbul Bogazi Girisinde Balık Yumurta-Larva Dagilimi Uzerine Bir Çalışma. X. Ulusal Biyoloji Kongresi Bildirileri. Ataturk Universitesi, Erzurum: 209-216.

Mavruk, S. 2009. Seasonal Changes on the Ichthyoplankton of Yumurtalık Coastal Zone (İskenderun Bay). MSc. thesis. Adana: University of Cukurova, Institute of Natural and Applied Sciences.

Miller, A.R. 1983. The Mediterranean Sea. A. Physical Aspects. In Estuaries and Enclosed Seas. In: B.H. Ketchum (Ed.), Elsevier, Amsterdam: 219-237.

Ozsoy, E., Hecht, A. and Unluata, U. 1989. Circulation and Hydrography of the Levantine Basin. Results of POEM Coordinated Experiments 1985-1986. Progress in Oceanography, 22: 125-170.

Ozsoy, E., Hecht, A., Unluata, U., Brener, S., Oguz, T. and Latif, M.A. 1991. A. Review of the Levantine Basin Circulation and its Variability During 1985-1989. Dynamics of Atmospheres and Oceans, 15: 421-456.

Ozsoy, E., Hecht, A., Unluata, U., Brenner, S., Sur, HI., Bishop, J., Oguz, T., Rosentraub, Z. and Latif, MA. 1993. A Synthesis of the Levantine Basin Circulation and Hydrography. 1985-1990 Deep Sea Research, 40(6): 1075-1119.

Palomera, I. and Pertierra, J.P. 1993. Anchovy Biomass Estimate by the Daily Egg Production Method in 1990 in the Western Mediterranean Sea. Scientia Marina, 57(2-3): 243-251.

Postel, L., Fock, H. and Hagen, W. 2000. Biomass and Abundance. ICES Zooplankton Methodology Manual. Academic Press. London: 83-192.

Reay, P.J. 1984. Reproductive Tactics: A Non-event in Aquaculture. Fish Reproduction Strategies and Tactics. Academic Pres., London: 291-310.

Satilmis, H.H. 2001. Pelajik Yumurta ve Larvalarin Sinop Yarimada'sinda Mevsimsel Olarak Dagilimi. MSc. Thesis, Samsun: Ondokuz Mayıs University, Graduate School of Natural and Applied Sciences.

Yuksek, A. and Gucu, A.C. 1994. Balık Yumurtaları Tayini Icin Bir Bilgisayar Yazılımı -Karadeniz Pelajik Yumurtaları- (Surum 1.2). Karadeniz Egitim Kultur ve Cevre Vakfi. 32 pp.