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Distribution of Ichthyoplankton during the Summer Period in the Northern Cyprus Marine Areas

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Abstract

In this study, ichthyoplankton samples collected during the July 1998 cruise of the *R/V K. Piri Reis* in the Northern Cyprus marine areas were evaluated. Samples were collected at 40 stations at 300–1200 m depth and yielded 73 eggs and 160 larvae in total belonging to 24 fish families including Clupeidae, Engraulidae, Gonostomatidae, Sternoptychidae, Chloropthalmidae, Paralepididae, Synodontidae, Myctophidae, Holocentridae, Triglidae, Carangidae, Sparidae, Mullidae, Labridae, Gobiidae, Trichiuridae and Soleidae. Among the deep marine species, Myctophiformes and Stomiiformes were the most important orders ranking first (29%) and second (12%), respectively. Anchovy eggs ranked first in the catch (49%; but with 28% dead), and Engraulidae 22%. Clupeidae also were abundant (11%), and Lessepsian (*Etrumeus teres) and (Sargocentrum rubrum)* larvae were reported from these waters for the first time. The important result of the present study is that pelagic fish sources in the area are dominant compared to the demersal fish species known previously.

Keywords: Ichthyoplankton, fish, eggs and larvae, Northern Cyprus, Eastern Mediterranean.

Kuzey Kıbrıs Denizel Alanında Yaz Dönemi İhtiyoplankton Dağılımı

Özet

Bu çalışmada,Kuzey Kıbrıs denizel alanında Temmuz 1998 boyunca *R/V K. Piri Reis* gemisiyle 300-1200 m derinliklerde toplanmış örnekler değerlendirilmiştir. Toplam 24 balık familyasına ait 73 yumurta ve 160 larva tanımlanmıştır. Bu familyalar Clupeidae, Engraulidae, Gonostomatidae, Sternoptychidae, Chloropthalmidae, Paralepididae, Synodontidae, Myctophidae, Holocentridae, Triglidae, Carangidae, Sparidae, Mullidae, Labridae, Gobiidae, Trichiuridae ve Soleidae'ye aittir. Derin deniz türleri arasında Myctophiformes (%29) ve Stomiiformes (%12) sırasıyla birinci ve ikinci sırada gelen en önemli grupları oluşturmuştur. Engraulidae larvaları tüm larval dağılım içerisinde %22'lik payla ikinci sıradadır. Hamsi yumurtaları %49'luk payla dağılımda birinci sırada olmakla beraber %28'i ölüdür. Clupeid türleri önemli yoğunluktadır (%11). Lesepsiyen *Etrumeus teres, Sargocentrum rubrum* larvaları bu sulardan ilk kez rapor edilmiştir. Pelajik balık kaynaklarının daha önceden bilinen demersal balıklara oranla alanda dominant oluşu bu çalışmanın önemli bir sonucudur.

Anahtar Kelimeler: Ihtiyoplankton, balık, yumurta ve larva, Kuzey Kıbrıs, Doğu Akdeniz.

Introduction

The Eastern Mediterranean is known to be a closed temperate sea characterised by oligotrophic conditions and colonised by subtropical species (Demir, 1954). The Cyprus area is one of the least diverse in the Mediterranean Sea in terms of fisheries, contrary to the coastal areas of Egypt, Lebanon and Syria. Overall, only 450 tons of shellfish are captured in the northern Cyprus area (NCMFAL, 2010), and the amount of total fish and shellfish in the Turkish Republic of Northern Cyprus (TRNC) accounts for 5,705 tons in total, of which 3,600 tons (63%) are from aquaculture and 2,100 tons (37%) from fishing activities. The main fish species commercially captured and processed are mullet (*Mullus surmuletus*), red mullet (*Mullus barbatus*), bogue (*Boops boops*), red sea bream (*Pagellus erythrinus*), sea bream (*Spicara smaris*), whiting (*Merlangius merlangus*), mackerel (*Scomber scombrus*), groupers (*Serranus* spp.), gild head bream (*Sparus aurata*), sea bass (*Dicentarchus labrax*), swordfish (*Xiphias gladius*), tuna (*Euthynnus alletteratus*), tunny (*Thynnus thynnus*) and common dentex (*Dentex*

dentex). For this reason, the fisheries of the area can be said to depend upon demersal species (Hoşsucu *et al*., 1998).

In recent years, the Mediterranean Sea has been under threat from invasive species through the Suez Canal. In this respect, Çınar *et al*. (2011) pointed that the highest number of exotic fish species (n = 86) occurs in the Turkish waters of the Eastern Mediterranean Basin, whereas Katsanevakis *et al.* (2009) identified 28 fish species, 12 of which Lessepsian invasive/migratory.

From the Turkish seas, Fricke *et al*. (2007) listed 503 fish species in total, 428 of which inhabiting the Mediterranean Sea. Bilecenoğlu *et al*. (2014) reported 441 species along the Levantine coast.On the other hand, no information is currently available on the number fish species inhabiting the northern Cyprus marine areas, even though.

Studies carried out so far along the Turkish coasts of Cyprus have been concerned with the exploration of biotopes, currents and hydrography, thus making it possible to establish locations suitable for aquaculture. Also, 57 reproducing teleost species have been recorded in the area (Hoşsucu *et al*., 1998), and trawl studies have identified 74 species (Benli *et al*., 1999), whereas another 25 species have been reported from Güzelyurt Bay (Oray and Karakulak, 2005a). Finally, Torcu *et al*. (2001) listed 49 teleost species for the area, Cihangir *et al*. (2002) explored demersal fisheries sources and identified 58 fish species.

The original ichthyoplankton studies by Arım (1957) are known to represent a good alternative to evaluate fish species diversity, and especially so in inshore locations where trawling does not occur, as well as to detect the presence of pelagic fishes. Ichthyoplankton investigations are of unique value for understanding of reproductive and early life history adaptations of fishes to their ecosystem (Moser and Smith, 1993)Accordingly, the aim of the present study was to assess the ichthyoplankton status in Mediterranean waters of the TRNC as of July 1998 (summer season) and to produce maps on the diversity, abundance and distribution of fish species at the 40 stations where Oray *et al*. (2010) examined samples in June 2004. Notably, the present study is the first to report on some previously unrecorded species inhabiting the TRNC and to provide an overview of ichthyoplankton distribution in the southern part of this region.

Materials and Methods

Ichthyoplankton samples were collected in July 1998 during the cruise of the *R/V K. Piri Reis* at 40 stations along the TRNC at 300–1200 m depth (Table 1; Figure 1). Also, sampling a 782 km long coastline represents a total area of 4391 km^2. Samples were collected from depths of 0–200 m with vertical tows using a WP-2 type 250 µ mesh size net. Nearshore stations were not sampled; Research Vessel couldn't cruise at the shallow waters due to the high tonnage. Coordinates and depths of the study stations are given in (Table 1).

Samples were stored in 1 L plastic bags containing buffered 4% formaldehyde solution. In the laboratory, fish eggs and larvae were separated from the rest of the zooplankton with the help of pipettes and pliers, and measurement was performed under an Olympus SZ61 stereomicroscope (4*10X). Fish eggs and larvae were identified to the lowest possible taxonomic level and enumerated. Mortality values indicate the rate of dead eggs. The presence of dead egg indicates that individuals were unable to complete their embryonic development, show in either an opaque capsule (normally transparent) at any stage of development or a ruptured capsule or damaged vitellus.

Species identification was after Raffaelle (1888), Cunningham (1889), Ehrenbaum (1905), Vodyanitski and Kazanova (1954), Arım (1957), Conand and Fagetti (1971), Dekhnikh (1973), Russell (1976), Mater (1981), Okiyama (1988), Matarese *et al.* (1989), Leis and Trnski (1989), Arias and Drake (1990), and Olivar and Fortuno (1991). Frequency of eggs and larvae was calculated after Benli *et al*. (1999):

F=occurrence in samples/total number of samples) *100

The volume of water filtered was calculated from a calibrated flow-meter in the mouth of net, and density as:

$$V = t * v * C \text{ (individual/m}^3 = \text{hour*m/h* m}^2\text{)}$$

where V is the sample volume, t the time of hauling, v the speed of hauling, and C the mouth area of the circle ($\pi * r^2$).

Even though quantitative results in ecological studies are typically shown as number of individuals per volume (n/m^3) or litre (n/L) the number of individuals in the area (n/m^2) can be used as a surrogate in ichthyoplankton studies due to differences in water temperature along the water column (Özel, 1992). Also, the abundance of the identified species was calculated as

$$N/\pi * r^2 \text{ (individual/m}^2\text{)},$$

where N is the number of samples across all stations (Harris *et al*., 2001). Notably, in the present study all eggs and larvae were sorted, although the number of collected larvae was very low mainly due to sampling net (WP-2) characteristics and hauling depth.During collection, the environmental parametres such as water temperature, salinity and dissolved oxygen were recorded by an instrument CTD. Finally, for all sampling stations the monthly abundance of eggs and larvae was computed along

Table 1. Station depths and coordinates of the study area

Stations	Latitude (N)	Longitude (E)	Depth (m)
1	33°002’	35°632′	1180
2	33°013′	35°478′	870
3	33°168′	35°632′	1071
4	33°167′	35°50′	787
5	33°165′	35°417′	No data
6	33°333′	35°632′	993
7	33°167′	35°417′	845
8	33°497′	35°632′	975
9	33°498′	35°495′	829
10	33°495′	35°415′	674
11	33°663′	35°632′	916
12	33°663′	35°497′	828
13	33°832′	35°633′	904
14	33°832′	35°50′	706
16	33°997′	35°582′	798
17	33°998′	35°50′	530
18	34°002′	35°25′	553
20	34°167′	35°663′	730
21	34°165′	35°417′	40
22	34°165′	35°25′	42
24	34°332′	35°665′	730
28	34°498′	35°748′	636
29	34°50′	35°582′	413
32	34°663′	35°75′	473
33	34°665′	35°583′	973
36	34°832′	35°75′	653
38	33°99′	35°172′	No data
39	33°958′	35°145′	No data
40	34°000′	35°145′	70

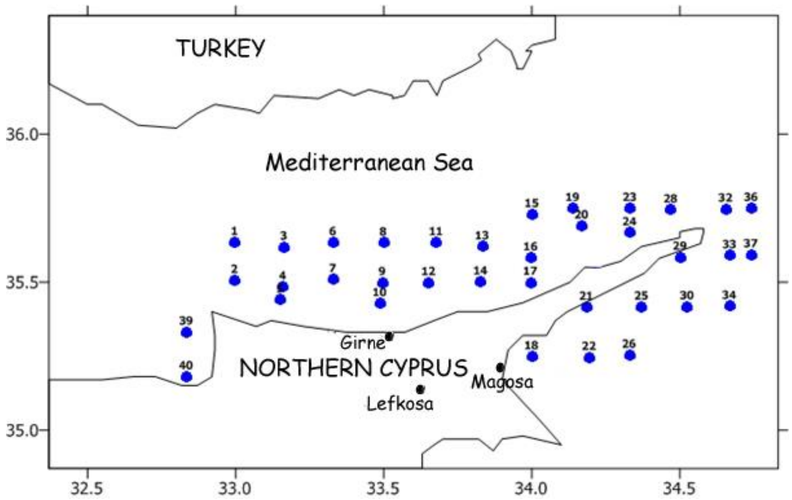

Figure 1. Study area and stations.

with the hydrographic parameters at 10, 50 and 100 m depth.

The Bray-Curtis similarity dendogram showing the similarity of the stations (Bray and Curtis, 1957). The Kruskal Wallis Test (Non-Parametric One-Way ANOVA) was applied to explain statistically the meaning of the densities at the stations.Kruskal-Wallis rank sum testdata: (number individual by station; P-value= 0.4699) (R Core Team, 2015; http://www.R.project.org).

In order to express the species diversity of the stations and number of eggs and larvae the Shannon-Wiener species diversity index was used (Hoşsucu and Ak, 2002).

Results

Hydrographic parameters including temperature, salinity and oxygen in the study area up to 100 m depth are shown in Figure 2. Temperatures ranged from 26.8 to 28.8°C on the surface and decreased to 18–20 °C at 50 m and 16.5°C at 100 m; min–max salinities were 38.97–39.30‰ and reached a minimum at 50 m depth; oxygen values were 4.20–4.70 ppm from surface to 10 m depth and increased to 6.20–6.40 ppm at 50–100 m.

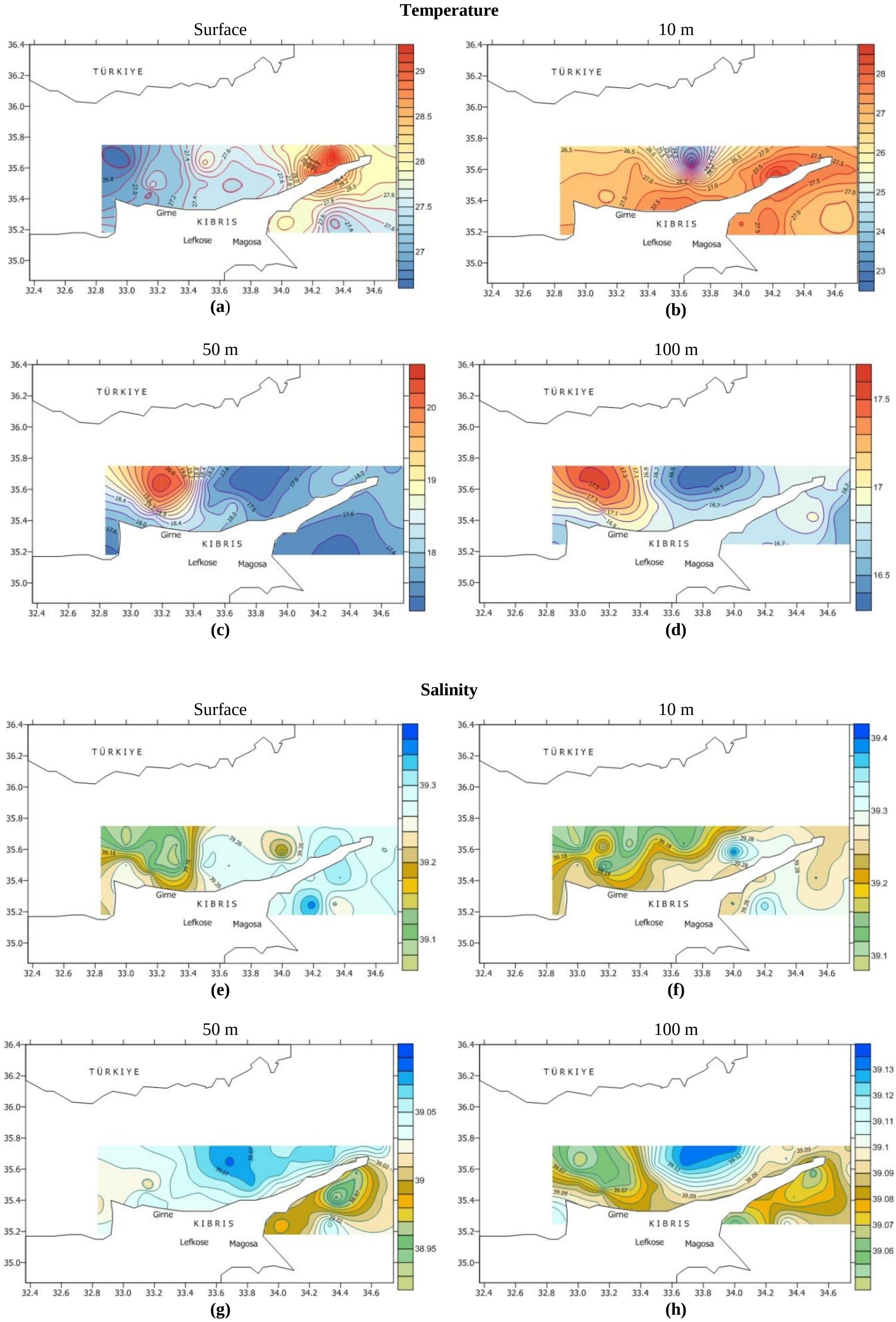

Figure 2. Temperature and salinity distributions (surface-10m-50m-100m).

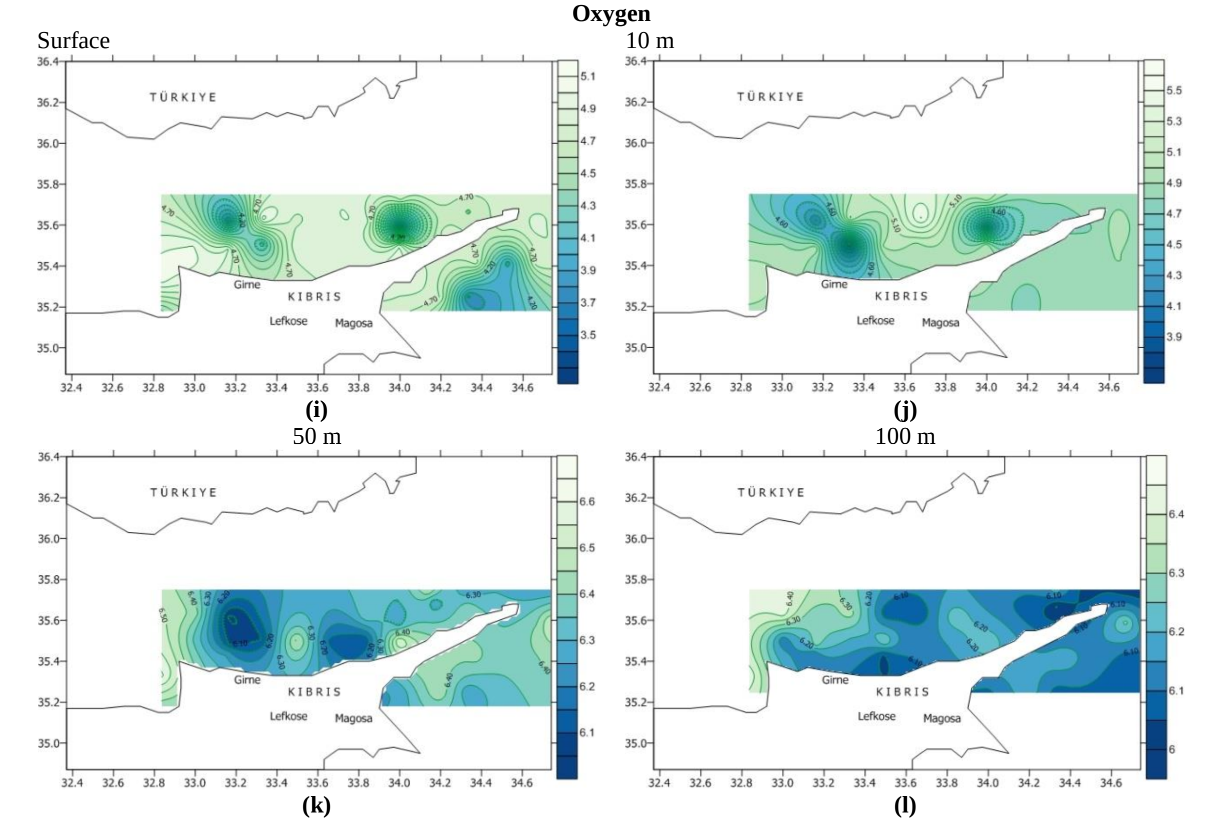

Figure 2. Oxygen distributions (surface-10m-50m-100m).

In total, 160 larvae and 73 eggs were identified belonging to 15 genera and 20 species and in 24 families and 5 orders, plus four unidentified eggs and one larva. *Engraulis encrasicholus*, *Dussumieria elopsoides*, *Hygophum* spp. and *Gobius paganellus* were the most abundant taxa in terms of occurrence of larvae. In addition, anchovy eggs and Unidentified species 2 also occurring in high abundance across the area (Table 2).

Overall, egg densities were not high. A maximum value of 44 specimens was recorded at stations 19 and 20 (off Incirli stream near Mercan Cape, in the northeastern part of the study area),where the highest egg densities (23.94 and 42.56 ind./m^2, respectively) were present. The northwestern section of the TRNC had low egg densities (2.66–5.32 ind./m^2), and the eastern section (between Limanbaşı and Mercan Cape) comparatively higher distribution (7.98–15.96 ind./m^2). n individual distribution dropped to 3 ind./m^2 in the southeastern section (off Dipkarpaz and Kumyalı).

Anchovy eggs ranked first, followed by dead eggs, unidentified species, *Solea* spp. (5%) and *Synodus* spp. (3%) (Figure 3). Also, the proportion of unidentified species was quite high, and 28% of anchovy eggs were dead and Figure 4 shows.

The highest larval densities ranged from 40 to 44 ind./m^2 and were recorded from the northern (off Güzelyurt and Yenierenköy) and eastern cape of the Island (Dipkarpaz shores). Anchovy was the species with the highest eggs numbers across the coastline, with a maximum of 38 ind./m^2 off Yenierenköy and a minimum of 2 ind./m^2 along the northern and southern shores of the Island. Anchovy larvae had a density of 7–10 ind./m^2 along the northern coast, peaked at 19–21 ind./m^2 in the northwestern section and decreased at 1–5 ind./m^2 in the southern shores (Figure 5).

The density of sardine larvae was comparatively lower than that of anchovy, with 8 ind./m^2off Girne and Yenierenköy inshores. *Thunnus* spp. were found both in the northern and southeastern parts of the Island; with a maximum value of 8 ind./m^2 of the north. Other representative groups were Stomiiformes (10–13 ind./m^2) in the northern part of the Island and Myctophiformes (4–20 ind./m^2) in the north and southeast. Finally, *Gobius paganellus* larvae occurred as 13 ind./m^2 in the westernmost section (Kayalar) and as 4 ind./m^2 north and south of TRCN. Myctophiformes made up for 29% of the total larval composition, Engraulidae and Stomiiformes represented 22% and 12%, respectively, with Clupeidae being the more representative family (11%) (Figure 6).

Based on the Bray-Curtis similarity index, nine clusters of stations were identified with a similarity level of 40% (Figure 7). Six clusters (I, II, III, IV, V and IX) comprised two similar stations, whereas clusters VI and VII consisted of four stations each and group VIII included seven stations. The highest similarity level (100%) was between stations 14 and 30.

When variations in the species diversity index

Table 2. Species recorded from TRNC and their frequencies of appearance (0.43-1: rare, 1-5 : frequent, 10-15 :abundant , 20-30: most frequent species). *e*: eggs, *l*: larvae

Clasis: TELEOSTEI	Larvae (Frequency of appearance)	Egg (Frequency of appearance)
ORDER: CLUPEIFORMES		
Family: CLUPEIDAE	1.31	
Sardina pilchardus (Walbaum, 1792) (*l*)	3.50	
Sardinella aurita Valenciennes, 1847 *(l)*	3.50	
Dussumieria elopsoides Bleeker, 1849 *(l)*	10.08	
Etrumeus teres (Dekay, 1842) *(l)*	2.19	
Family: ENGRAULIDAE		
Engraulis encrasicholus (Linnaeus, 1758) *(e, l)*	22.80	48.33
ORDER: STOMIIFORMES		
Family: GONOSTOMATIDAE	2.19	
Cyclothone spp.*(l)*	2.63	
Gonostoma spp.*(l)*	4.38	
Gonostoma atlanticum Norman, 1930 *(l)*	0.43	
Family: STERNOPHYCTIDAE		
Maurolicus muelleri (Gmelin, 1789) (l)	0.43	
Argyropelecus hemigymnus Cocco, 1829 *(l)*	0.43	
Family: PHOSICHTHYIDAE		
Vinciguerra spp. *(l)*	1.75	
Family: PARALEPIDIDAE	0.87	
Family: TRICHIURIDAE		
Lepidopus caudatus (Euphrasen, 1788)*(l)*	0.43	
ORDER: AULOPIFORMES		
Family: CHLOROPHTHALMIDAE		
Chlorophthalmusagassizi Bonaparte, 1840 *(l)*	0.43	
Family: SYNODONTIDAE		
Synodus saurus (Linnaeus, 1758) *(l)*	0.43	3.33
Synodus spp. (e)		
Family: PARALEPIDIDAE		
ORDER :MYCTOPHIFORMES		
Family: MYCTOPHIDAE	0.43	
Ceratoscopelus spp. *(l)*	0.43	
Electrona spp. *(l)*		
Electrona rissoi (Cocco,1829)*(l)*	1.31	
Hygophum spp. *(l)*	13.15	
Hygophum benoiti (Cocco,1838)*(l)*	0.87	
Lampanyctus spp.*(l)*	0.87	
Myctophum spp. *(l)*		
Nonidentified deep water species	2.19	
Ichthyococcus spp. *(l)*	0.43	
Family: HOLOCENTRIDAE		
Sargocentrum rubrum (Forsskål,1775) *(l)*	0.43	
Family: MACRORHAMPHOSIDAE		
Macrorhamphus scolopax (Linnaeus, 1758) *(l)*	0.43	
Family: SERRANIDAE		
Serranus spp.*(l)*	1.75	
Family: POMATOMIDAE		
Pomatomus saltatrix (Linnaeus, 1766) *(l)*	0.87	
Family: CARANGIDAE		
Trachurus trachurus (Linnaeus, 1758)*(l)*	0.87	
Tarchurus spp.*(l)*		
Family: CORYPHAENIDAE		
Coryphaena hippurus Linnaeus, 1758 *(l)*	0.43	
Family: SPARIDAE	1.31	
Family: AMMODYTIDAE		
Gymammodytes cicerellus (Rafinesque, 1810) *(l)*	0.43	
Family: MULLIIDAE		
Mullus spp. *(l)*	0.43	
Family: XYRICHTHYIDAE		
Xyrichthys novacula (Linnaeus, 1758) *(l)*	0.43	
Family: CALLIONYMIDAE		
Callionymus spp.*(l)*		
Family: GOBIIDAE		
Gobius paganellus (l)	9.21	
Family:SCOMBRIDAE		
Thunnus thynnus (Linnaeus, 1758) *sp1 (l)*	0.87	
Thunnus sp2 *(l)*	4.38	
ORDER: HETEROSOMATA		6.66
Family: SOLEIDAE		
Solea spp.(e)		3.33
Family: BOTHIDAE		
Arnoglossus spp.*(l)*	0.43	
Not identified (l)		
Unidentified species 1 *(e)*		8.33
Unidentified species 2 *(e)*		18.33
Unidentified species 3 *(e)*		6.66
Unidentified species 4 *(e)*		1.66
Unidentified species 5 *(e)*		3.33

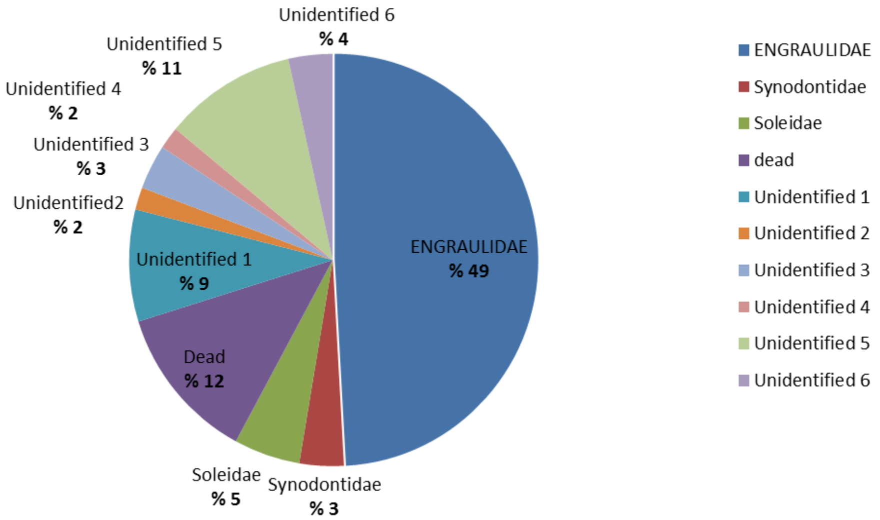

Figure 3. Percentage contribution of the eggs.

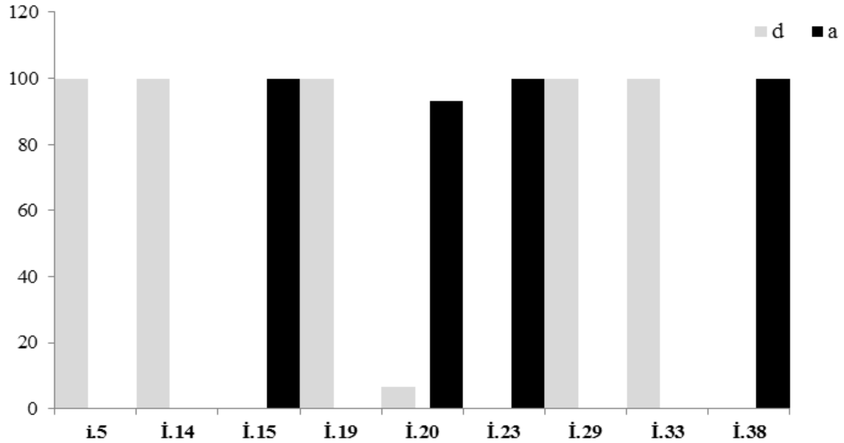

Figure 4. Percentages of anchovy's live and dead eggs at the stations (a: alive, d: dead).

the Shannon-Wiener were examined, index value were found to be for eggs H'(log10) 3,845 and larvae H'(log10) 4,58.8 while the maximum diversity index were 0,55 at stations 1 and 5, and the minumum value 0.19 at stations 23 and 24.

As a result of the Kruskal Wallis Test, the P value was found to be >0.05, indicating that the change of density among stations is not statistically significant (Gamgam, 2008).

Discussion

The ichthyoplankton surveys carried out in this study across the TRCN have identified 24 families belonging to 5 orders in total, and failure to identify eggs was caused by the fact that some of these were in their initial embryonic stage whereas others could not be morphologically defined (mostly eggs of deep marine species). The present study has extended to the southern area of Cyprus previous findings from ichthyoplankton research conducted at 104 stations in its northern part, Oray *et al*. (2010) where 80 types of eggs and larvae from 13 genera and 37 families were identified in June 2004 (summer season) across a region between northeastern Cyprus and the south of Turkey including Mersin and Iskenderun Bays.

In the northeastern Mediterranean, Ak (2004) found eggs and larvae of 129 species in Mersin Bay, Mavruk (2009) recorded 120 species from İskenderun Bay, and Avsar and Mavruk (2010) found 20 species in Yumurtalık Bay. In the present study, the anchovy mortality rates recorded in the July 1998 samples were reported for the first time.Also, the proportion of species according to their origin was 60% Atlanto-Mediterranean, 20% cosmopolite, 15% Lessepsian and 5% Mediterranean endemic. Habitat-wise, the proportion of pelagic adult species was 61.1% epipelagic, 22.2% mesopelagic 11.1% and benthic 38.9%. (Somarakis *et al*., 2011) reported that in coastal waters of central Greece identified groups of the stations dominated by larvae of epipelagic, bentopelagic and mesopelagic species. Mesopelagic species also have a very low economic value, nevertheless, their abundance in the Mediterranean

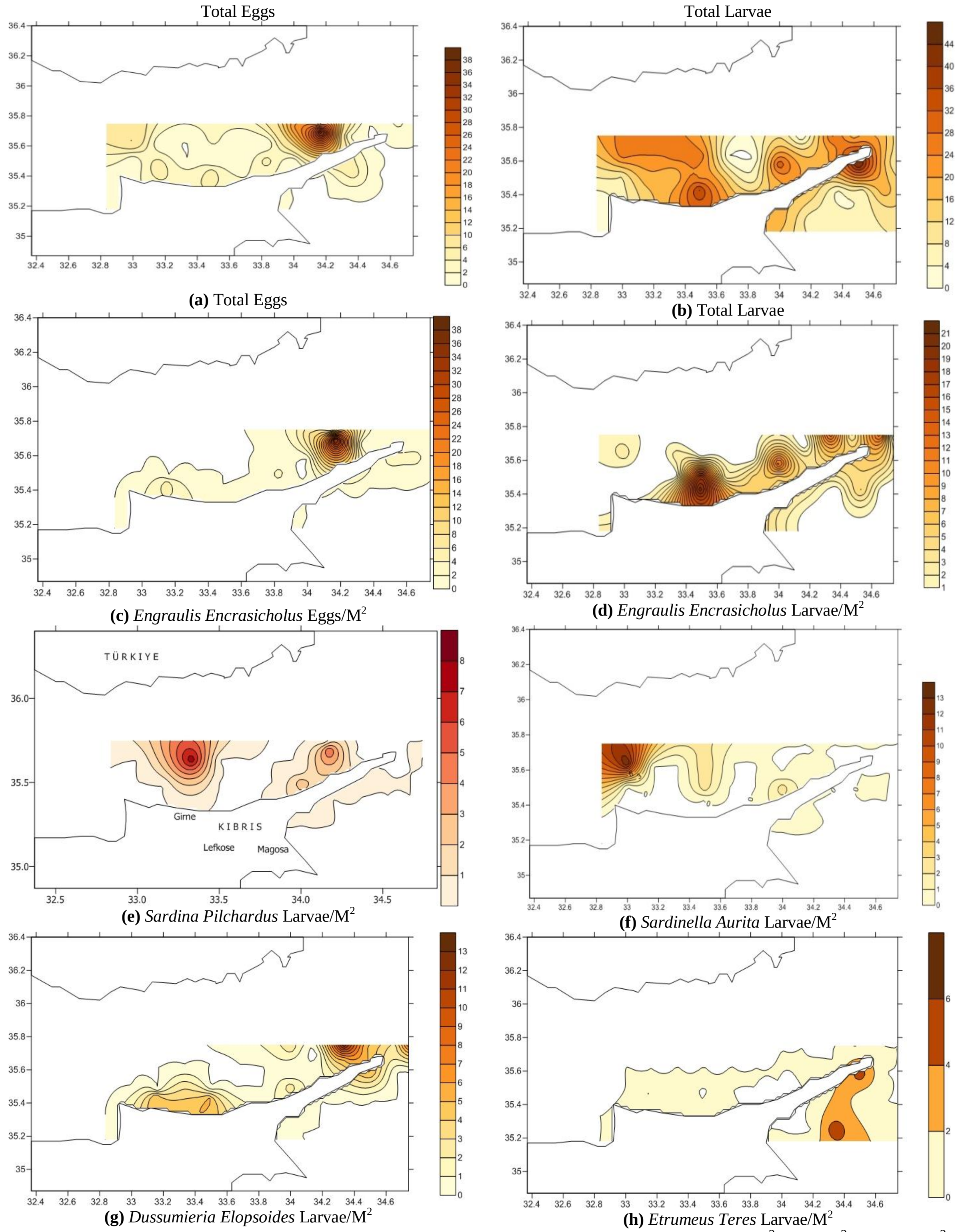

Figure 5. Distribution maps of several species recorded from the study are of TRNC (individual/m^2; eggs/m^2 or larvae/m^2).

sea makes them the best-represented member of the deep water fauna they are the most common prey to other fish species (Olivar *et al*., 1998; Somarakis *et al*., 2002).

In the present study, 10 species were reported for the first time from this region. Specifically, larvae and adults of *Dussumeira elopsoides* (Lessepsian), *Argyropelecus hemigymnus*, *Hygophum benoiti*, *Gymnoammodytes cicerellus* and *Gobius paganellus* were not reported in previous studies from the same area, whereas for *Etrumeus teres* (Lessepsian), *Sargocentrum rubrum* (Lessepsian), *Macrorhamphosus scolopax*, *Pomatomus saltatrix* and *Coryphaena hippurus*, which were previously

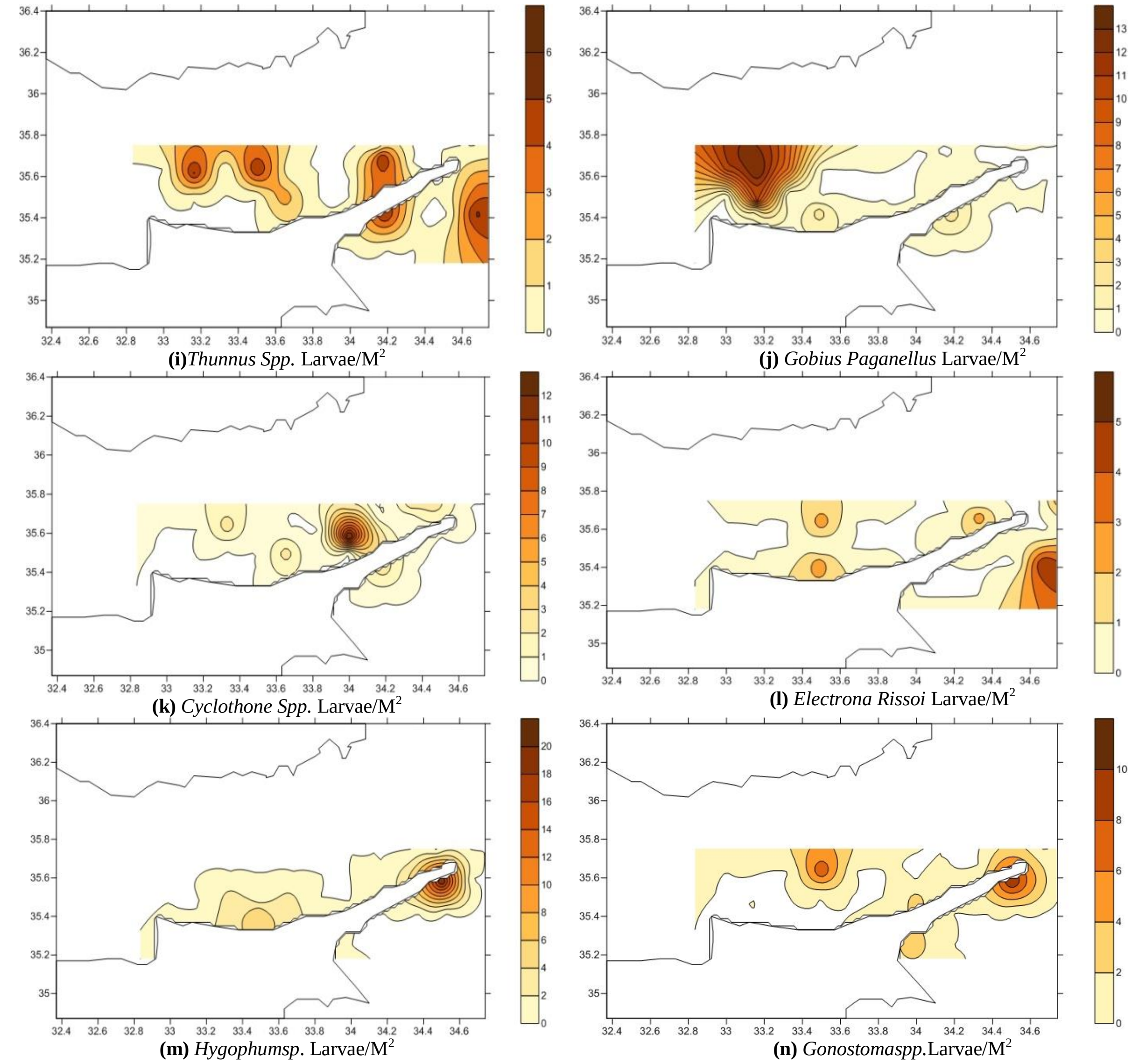

Figure 5. Distribution maps of several species recorded from the study are of TRNC (individual/m^2; eggs/m^2 or larvae/m^2).

recorded only as adults, the finding of larvae indicates successful reproduction.The number of Lessepsian species so far reported from Cyprus is twelve, with the adult record of *E. teres* and *S. rubrum* being reported by Cihangir *et al*. (2002) and Torcu *et al*. (2001), whereas *D. elopsoides* was not previously recorded. Some Lessepsian migrant species reported by Katsanevakis *et al*. (2009) from Cyprus waters until July 2009 were *Fistularia commersoni*, *Lagocephalus sceleratus*, *Siganus luridus*, *Siganus rivulatus*, with *Lagocephalus spadiceus*, *Lagocephalus suezensis*, *Scomberomorus commerson*, *Sillago sihama* and *Sphoeroides pachygaster* being new records. Townsend and Rashidi (1991) reported *Sympholophorus veranyi* and *Selar djeddaba* from Israel and Egyptian waters, and Lakkis *et al*. (2011) in Syria-Lebanon inshores reported *S. rubrum*, *Apogon imberbis*, *S. luridus*, *S. rivulatus* as well as *Callionymus filamentosus*, *Symphurus nigrescens*, *Cynoglossus cinusarabici*, adults which have also been reported from the Turkish Mediterranean.

Katsanevakis (2009) claimed that Anatolia isolated from Cyprus to form a geographical barrier that ultimately prevented numerous species from colonising the island, mainly due to the absence of strong currents which would have otherwise connected the region with Levantine inshores. However, some records of larvae are also probably due to the lack of inshore scientific studies. In this respect, *Engraulis encrasicolus*, *D. elopsoides*, *E. teres, Xyrichthys novacula*, *M. scolopax*, *G. paganellus*, *Thunnus* spp *and Paralepis* sp. were reported for the first time in the present study from the southern waters of TRNC. Also, Oray *et al*. (2010) were the first to report larvae of *Evermanella balboa* and *Osmerus* spp. in Cyprus for Turkish waters, and the first record of adult *E. balboa* was from Antalya Bay in 2009–2011 by Deval (2013). This is a mesopelagic species found at 900-1000 m depth. All species exist in meroplankton either they

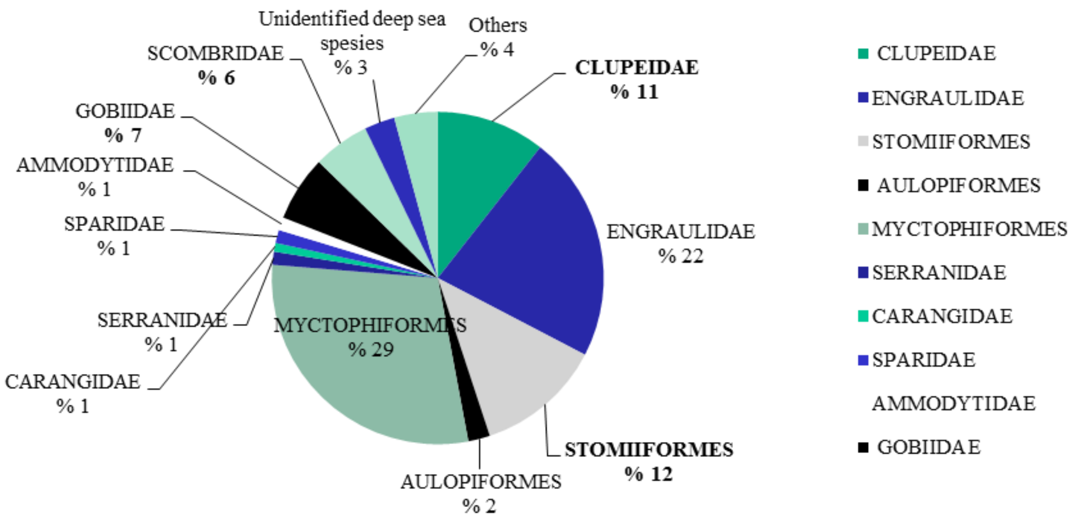

Figure 6. Percentage contribution of larvae.

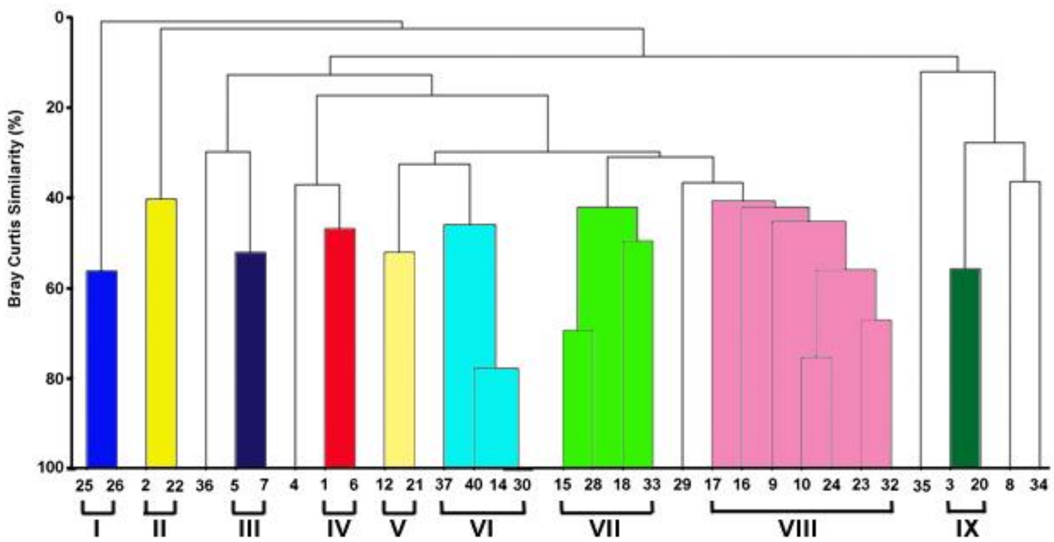

Figure 7. Dendogram showing the similarities among the stations.

are benthopelagic or mesopelagic (Leiby, 1984).

In this study, the overall number of larvae was very low, and this was likely due to the oligotrophic waters surrounding Northern Cyprus waters. Benli *et al*. (1999) reported that the productivity in Northern Cyprus waters was less compared to other seas such as the Northern Aegean and Black Seas, mainly due to low amounts of nutrients depressing plankton densities. Cyprus waters are subject to important currents flowing across the eastern Mediterranean Basin,where the Atlantic current entering the Mediterranean Sea through the Gibraltar Strait sweeps along the north African shores eastwards and bifurcates south west of Cyprus to create the eddy called the 'Cyprus cyclonic turbulence'.The middle Mediterranean jet flows along southern Cyprus, pointing south and occasionally bifurcating toward northern Anatolia to create the Kilikia current. Finally, the Lattakia cyclonic eddy, with a diameter of 10–15 km emerges, from the Lattakia Basin east of Cyprus (Emery *et al*., 1966).

In Cyprus waters, Oray *et al*. (2010) reported found the larvae of *Electrona risso* to be the most dominant (426 ind./1000 m^3), followed by *Sardina pilchardus* (404 ind./1000 m^3), *Sardinella aurita* (216 ind./1000 m^3) and *E. encrasicolus* (128 ind./1000 m^3). These findings are all consistent with the results of the present study, in which Myctophidae (29%), Engraulidae (22%), Stomiiformes (1%) and Clupeidae (11%) were also proportionally high, with *D. elopsoides* (F = 10.08), *E. encrasicolus* (F = 22.80) and *Hygophum* spp. (F = 13.15) having the highest occurences. (Tsikliras *et al*., 2011) found that the most abundant and frequently occurring larvae, especially the European anchovy (*E. encrasicolus*) in Kavala Gulf (northern Aegean Sea). As the current study was conducted in deep waters (413–1071 m), the higher percentages of Myctophidae and Stomiidae may be attributable to such hauling depths. The vertical distribution of mesopelagic fish larvae indicates that they tend to dwell at depths above 200 m (Sabates and Mercedes, 1990).

Also, the number of anchovy eggs and larvae was considerably higher compared to those of the other species due to their extended spawning time. Thus, *S. pilchardus* and *S. aurita* had a low emergence of 3.50 (frequency of appearance) and their eggs were not found, possibly due to *S. aurita* normally preferring inshore coastlines for spawning. The frequency of *D. elopsoides* was found to be higher relative to the other species, and the fewer samples of Clupeid eggs could have been due either to the sampling being carried out at the end of the species's spawning period or to the species's preference for shallow spawning grounds.

In the present study, the larvae of *Thunnus thynnus* and *Thunnus* spp. represented 6% of the total distribution, with an emergence of 0.87 and 4.38, respectively, and showed similar distribution in the southeastern part of the Island (2–6 ind./m^2). (Oray and Karakulak 2005b) found Mersin Bay and Kilikia basin (located between Turkey and north Cyprus) to be the preferred spawning areas of Scombridae (tuna fish *T. thynnus*; little tunny *Euthynnus alletteratus*; bullet tuna *Auxis rochei*). Also, Ak (2004) recorded eggs and larvae of *Thunnus alalunga (*4-8 ind./m^2) and larvae of *Thunnus* spp. (4 ind./m^2) in Mersin Bay, and Mavruk (2009) identified postlarvae of *E. alletteratus* (9 ind./1000 m^3) and *Katsuwonus pelamis* (19–97 ind./1000m^3) and *T. thynnus* (11 ind./1000m^3) in Iskenderun Bay (spring and summer).

Further longer term monitoring surveys should be carried out on ichthyoplankton biology to support the development of fisheries in TRNC (Benli *et al.*, 1999). In this respect, the present study has contributed new knowledge of the pelagic and deep marine species of the area, so far not reported by official ichthyoplankton statistics for the Turkish seas. The pelagic stage is more likely used to determine the geographical size of fishes than the adult stage (Leis, 1986).

Also, settlement time between native and migratory species and its early determination is of great importance for the future of fisheries in the northeastern and southeastern Mediterranean Sea. Finally, it now seem possible to determine more accurately the spawning locations and reproductive periods of Myctophiformes, Stomiiformes and, especially, Scombridae through research conducted all year round at the relevant sampling stations.

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