Iranian Journal of Fisheries Sciences 12(2) 265-276 2013

Seasonal zooplankton community variation in Karataş Lake, Turkey

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Received: June 2012 Accepted: December 2012

Abstract

This study was carried out to determine seasonal variation and zooplankton community structure in Karataş Lake, Southern Turkey. Zooplankton samples were collected seasonally between 2002 and 2003 in two stations using a zooplankton net of 55-µm mesh size. A total of 42 taxa were identified, including 19 taxa (45.2 %) Rotifera, 16 taxa (38.1 %) Cladocera, and 7 taxa (16.7 %). Copepoda. Among them, *Keratella quadrata*, *Asplanchna priodonta* from Rotifera, *Daphnia longispina*, *Ceriodaphnia quadrangula*, *Chydorus sphaericus*, *Coranatella rectangula* from Cladocera, and *Eudiaptomus drieschi*, *Eucyclops speratus* from Copepoda were dominant species. Spring and autumn seasons were found to be the most similar by using Sorenson index value.

Keywords: Zooplankton, Community, Seasonal change, Karataş Lake

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Introduction

The abundance of organic matter of aquatic habitats depends completely on the food chain process. In the food chain of freshwater ecosystems, the first chain is Phytoplankton and the second chain is Zooplankton. It has been reported that zooplankton is the best bait in terms of natural foods in trout feeding (Başçınar and Çakmak, 2010). Cladocera and Copepoda have a crucial role in zooplanktonic organism groups which is the second chain of aquatic ecosystems. A considerable amount of Cladocera lives in freshwater; whereas, a very limited amount lives in brackish one. Cladoceran inhabits diverse habitats and are at times exposed to a great variety of harsh and extreme environmental conditions. Cyclopoid and Harpacticoid copedods are determinant as indicators in decision of trophic state (Geng et al., 2005; Sarma et al., 2005). Rotifera or wheel animalcules are one of the most interesting groups of freshwater invertebrates. Their size ranges between 45µm and about 2.5 mm, the most common length being 100-500 µm (Sládeček, 1983; Dumont, 2007). Phyllum rotifera is divided into three classes: Monogononta, Bdelloidea, and Seisonidea. The largest group is the Monogononta, with about 1500 species, followed by the Bdelloidea, with about 350 species. Rotifera is an important component of freshwater zooplankton and is not only important food for many fishes but also used as an indicator of water quality (Geng et al., 2005).

Many studies on zooplanktonic organisms of lentic ecosystems in Turkey were conducted by Ustaoğlu (1986) in Karagöl Lake, Gündüz (1987) in Karamık and Hoyran Lake, Dumont and De Ridder (1987) in Burdur, Beyşehir, Eğridir and Akşehir Lake, Ustaoğlu and Balık (1990) in Gebekirse Lake, Segers et al. (1992) in Çıldır and Hafik Lake, Emir and Demirsoy (1996) in Karamık Lake, Altındağ and Yiğit (2002) in Burdur Lake, Güher and Kırgız (2004) in Terkos Lake, Bozkurt (2006) in Yenişehir Lake, Kaya and Altındağ (2007) in Eğirdir and Kovada Lake, Altındağ et al. (2009) in Karaman Stream, Bekleyen and İpek (2010) in Balikligol, Apaydın Yağcı and Ustaoğlu (2012) in İznik Lake. The zooplankton fauna of Turkey were listed by Ustaoğlu (2004).

In the study of 1972 and 1997 in Karataş Lake (Ongan et al., 1972; Gündüz, 1997), the lake's cladocera species have been investigated, and in the study of 1990 and 1991 the lake's rotifera species have been reported (Emir, 1990, 1991). In 1999, zooplankton fauna have been studied in research about the lake's biological diversity, but very few zooplanktonic organisms have been reported in terms of number of species. In the studies carried out in the lake so far, the *Cyclops* sp. belonging to the copepoda group has been stated, but it is thought that there is a literature insufficiency about the copepoda fauna (Kazancı et al., 1999). The purpose of this study is to determine the seasonal variation of Karataş Lake's zooplankton to contribute to zooplankton of that lake and especially to the copepoda and cladocera

group, in terms of species and also to show the change of about 30 years of the zooplankton fauna of the Karataş Lake. In addition, areas of the world, to draw attention to the habitat of White-Headed Duck birds.

Materials and methods

Study Area

Karataş Lake, which is in the Lakes Region, is in the border of Burdur, in the northeastwards of Tefenni Plain. The coordinates of the lake are 37°21'36"-37°25'17"N, 29°57'11"-29°59'19"E with the altitude of 1050 m. The maximum area is 11.9 km^2 and the maximum depth is 2 m. The main source of the lake is Bozçay. It is used as irrigation source with dikes built. All around lake, especially the west side is covered with reddy. Creals agriculture is intense in the region (Yarar and Magnin, 1997). Lake Karataş contains important fish species, namely; *Cyprinus carpio* Linnaeus, 1758, *Scardinius erytrophthalmus* (Linnaeus, 1758), *Sander lucioperca* (Linnaeus, 1758), *Knipowitschia caucasica* (Berg, 1916), *Aphanius anatoliae anatoliae* (Leidenfrost, 1912), *Capoeta capoeta bergamae* (Karaman, 1969) (Geldiay and Balık, 2002; Kır, 2005; Yeğen et al., 2006). Yarar and Magnin (1997) stated that, Karataş Lake was taken to the Wildlife Protection Area by the Turkish Government in 1995. According to Hughes et al. (2006), the White-Headed Duck (*Oxyura leucocephala*), whose wintering area is Karataş Lake, is in the list of RAMSAR, CBD, CITES, and BERN convention which have an international importance. Turkey has the largest wintering population of the White-Headed Duck of any rangestate,and also holds a major breeding population. The most important site in Turkey is Burdur Lake which often holds over 50% of the known world population during winter (Green and Hughes, 1996).

This study was carried out in 2002-2003. The samples were collected seasonally at two different stations in Karataş Lake (Fig. 1). Station 1 was at the middle southwest coasts ; and Station 2 at the northeast coasts of the lake.

The zooplankton samples were collected using a standard plankton net (Hydrobios model 55 µm mesh size). Samples were preserved in 4% formaldehyde in 250 ml plastic bottles. Binocular biological research samples. In the rotifera species, the identification with the trophi; and in the cladocera and copepoda species the identification with the dissection were carried out. In the systematic identification of zooplankton samples Mann (1940), Muckle (1951), Negrea (1983), Korovchinsky (1992), Smirnov (1996) were used for Cladocera; Kiefer (1952- 1955), Dussart (1967-1969), Kiefer and Fryer (1978), Alekseev et al. (2006) were used for Copepoda; Ruttner-Kolisko (1974), Koste (1978), Segers (1995) and Nogrady and Segers (2002) were used for Rotifera. Water temperature, pH, conductivity and dissolved oxygen concentrations were measured with a W.T.W. 340 I. Coordinates of the stations were identified with Magellan Sportrak.

In comparing the faunastic composition of zooplankton were used the Sorenson similarity index (S) and Jaccard index (CJ) (Hellawell, 1986).

S= 2C/A+B Where: "A" is the number of species present in one population, "B" is the number of species present in the other population, and "C" is the number of species present in both populations.

CJ=J/(a+b-J) Where: "a" is the number of species present in one population, "b" is the number of species present in the other population, and "J" is the number of species common to both populations.

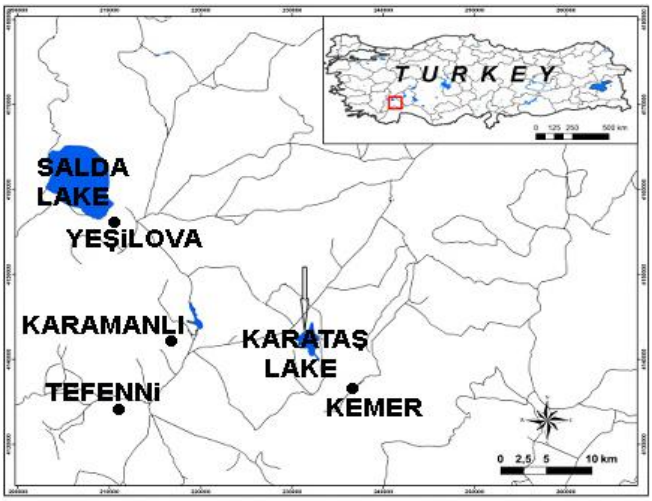


Figure 1: Map of study area of Karataş Lake

Results

As a result of the qualitative determinations, 16 taxa belonging to 5 families from cladocera; 7 taxa belonging to 3 family from copepoda; 19 taxa belonging to 10 family from rotifera were identified. The identified species are as follows:

Phylum: **Rotifera**
Subclass: **Monogononta**
Order: **Ploimia**
Family: **Branchionidae**
Brachionus angularis Gosse, 1851
Keratella cochlearis (Gosse, 1851)
Keratella quadrata (O. F. Müller, 1786)
Keratella tropica (Apstein, 1907)
Notholca acuminata (Ehrenberg, 1832)
Notholca squamula (O. F. Müler, 1786)
Family: **Mytilinidae**
Mytilina sp.
Family: **Lecanidae**
Lecane bulla (Gosse, 1851)
Lecane luna (O. F. Müler, 1776)
Lecane sp.
Family: **Trichotriidae**
Trichotria tetractis (Ehrenberg, 1830)
Family: **Synchaetidae**
Synchaeta pectinata Ehrenberg, 1832
Polyarthra dolichoptera Idelson, 1925
Family: **Asplanchnidae**
Asplanchna priodonta Gosse, 1850
Order: Floscullariacea

Family: **Testudinellidae**
Testudinella patina (Hermann, 1783)
Family: **Conochilidae**
Conochilus dossuarius (Hudson, 1885)
Family: **Hexarthridae**
Hexarthra fennica (Levander, 1892)
Family: **Filiniidae**
Filinia terminalis (Plate, 1886)
Filinia longiseta (Ehrenberg, 1834)

Phylum: **Cladocera**
Subphylum: **Crustacea**
Subclass: **Phyllopoa**
Order: **Diplostraca**
Family: **Sididae**
Diaphanosoma brachyurum (Liévin, 1848)
Diaphanosoma lacustris Korinek, 1981
Infraorder: Anomopoda
Family: **Daphniidae**
Daphnia magna Straus, 1820
Daphnia longispina O.F.Müller, 1776
Phylum: **Cladocera**
Subphylum: **Crustacea**
Subclass: **Phyllopoa**
Infraorder: Anomopoda
Family: **Daphniidae**
Ceridaphnia quadrangula (Müller, 1785)
Family: **Moinidae**
Moina brachiata (Jurine, 1820)
Family: **Bosminidae**
Bosmina longirostris (Müller, 1776)
Family: Chydoridae
Subfamily: **Chydorinae**
Pleuroxus aduncus (Jurine, 1820)
Pleuroxus trigonellus(Müller, 1776)
Pleuroxus sp. (Sars, 1862)
Disparalona rostrata (Koch, 1841)
Chydorus sphaericus (Müller, 1776)
Subfamily: **Aloninae**
Alona costata Sars, 1862
Coranatella rectangula Sars, 1862
Acroperus harpae (Baird, 1835)
Graptoleberis testudinaria (Fischer, 1848)
Class: **Maxilopoda**
Subclassis: **Copepoda**
Order: **Calanoida**
Family: **Diaptominae**
Subfamily: Diaptominae
Acanthodiaptomus denticornis (Wierzejski,1887)
Eudiaptomus drieschi (Poppe & Mrazek, 1895)
Arctodiaptomus bacillifer (Koelbel, 1885)
Order: **Cyclopoida**
Family: **Cyclopoidae**
Subfamily: Eucyclopinae
Eucyclops speratus (Lilljeborg, 1901)
Paracyclops fimbriatus (Fischer, 1853)
Subfamily: Cyclopinae
Cyclops abyssorum Sars, 1863
Order: **Harpacticoida**
Family: **Canthocamptidae**
Canthocamptus staphylinus (Jurine, 1820)

The seasonal mean values in the study area , the surface water temperature in the lake ranged from 10.6 to 17.1 °C, pH from 8.51 to 8.53, DO from 3.3 to 7.7 mg/L and conductivity from 454 to 549µS/cm^2 were ditermined. When the distribution of species according to stations in all seasons is examined from the Table 1, it is realized that there are 30 species in the Station 1 and 38 species in Station 2. Moreover it is identified that the greatest number of species is observed in summer (26 taxa) and autumn (23 taxa) and the least number of species is observed in spring (15 taxa) (Table 1). Summer, with 26 species, was the seasonal when the highest number of species was observed; Spring, with 17 species, was the seasonal with the lowest number of species (Fig. 2). The lower value of Sorenson index (27%) and Jaccard index (15 %) were recorded in summer zooplankton and higher value Sorenson index (79 %) and Jaccard index (65%) were recorded in autumn zooplankton (Table 2).

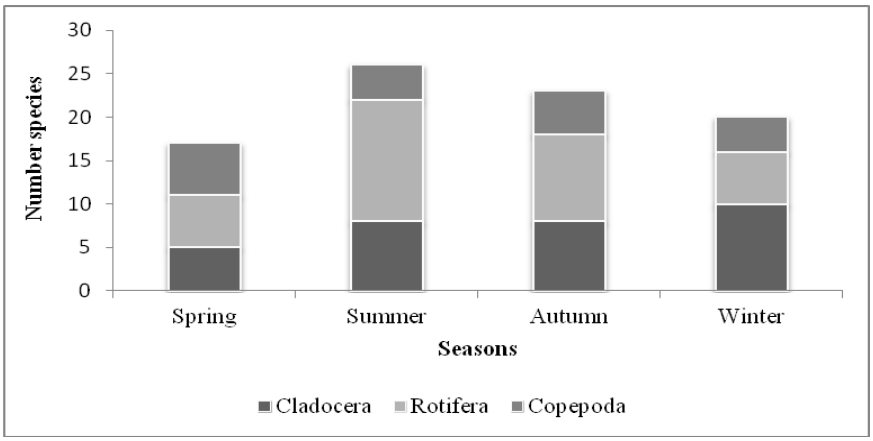
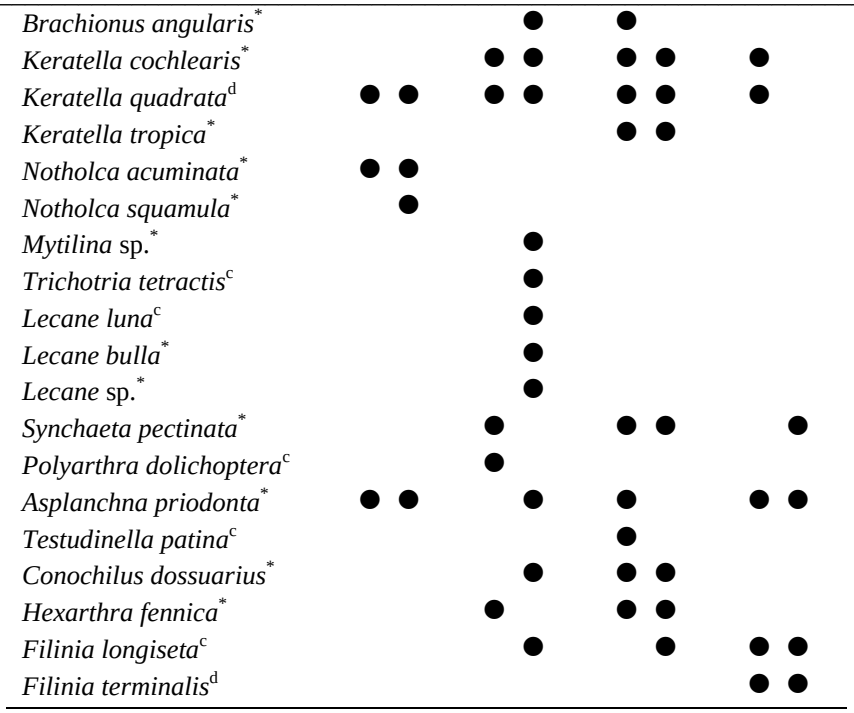


Figure 2: Seasonal changes in the number of zooplankton species in Karataş Lake

Table 1 : Seasonal distributions of zooplankton species in Karataş Lake

Species	Seasons and Stations							
	2002 Spring		2002 Summer		2002 Autumn		2003 Winter	
	1	2	1	2	1	2	1	2
CLADOCERA								
Diaphanosoma brachyurum[a,b,d]				●		●		
Diaphanosoma lacustris[b]				●	●	●		
Daphnia magna[a,b]	●	●	●					
Daphnia longispina[a,b]	●	●	●	●	●		●	●
Ceriodaphnia quadrangula[a]	●			●	●			
Moina brachiata[*]					●	●		
Bosmina longirostris[b,d]					●	●	●	●
Pleuroxus aduncus[*]							●	
Pleuroxus trigonellus[*]							●	●
Pleuroxus sp.[*]							●	
Disparalona rostrata[*]				●				
Chydorus sphaericus[a,b]	●	●	●		●	●	●	●
Alona costata[*]								●
Coranatella rectangula[*]		●	●	●	●	●		●
Acroperus harpae[*]								●
Graptoleberis testudinaria[*]								●
COPEPODA								
Acanthodiaptomus denticornis[*]				●	●	●		
Eudiaptomus drieschi [*]	●		●		●	●	●	●
Arctodiaptomus bacillifer[*]	●				●	●		●
Eucyclops speratus[*]	●	●		●	●	●		●
Paracyclops fimbriatus[*]		●						
Cyclops abyssorum[*]	●	●				●		
Canthocamptus staphylinus[*]	●	●	●					
ROTIFERA								



a: Ongan et al., 1972 **b**: Gündüz, 1997 **c**: Emir, 1990–1991 **d**: Kazancı et al., 1999

*****: Species marked by an asteriks are new records for Karataş Lake

Table 2: Sorenson Similarity Index for zooplankton species present in Karataş Lake

Zooplankton	Spring	Summer	Autumn	Winter
S	75 %	27 %	79 %	59 %
CJ	60 %	15 %	65 %	42 %

Discussion

In all seasons, dominant species in the lake were observed as *Daphnia longispina*, *Chydorus sphaericus*, and *Coranatella rectangula* belonging to Cladocera and *Eucyclops speratus*, *Eudiaptomus drieschi* belonging to Copepoda. *Disparalona rostrata*, *Moina brachiata*, *Acroperus harpae* and *Graptoleberis testudinaria* from cladocera were observed in summer, autumn and winter, respectively. *Paracyclops fimbriatus* from copepoda was observed only in spring. In this study, especially in summer, determined *Trichotria tetractis*, *Lecane luna*, *Lecane bulla*, *Lecane sp.*, *Polyarthra dolichoptera* and *Mytilina sp.* were rotifera. *Keratella tropica* and *Testudinella patina* were observed in autumn only. *Notholca squamula* and *N. acuminata* were observed in spring only. *Filinia terminalis* was found in winter only. The lower value of Sorenson's index for total zooplankton composition reveal the change in community structure (Table 2). In Lake Karataş total zooplankton composition has significantly changed compared to earlier study. The low value of Sorenson index (27 %) and Jaccard index (15 %) in Karataş Lake reveals that the some change in the rotifera composition due to the disappearance of 3 species (Table 1). *Polyarthra dolichoptera*, *Testudinella patina* and *Filinia terminalis* group of rotifera species were not found in summer zooplankton.

In this study, the zooplankton fauna contained 42 taxa, among them 19 were from rotifera, 7 from copepod and 16 from cladocera. In the studies of Karataş Lake in 1990 and 1991 (Emir, 1990, 1991), 10 rotifera species (*Filinia longiseta*, *Brachionus urceolaris*, *Trichotria tetractis*, *Lecane luna*, *Polyarthra vulgaris*, *P. dolicoptera*, *P. remata*); and in the study of 1999 (Kazancı et al., 1999), 2 rotifera species (*Keratella quadrata* and *Filinia terminalis*) have been presented. From these species, 5 species (*Brachionus urceolaris*, *Polyarthra vulgaris*, *P. remata*, *Lophocharis salpina* and *Ascomorpha saltans*) were not observed in this investigation. *Macrothrix laticornis*, from cladocera found by Ongan et al. (1972) and *Ceriodaphnia dubia*, *C. reticulata*, *C. pulchella*, *Biapertura affinis*, *Macrothrix laticornis* from cladocera found by Gündüz (1997) were not determined in this study. Zooplankton fauna for Karataş Lake, *Moina brachiata*, *Pleuroxus trigonellus*, *P. aduncus*, *P.* sp., *Disparalona rostrata*, *Coranatella rectangula*, *Alona costata*, *Acroperus harpae*, *Graptoleberis testudinaria* from cladocera; *Keratella cochlearis*, *Keratella tropica*, *Brachionus angularis*, *Notholca acuminata*, *Notholca squamula*, *Lecane bulla*, *Lecane* sp., *Hexarthra fennica*, *Synchaeta pectinata*, *Asplanchna priodonta*, *Conochilus dossuarius*, *Mytilina* sp., from rotifera were new records for the region .

In previous studies carried for copepoda, no records were determined except *Cylops* sp. (Kazancı et al. (1999). *Acanthodiaptomus denticornis*, *Eudiaptomus drieschi*, *Arctodiaptomus bacillifer*, *Eucyclops speratus*, *Cyclops abyssorum*, *Paracyclops fimbriatus*, and *Canthocamptus staphylinus* from copepoda were identified in our study. Karataş Lake zooplankton species are species that contribute to the fauna of copepoda. *Paracyclops fimbriatus* from Cyclopoida was observed in spring only in Station 2. Similarly, *Canthocamptus staphylinus* from Harpacticoida was observed in spring only in both first and second stations. In addition, very few of *Canthocamptus staphylinus* and *Paracyclops fimbriatus* were found in summer in the Station 1. These species are originally benthic forms and encountered in areas where macrophyta vegetation are dense. They are rarely found in pelagic zone. Depending on this fact, finding macrophyta vegetation in the stations where these species live, having low level of water in the stations and observing limited number of species in sampling may be evidence that these species are accidentally come into the plankton net. Sharma and Kotwal (2011) reported that *Chydorus sphaericus*, *Coranatella rectangula* and *Moina brachiata* species distributed in the freshwater the range of pH 7.1–8.3. Some species identified in this study were determined living in pH 8.51–8.53, which supports the pH values in other literature studies (Sharma and Kotwal, 2011). *Filinia terminalis*, a kind of cold stenotherm and outspread between 4–19°C, is generally observed in winter (Nogrady and Segers, 2002). During the winter, *Filinia terminalis* species were observed in both of the stations. According to Ruttner - Kolisko (1974) *Brachionus* species prefer especially to hot waters. In our study, *Brachionus* species are encountered not only in summer

but in autumn as well. Lake Karataş is evaluated as ultra- oligotrophic and eutrophic in the studies carried out thus far. (Kazancı et al., 1999). *Brachionus angularis* has been designated as indicators of heavy pollution (eutrophic). *Lecane bulla* is indicator of fresh and clean waters (oligotrophic) while a variety of rotifers including *Brachionus, Keratella* species are inhabitants of moderately clean (mesotrophic) waters (Saksena, 1986). Generally, the indicators of eutrophic lakes are *Filinia longiseta, Keratella cochlearis, Keratella quadrata* (Geng et al., 2005). Studies in literature revealed the fact that *Cyclops abyssorum* is the indicator of oligotrophic water, *Bosmina longirostris* and *Chydorus sphaericus* are the indicators of oligotrophic-eutrophic waters, *Diaphanosoma brachyurum* and *Diaphanosoma* sp., are the indicators of mesotrophic-eutrophic waters, *Daphnia longispina* is the indicator of eutrophic waters, *Graptoleberis testudinaria* is the indicator of distrophic waters, *Canthocamptus staphylinus* is the indicator of eutrophic waters (Ustaoğlu, 1989; Makarewicz, 1993; Hämäläinen and Karjalainen, 1994). In conclusion, in terms of zooplankton Lake Karataş had a oligotrophic-eutrophic character and was, thus vulnerable to eutrophiction. Karataş Lake and its surrounding areas are among the wetlands that ought to be protected because of both its richness in terms of species and its aesthetic beauty. Zooplankton, which is very important for fish, have an important place in the food chain. Therefore, it is necessary to reserve the biological abundance of the lakes. This study is expected to contribute to the knowledge of zooplankton fauna of the lake and of Turkey (particularly to cladocera and copepoda fauna) and provide a resource for future studies in the Karataş Lake.

Acknowledgements

I would like to thank the Mediterranean Fisheries Research Production and Education Institute and its technical staff; Senior Aquaculture Engineer Vedat Yeğen, Aquaculture Engineer Rahmi Uysal and Aquaculture Engineer Abdulkadir Yağcı for their support during field studies. It is a pleasure to thank to Ege University Faculty of Fisheries Professor M. Ruşen Ustaoğlu for his investigation of my article.

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