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RESEARCH ARTICLE

The seasonal occurrence and abundance of gelatinous macrozooplankton in Izmit Bay (the northeastern Marmara Sea)

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Abstract

In this study, temporal distributions of four gelatinous zooplankton, the scyphozoan *Aurelia aurita* and the ctenophores *Mnemiopsis leidyi*, *Beroe ovata* and *Pleurobrachia pileus*, were evaluated using data obtained from 17 cruises to Izmit Bay carried out from July 2001 to November 2002. *Mnemiopsis leidyi* was always present in all seasons. The appearance of *Beroe ovata* resulted in a sharp decrease of *M. leidyi* biomass. *Beroe ovata* was found only in summer-autumn periods in Izmit Bay, with the highest average abundance (120.9 ± 250.5 ind.m^{-3}) occurring in September 2001. *Pleurobrachia pileus* was observed from February to June 2002. *Aurelia aurita* was always present in the all seasons Small individuals of *M. leidyi* (<10 mm) were observed throughout the year, and mean lengths of individuals increased from summer to spring, when large individuals dominated the population.

Key words: gelatinous macrozooplankton, abundance, size distribution, Izmit Bay

Introduction

Gelatinous macrozooplankton are the dominant planktivores in many coastal systems and are known for forming extraordinary population blooms (CIESM 2002). There is now compelling evidence that the biomass of jellyfish has increased in many parts of the world (Mills 2001; Purcell 2005; Link and Ford 2006). Gelatinous macrozooplankton typically prey on mesozooplankton as well as fish egg and larvae, and can affect the structure of the pelagic community through direct predation as well as by competition for food (Purcell 1985).

Gelatinous macrozooplankton have been well documented in estuaries and enclosed seas (Kremer and Nixon 1976; Kremer 1976; Kremer 1994; Mutlu 1999; 2001; 2009; Mutlu and Bingel 1999; Kideys and Romanova 2001;

Shiganova 1998; Shiganova and Malej 2009). The arrival of the ctenophore *Mnemiopsis leidyi* from the western Atlantic to the Black Sea with ballast water at the end of the 1980s accelerated several adverse events (Vinogradov *et al.* 1989; Kideys *et al.* 1999; Kideys *et al.* 2000). *Beroe ovata* was first observed in the Black Sea in 1997 (Konsulov and Kamburska 1998). Via the surface currents flowing from the Black Sea through the Bosphorus, *Mnemiopsis leidyi* and *Beroe ovata* must have immediately invaded the Marmara Sea following their respective occurrence in the Black Sea (Shiganova *et al.* 1995). Until very recently, six species of gelatinous macrozooplankton were present in the Marmara Sea: three scyphozoan medusae [*Rhizostoma pulmo*, *Aurelia aurita* and the new invader *Chrysaora hysoscella*] and three ctenophores [the indigenous *Pleurobrachia pileus* and the invaders *Mnemiopsis leidyi* and *Beroe ovata*].

Izmit Bay, located at the NE Marmara Sea, is an elongated, semi-enclosed bay with a length of 50 km and width varying between 2 and 10 km and the depth of the bay between 30 and 200 m. Izmit Bay is oceanographically an extension of the Marmara Sea, having a permanent two-layered water system. The upper layer originates from less saline Black Sea waters (18.0–22.0ppt), whereas the lower layer originates from the Mediterranean Sea waters that are more saline (37.5–38.5ppt) (Unluata *et al.* 1990). Although a permanent stratification occurs at ~25 m in the Marmara Sea (Besiktepe *et al.* 1994), it is highly variable in Izmit Bay (Oguz and Sur 1986). The thickness of the upper layer changes seasonally from 9 to 18 m in spring and autumn, respectively (Oguz and Sur 1986; Algan *et al.* 1999).

Although there have been several studies on the pollution and physical and chemical characteristics of the bay (e.g. Okay *et al.* 2001; Morkoc *et al.* 2001; Balkis 2003; Pekey *et al.* 2004; Aktan *et al.* 2005; Isinibilir *et al.* 2008), so far there is no data on annual gelatinous macrozooplankton abundance and distribution for this region. Meanwhile, previous studies on gelatinous macrozooplankton in the Marmara Sea have involved only short time periods (Shiganova *et al.* 1995; Isinibilir and Tarkan 2001; Isinibilir *et al.* 2004).

The aim of the present study is to provide information on the seasonal abundance, biomass and population structure of gelatinous macrozooplankton in Izmit Bay.

Materials and Methods

Gelatinous macrozooplankton were collected vertically during daytime, by a WP2 closing net (157 mm mesh, 0.5 m diameter) from the interface (18–20 m), to the surface in Izmit Bay at monthly with one haul at 11 stations (Figure 1) from July 2001 to November 2002. The 11 sampling sites were categorized into three groups (eastern, middle and western parts). The eastern part of the bay is represented by stations 1, 2, 3; the middle part by 4, 5, 6; and the western part by 7, 8, 9, 10 and 11 (Figure 1). Furthermore, gelatinous macrozooplankton samples were collected using hand net for determining relationship between total length or umbrella diameter and wet weight for gelatinous macrozooplankton size structure in the surface waters. Gelatinous macrozooplankton specimens were identified and measured immediately on board.

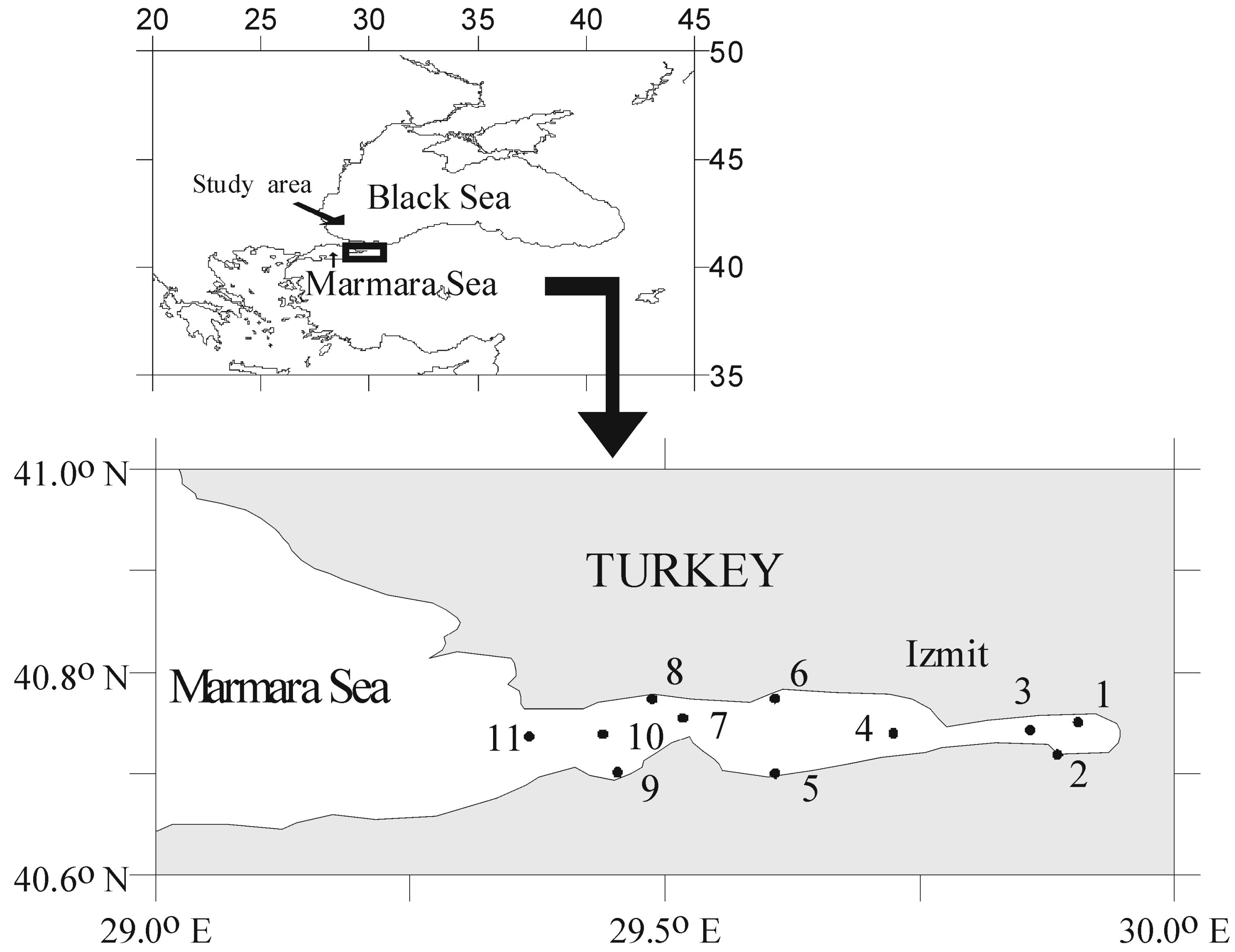

Figure 1. Positions of sampling stations in Izmit Bay.

Zooplankton samples were collected from the same net and immediately preserved in 4% neutral formaldehyde until further analysis in the laboratory. Water temperature and salinity were measured by pIONeer 65 multiprobe, according to the practical salinity unit. Chlorophyll a analyses were performed following the methodology of Nusch (1980). Salinity and chlorophyll a could not be measured in July, August and September 2001.

The relationship between total length or umbrella diameter and wet weight for gelatinous macrozooplankton was produced from this study as expressed by the following power regressions:

For *A. aurita*,
Wet Weight (g) = 0.1818 x Umbrella diameter (cm)$^{2.397}$
N = 57 r^2 = 0.98
For *M. leidyi,*
Wet Weight (g) = 1.4061 x Total Length (cm)$^{1.6161}$
N = 101 r^2 = 0.89
For *B. ovata,*
Wet Weight (g) = 0.2288 x Total Length (cm)$^{2.3103}$
N = 50 r^2 = 0.97
For *P. pileus,* (Mutlu and Bingel 1999)
Wet Weight (mg) = 0.682 x Length (mm)$^{2.522}$
N = 50 r^2 = 0.97

Data analyses were conducted in SPSS 11. A Spearman rank correlation was applied to find the distribution of gelatinous macrozooplankton in relation to the environmental variables.

Results

From detailed analyses of the parameters it is seen that, the dynamics of temperature was typically seasonal in surface water of Izmit Bay; the highest average temperatures (27.8 ºC) were measured in July 2001, while lowest (8.4 ºC) were measured in December 2001 (Figure 2). The salinity decreased in summer due to the arrival of the south western Black Sea shelf waters, while in winter the bay had lower salinity due to precipitation. The highest average surface water salinity was observed in November 2001 (24.7ppt). In July 2002, salinity decreased to 19.7ppt. Chlorophyll a concentrations were highest in November 2002.

The first peak of zooplankton occurred in July 2001 (51334 ind.m^{-3}) and the highest biomass was 909.7 mg.m^{-3} in July 2001. Copepods, with their highest abundance of 35395.5 ind.m^{-3} in September 2001, were by far the most abundant group of mesozooplankton community throughout the year, accounting for more than 60% of the total abundance of mesozooplankton. Cladoceran species and meroplankton (especially larvae of Cirripedia and Bivalvia) ranked second (20%) and third (15%) in relative abundance, respectively (Figure 3).

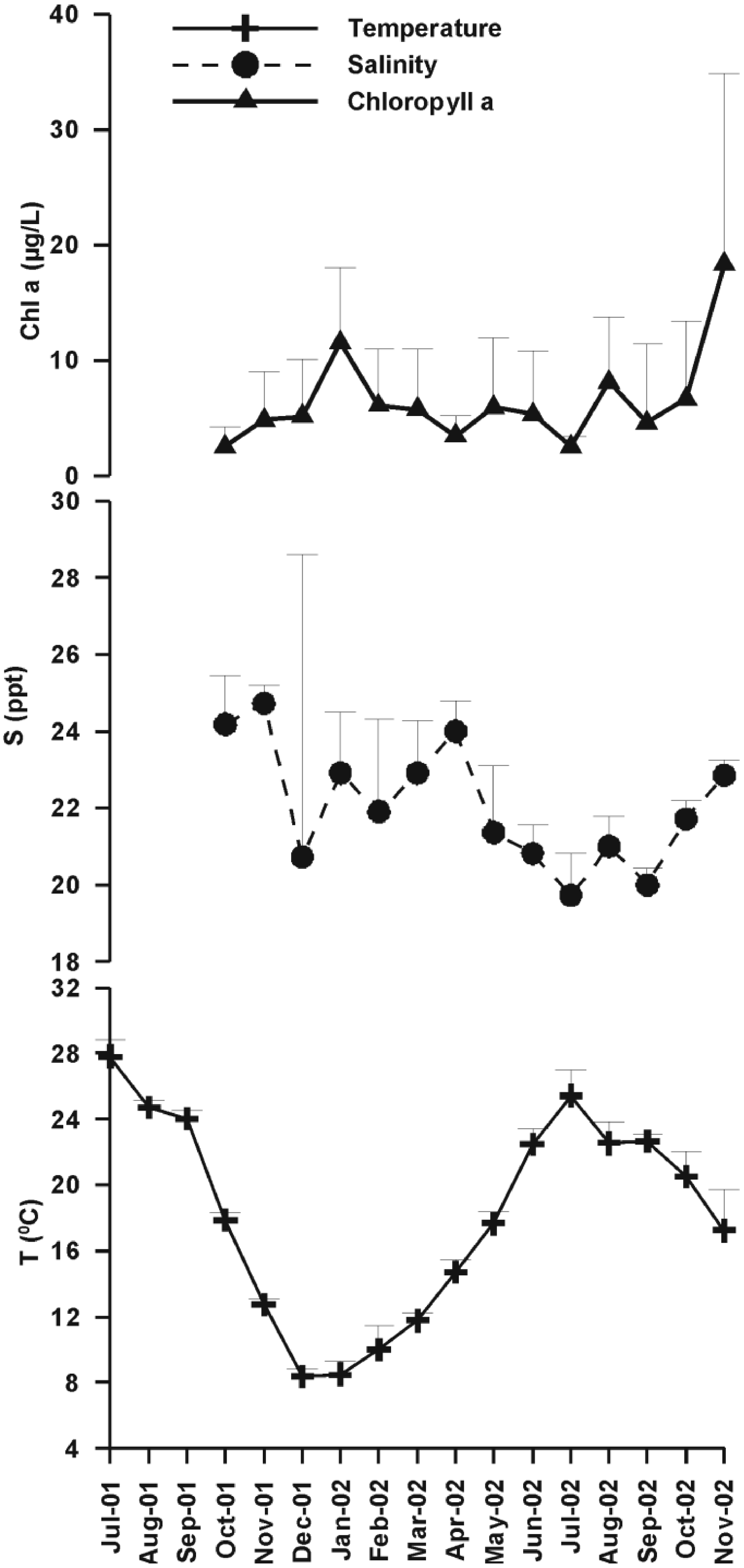

Figure 2. Seasonal changes in surface temperatures (ºC), salinities (ppt) and Chlorophyll a (µg/L) in Izmit Bay. Values are the averages of the stations (Vertical bar shows standard deviation).

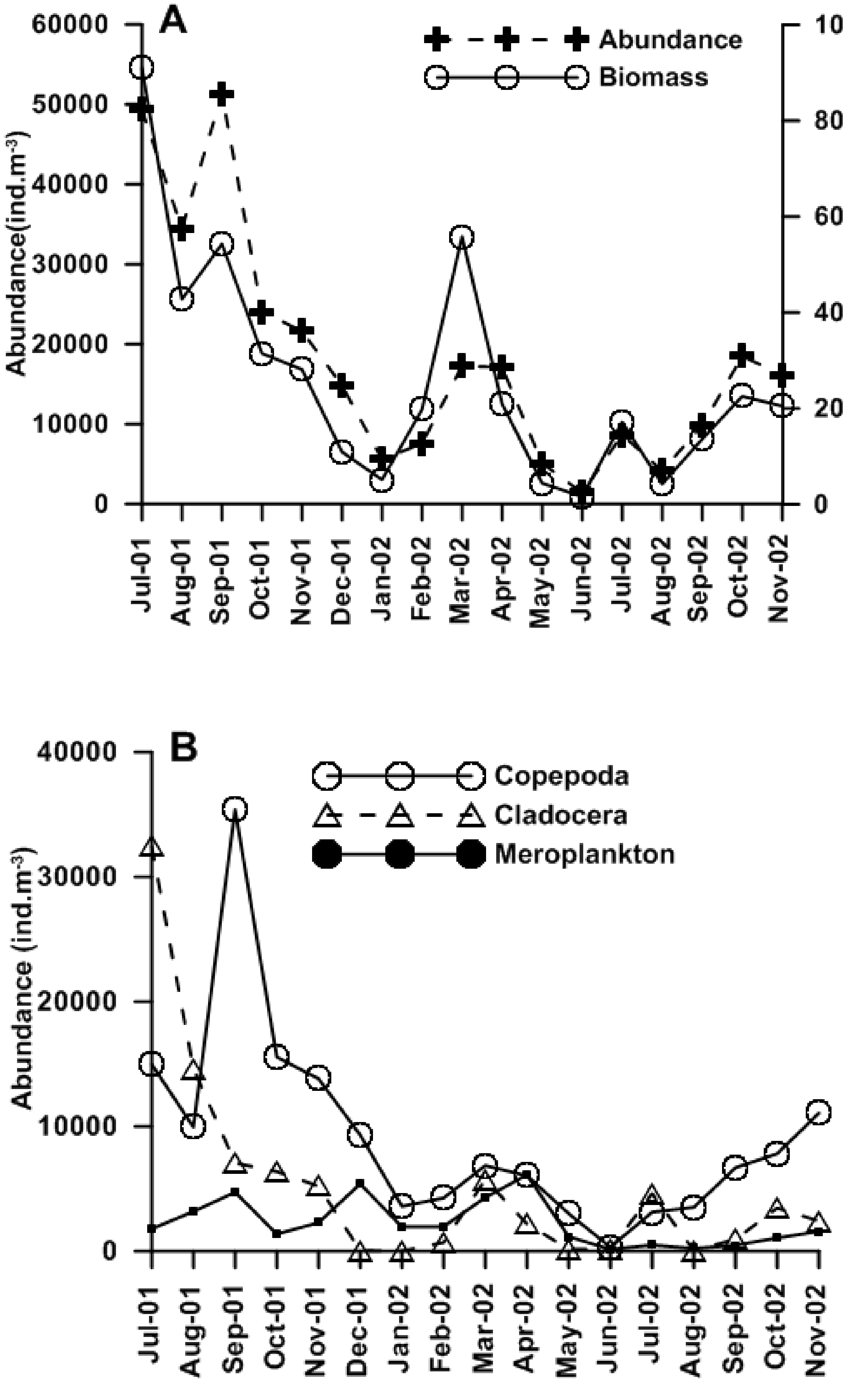

Figure 3. Fluctuations of the upper layers in (A) zooplankton abundance (ind.m^{-3}), biomass (mg.m^{-3}) and (B) copepoda, cladocera and meroplankton abundance (ind.m^{-3}). Values are the averages of the stations.

We found significant fluctuations in jelly distribution in time (Figure 4). During the study period, *Mnemiopsis leidyi* was always present except in September 2001, October 2001, October 2002 and November 2002. In July 2001, the average abundance of *M. leidyi* was 0.7 ind.m^{-3}, whilst its population density increased to 12.1 ind.m^{-3} in August 2001, which was followed by its almost total disappearance in September 2001. Its average abundance showed a second peak (7.3 ind.m^{-3}) in November 2001 and remained low in the other months. The appearance of *Beroe ovata* resulted in a complete disappearance of *M. leidyi* biomass in September 2001 and decreased the biomass of *M. leidyi* down to 0.1 g.m^{-3} in July 2002 and again completely eliminated it in October 2002. *Beroe ovata* was found in the plankton of Izmit Bay from August to November 2001 and from June to November 2002. The highest average of *B. ovata* abundance (120.9 ± 250.5 ind.m^{-3}) was in September 2001, while the highest biomass (45.1 ± 167.6 g. m^{-3}) was in August 2001. After the disappearance of *B. ovata* in winter, *M. leidyi* displayed a few small peaks that were lower than in autumn 2001. *Pleurobrachia pileus* was found from February to June in Izmit Bay. The abundance and biomass of *Pleurobrachia pileus* peaked in April 2002 (8.4 ind.m^{-3} and 5.6 g.m^{-3}, respectively) in the bay. *Aurelia aurita* was always present in the bay except in August 2001, November 2001, January 2001 and September 2002. *A. aurita* was generally present in low numbers, ranging from 0.3-4.6 ind.m^{-3}. The mean abundance and biomass of *A. aurita* peaked (2.3 ind.m^{-3} and 565 g.m^{-3}, respectively) in October 2002.

A significant Spearman Rank correlation was found between the abundance and biomass of *B. ovata* and the water temperature ($P<0.05$) and the abundance and biomass of zooplankton ($P<0.01$). A significant negative Spearman Rank correlation was found between the abundance of *M. leidyi* and abundance of *B. ovata* ($P<0.01$). There was a negative correlation between temperature and the abundance and biomass of *M. leidyi*, but it was not significant. Temperature had a negative significant correlation with the abundance and biomass of *P. pileus.*

Mnemiopsis leidyi was always present in the all seasons (Figure 5, Table 1). In summer 2001, the distribution of *M. leidyi* shifted further to west. The average abundance was 6.4 ind.m^{-3} and the biomass was 34.8 g.m^{-3} (Table 1). The maximum abundance and biomass of *M. leidyi* were recorded to be 25.5 ind.m^{-3} and 122.1 g.m^{-3}. In autumn 2001, *M. leidyi* was found mainly in the western-middle part of the bay. Mean abundance and biomass were found to be 2.4 ind.m^{-3} and 1.1 g.m^{-3}. The maximum individual number (19.7 ind.m^{-3}) and biomass (9.2 g.m^{-3}) was found in the middle part of the bay. In winter 2002, *M. leidyi* was found in all parts of the bay. In spring 2002, the distribution of *M. leidyi* shifted further to east. The biomass of *M. leidyi* was higher in the eastern part (130.3 g.m^{-3}) of the bay. In summer 2002, the average abundance was 0.5 ind.m^{-3} and the biomass was 0.7 g.m^{-3}. In autumn 2002, *M. leidyi* was found only in middle part of the bay Bay (at station 5).

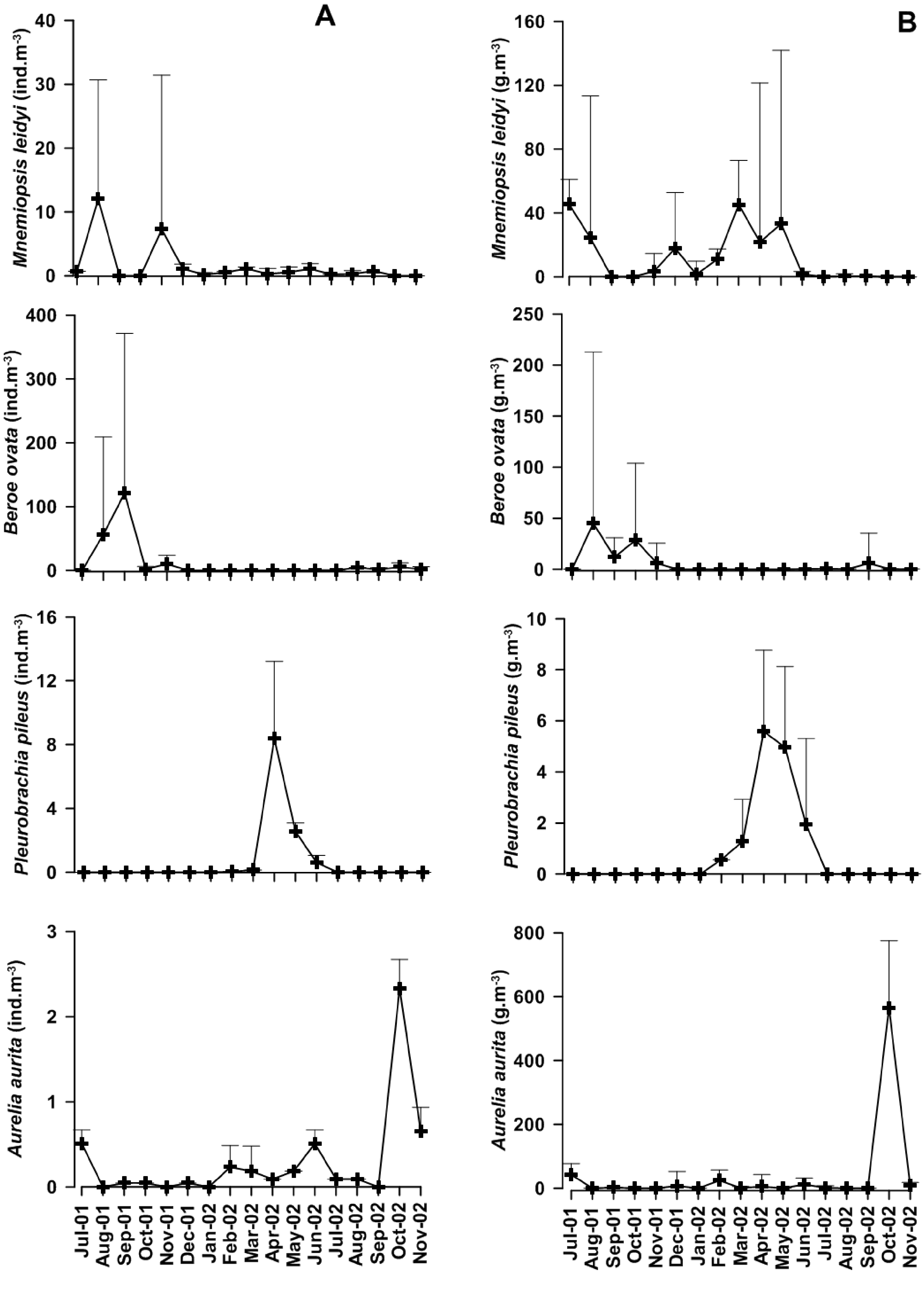

Figure 4. Fluctuations of the upper layers in (A) abundance (ind.m^{-3}) and (B) biomass (g.m^{-3}) *Mnemiopsis leidyi, Beroe ovata, Pleurobrachia pileus* and *Aurelia aurita*. Values are the averages of the stations (Vertical bar shows standard deviation).

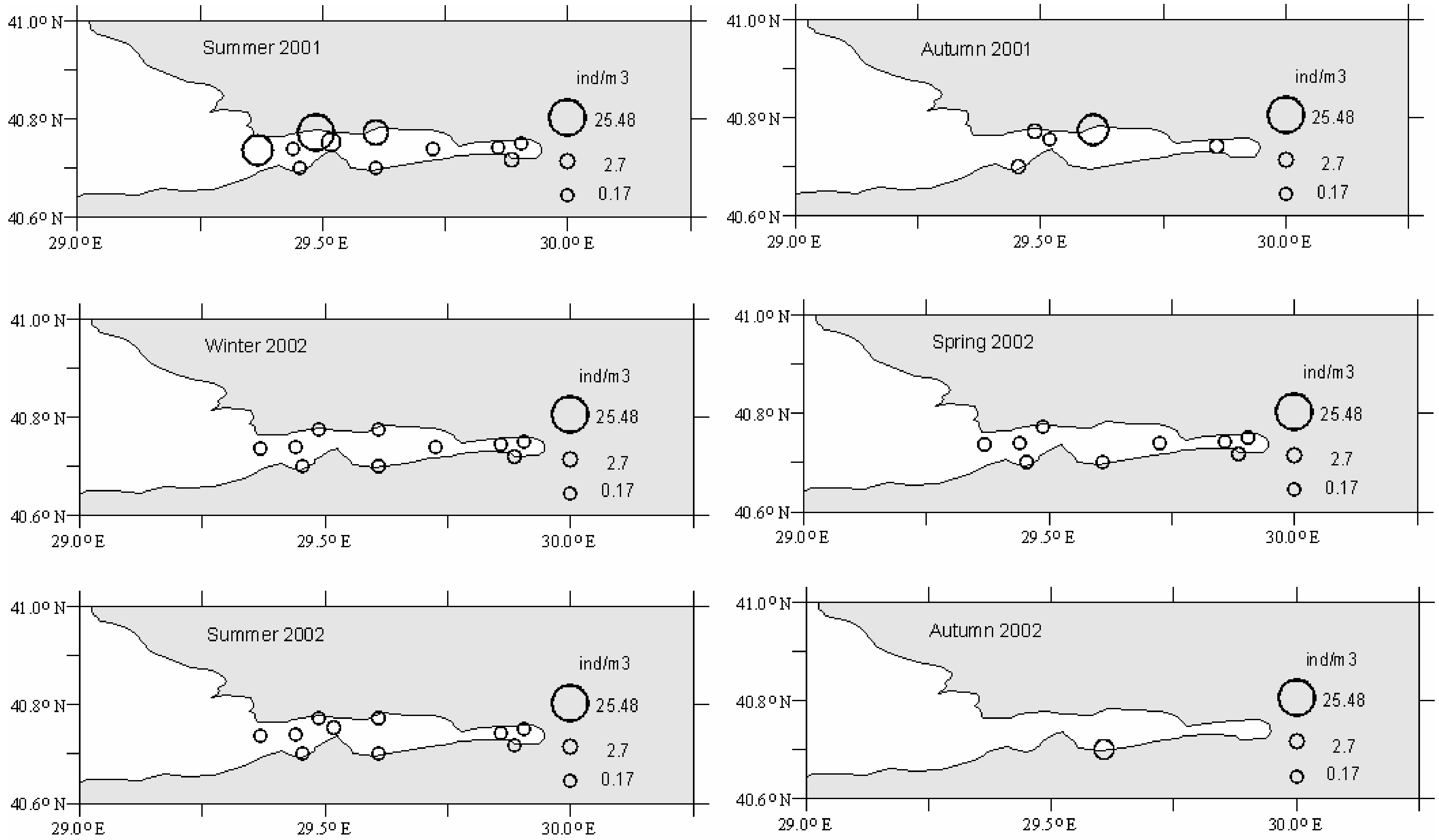

Figure 5. Seasonal abundance of *Mnemiopsis leidyi* in Izmit Bay.

Table 1. Seasonal estimation of the abundance (numbers $m^{-3} \pm SD$) and biomass (wet weight: g $m^{-3} \pm SD$) and body size (mm) of *Beroe ovata*, *Mnemiopsis leidyi*, *Pleurobrachia pileus*, and *Aurelia aurita* in the Izmit Bay.

	Summer 2001	Autumn 2001	Winter 2002	Spring 2002	Summer 2002	Autumn 2002
Mnemiopsis leidyi						
Maximum number of individuals (m^{-3})	51.0	59.12	4.6	4.6	4.1	8.2
Maximum wet weight (g m^{-3})	244.8	27.6	109.6	391.0	6.3	3.8
Mean number of individuals ($m^{-3} \pm SD$)	6.4 ± 14.4	2.4 ± 24.2	0.6 ± 0.6	0.7 ± 0.6	0.5 ± 0.8	0.6 ± 0.6
Mean wet weight (g $m^{-3} \pm SD$)	34.8 ± 44.0	1.1 ± 11.3	10.2 ± 23.4	33.4 ± 59.3	0.7 ± 1.6	10.2 ± 23.4
Maximum length (mm ± SD)	170	10	150	140	30	10
Mean length (mm ± SD)	19.2 ± 25.8	8.6 ± 2.3	50 ± 47	91.4 ± 52.8	13.2 ± 6.8	10 ± 0
Beroe ovata						
Maximum number of individuals (m^{-3})	407.6	772.5			51.0	28.0
Maximum wet weight (g m^{-3})	422.7	227.1			8.8	67.0
Mean number of individuals ($m^{-3} \pm SD$)	28.2 ± 152.8	44.5 ± 162.7			1.6 ± 29.1	2.5 ± 5.3
Mean wet weight (g $m^{-3} \pm SD$)	22.6 ± 167.6	15.5 ± 43.2			0.5 ± 3.4	2.7 ± 19.7
Maximum length (mm ± SD)	90	150			70	160
Mean length (mm ± SD)	15.1 ± 11.7	10.5 ± 7.8			11.0 ± 7.1	11.2 ± 13.5
Pleurobrachia pileus						
Maximum number of individuals (m^{-3})			0.5	54.52	3.6	
Maximum wet weight (g m^{-3})			6.3	32.46	11.8	
Mean number of individuals ($m^{-3} \pm SD$)			0.02 ± 0	3.7 ± 3.7	0.2 ± 0.5	
Mean wet weight (g $m^{-3} \pm SD$)			0.2 ± 0	3.9 ± 3.1	0.6 ± 3.4	
Maximum length (mm ± SD)			20	20	20	
Mean length (mm ± SD)			20 ± 0	5.4 ± 4.4	10 ± 5.4	
Aurelia aurita						
Maximum number of individuals (m^{-3})	2.6	0.5	1.0	1.0	1.5	5.6
Maximum wet weight (g m^{-3})	268.4	26.0	200.0	59.8	66.1	2076.9
Mean number of individuals ($m^{-3} \pm SD$)	0.3 ± 0.2	0.03 ± 0	0.1 ± 0.3	0.2 ± 0.2	0.2 ± 0.2	0.8 ± 0.3
Mean wet weight (g $m^{-3} \pm SD$)	21.4 ± 43.9	0.8 ± 17.1	10.5 ± 77.4	2.1 ± 18.4	4.54 ± 17.8	160.5 ± 208.6
Maximum length (mm ± SD)	200	110	250	150	160	350
Mean length (mm ± SD)	123.6 ± 46.5	75 ± 49.5	105.7 ± 105.0	40 ± 43.5	62 ± 35.3	157.6 ± 87.0

Beroe ovata was absent in the winter and spring 2002. In summer 2001, *B. ovata* was mainly distributed in the waters of eastern part of Izmit Bay (Figure 6, Table 1). Mean abundance and biomass of *B. ovata* was 28.2 ind.m^{-3} and 22.6 g.m^{-3} in summer 2001. Maximum abundance and biomass were recorded to be 203.8 ind.m^{-3} and 211.4 g.m^{-3}. In autumn 2001, *B. ovata* was distributed all over area with maximum abundance and biomass (257.5 ind.m^{-3} and 75.7 g.m^{-3}) in eastern area. In summer 2002, *B. ovata* was found in western part of the bay. The maximum abundance and biomass of *B. ovata* were 17.0 ind.m^{-3} and 2.9 g.m^{-3}. In autumn 2002, *B. ovata* was uniformly distributed wider area.

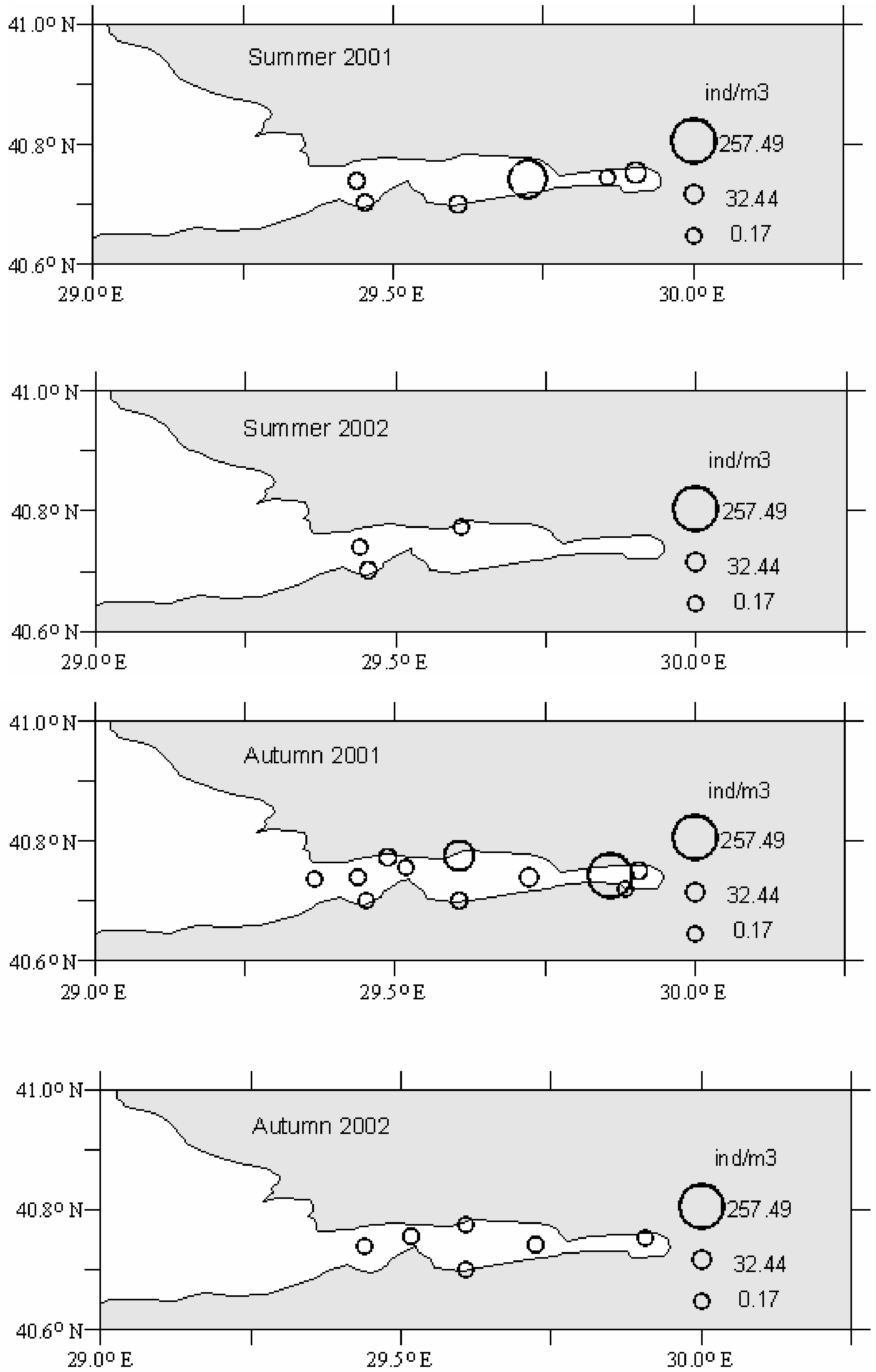

Figure 6. Seasonal abundance of *Beroe ovata* in Izmit Bay.

Pleurobrachia pileus was absent in the summer and autumn 2001 and autumn 2002 (Figure 7, Table 1). In winter 2002, *P. pileus* was just found in the western part (at st. 10) of the bay. In spring, the distribution of *P. pileus* shifted further to west. The average abundance was 3.7 ind.m^{-3} and the biomass was 3.9 g.m^{-3}. The maximum abundance and biomass of *P. pileus* were recorded to be 18.2 ind.m^{-3} and 10.8 g.m^{-3}. In summer 2002, *P. pileus* was distributed in western part of the bay, with maximum abundance and biomass of 1.2 ind.m^{-3} and 3.9 g.m^{-3}, respectively.

Aurelia aurita was always present in the all seasons (Figure 8, Table 1). In summer 2001, *A. aurita* was found mainly in eastern part of the bay. Maximum abundance (1.3 ind.m^{-3}) and biomass (134.2 g.m^{-3}) was found in the eastern part of the bay. In autumn 2001, maximum biomass was 8.7 g.m^{-3} in Izmit Bay. In winter 2002, *A. aurita* was distributed mainly in the middle part. The maximum biomass was recorded to be 66.7 g.m^{-3}. In spring 2002, *A. aurita* was found in the western part of the bay. The maximum abundance and biomass of *A. aurita* were 0.5 ind.m^{-3} and 19.9 g.m^{-3}. In summer 2002, *A. aurita* was found in all parts of the bay. In autumn 2002, the distribution of *A. aurita* shifted further to east. The average abundance was 0.8 ind.m^{-3} and the biomass was 160.5 g.m^{-3}. The maximum abundance and biomass of *A. aurita* were recorded to be 1.9 ind.m^{-3} and 692.3 g.m^{-3}.

During the whole study period and all stations, small individuals (<10 mm) of *M. leidyi* constituted 72% of all individuals, whereas 5% of the individuals were 40-50 mm in size (Figure 9). Maximum length of *M. leidyi* was 180 mm that was found in spring 2002 (Table 1). Comparison of the mean lengths revealed that the smallest mean length occurred in autumn 2001. The mean length increased slightly in winter 2002 (45.4 mm) and reached 66.2 mm in spring 2002 (Table 1).

The population of *B. ovata* consisted of animals measuring from <10 mm to 180 mm in length, whilst ctenophores of <10 mm were again dominant (Figure 9). Mean length of *B. ovata* was larger in summer 2002 (Table 1).

Although individuals with lengths as much as 21 mm were observed, *P. pileus* with lengths >15 mm formed almost 1% of the population on whole study. Specimens <10 mm in length formed 82% of the population in the spring period. However, ctenophores of 4-5, 9-10, 14-15 mm were also dominant size group in Izmit Bay (Figure 9).

Largest individual of *A. aurita* was 350 mm in autumn 2002 (Table 1). Individuals with length of 40-50 mm in umbrella diameter dominated Izmit Bay (Figure 9). The mean umbrella diameter of *A. aurita* increased from spring to autumn and decreased again in winter. The highest mean umbrella diameter of *A. aurita* (350 mm) was in autumn 2002 (Table 1).

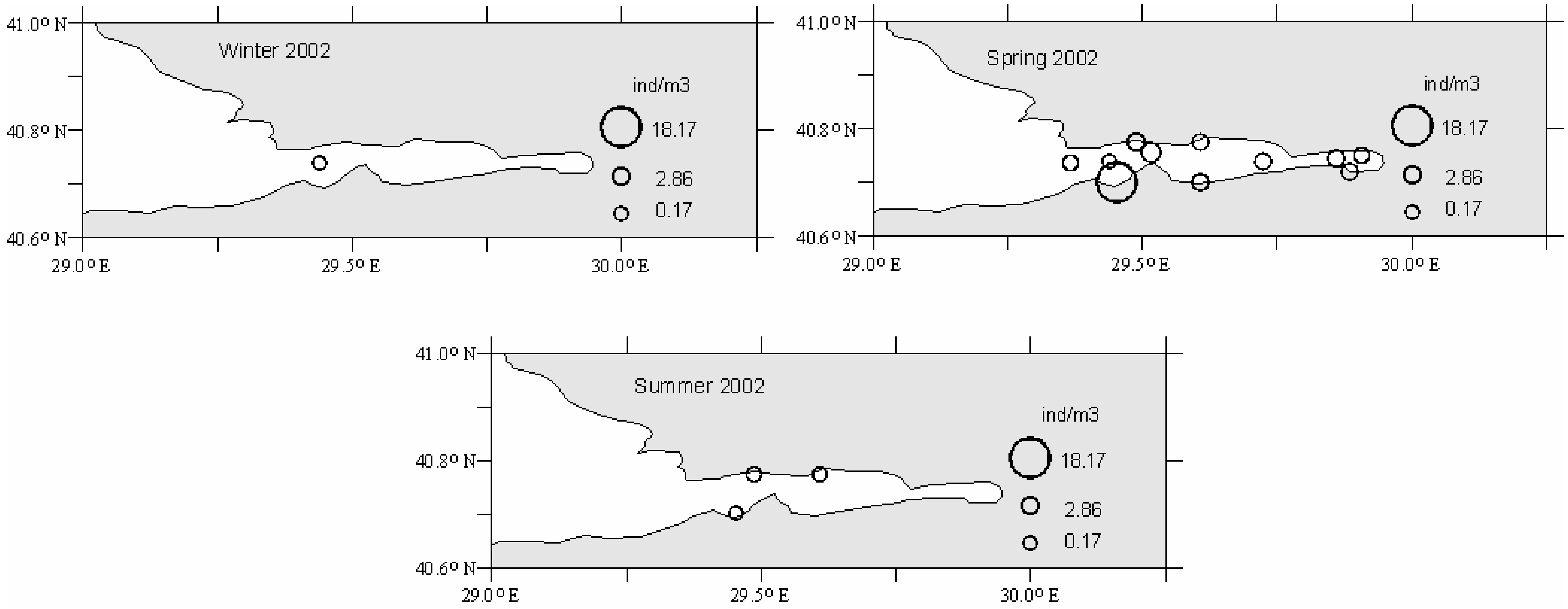

Figure 7. Seasonal abundance of *Pleurobrachia pileus* in Izmit Bay.

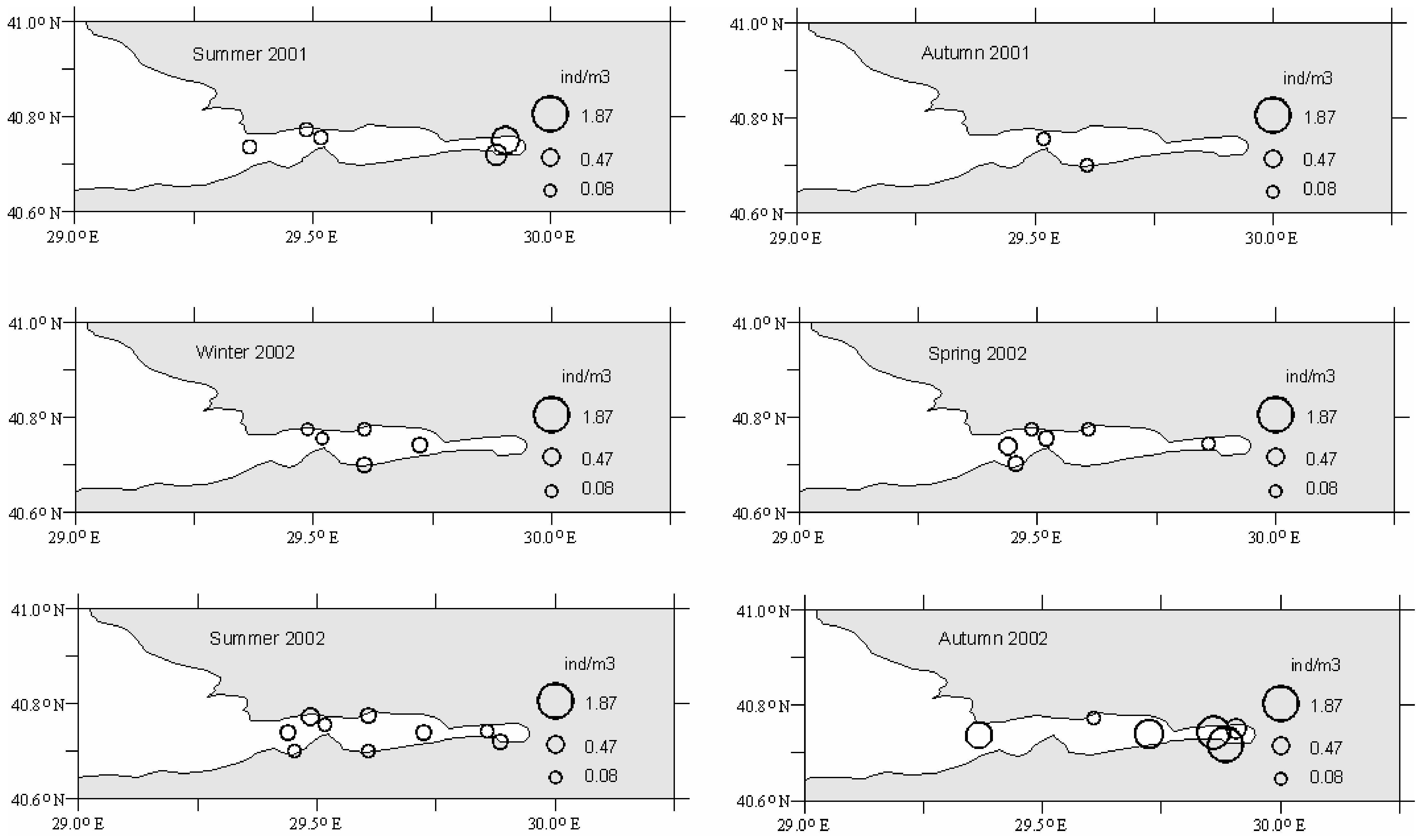

Figure 8. Seasonal abundance of *Aurelia aurita* in Izmit Bay.

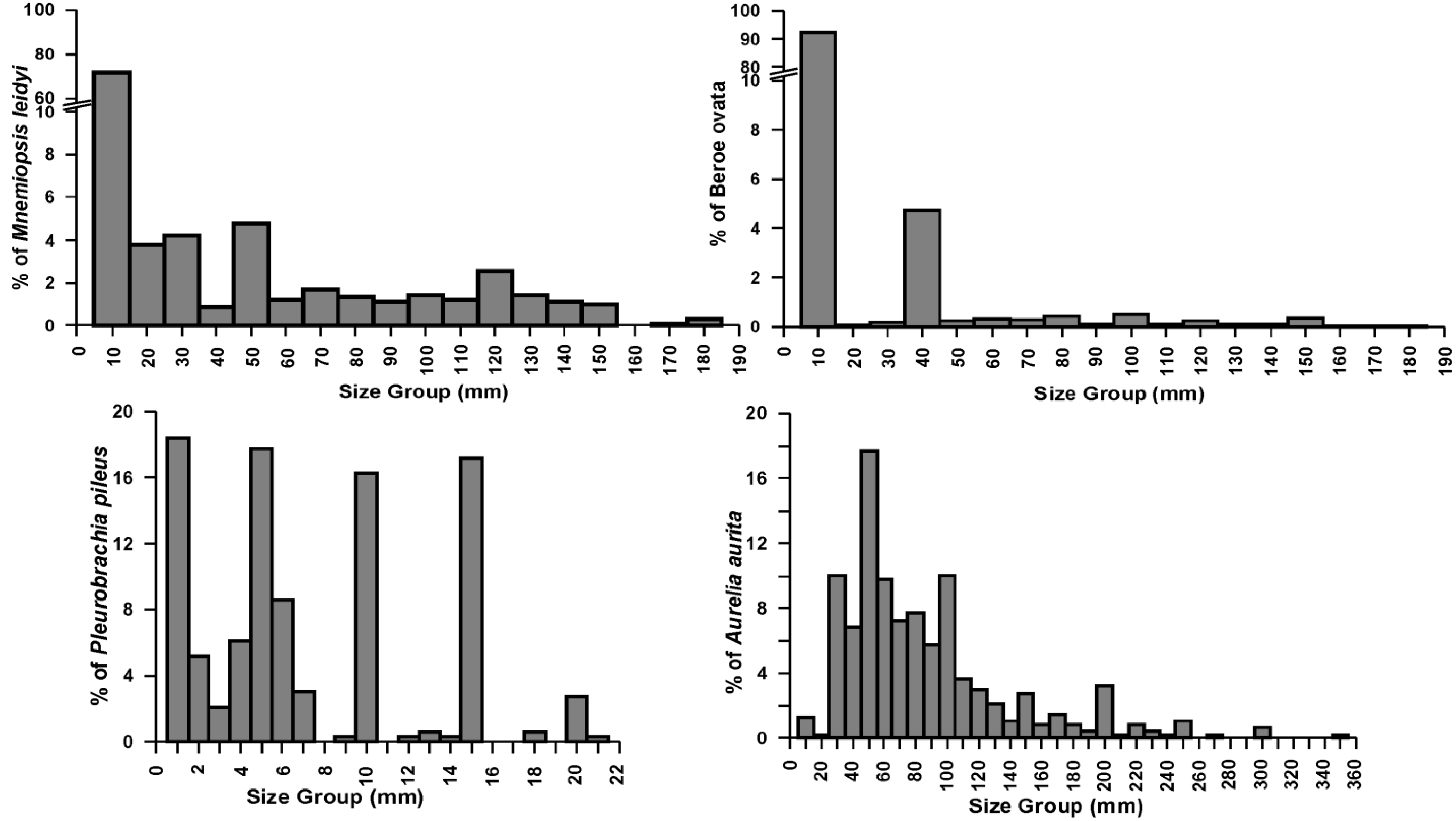

Figure 9. Size structure of *Mnemiopsis leidyi, Beroe ovata, Pleurobrachia pileus, Aurelia aurita* population and their percentage within total number of individuals at all stations in Izmit Bay from July 2001 to November 2002.

Discussion

The biomass of gelatinous macrozooplankton has increased in many parts of the world (Purcell 2005). In some cases this has resulted from the introduction of invasive species (Shiganova 1998), but increases in abundance of native species have also occurred (Link and Ford 2006).

In Izmit bay, inward currents are effective in spring and summer, related to the freshwater inflow changes at the Black Sea. This regime shifts in autumn and winter when there is an outward flow from the Bay to the Marmara Sea (Oguz and Sur, 1986). Meanwhile anticlockwise current together with the westerly winds in Izmit Bay force some of the water into the central part of the Bay away from the narrow strait (Algan *et al*. 1999). The spatio-temporal distribution of gelatinous macrozooplankton (*M. leidyi, B. ovata, P. pileus* and *A. aurita*) seems to be related to the general current circulation of Izmit Bay. The effects of currents, water temperatures and salinity on the horizontal distribution of gelatinous macrozooplankton have been shown earlier (Mutlu and Bingel, 1999; Mutlu, 1999; 2001).

M. leidyi is adapted to seasonal fluctuations in food abundance and temperature, and its population density increases very rapidly (Finenko *et al.* 2003). Although the *M. leidyi* peak biomass is found to be governed by temperature in the northwestern Atlantic (Purcell *et al.* 2001), in the past, high biomass and abundance of *M. leidyi* were observed even in winter in the Black Sea (Mutlu 1999). Though previous data on *M. leidyi* in the Marmara Sea are scarce, we found a seasonal distribution with lower values in winter.

As revealed in this study, after the *B. ovata* appearance, sharp decreases occurred in *M. leidyi* quantity in September and October 2001, and October and November 2002. When *M. leidyi* biomass and abundance reach peak values, *B. ovata* starts to increase sharply, and in the following 2 months, this predator controls the levels of *M. leidyi* very effectively in Izmit Bay. After the disappearance of *B. ovata* in late autumn, the *M. leidyi* biomass again increased in spring. Finenko *et al.* (2001, 2003) demonstrated for the Black Sea area off Sevastopol that *B. ovata* could control the *M. leidyi* stocks. Kremer and Nixon (1976) also noticed that a reduction of *M. leidyi* biomass coincided with an increase in *B. ovata* abundance.

P. pileus displayed monthly variations in biomass and abundance from February to June in Izmit Bay. Starting in winter, when the lowest values were observed, *P. pileus* showed marked increases in biomass and abundance until spring, when the maximum values occurred. A significant increase in weight and biomass between April and May suggests that *P. pileus* reproduction began in February/March and continued to increase until May, ceasing in June. Mutlu and Bingel (1999) found a similar trend in the seasonal biomass of *P. pileus* in the Black Sea.

Compared to other gelatinous species, *A. aurita* showed more regular variations. Starting in winter when the lowest values were observed, *A. aurita* showed an increase in spring, due to the contribution of a new generation. A peak occurred in summer and autumn, due to growth of the spring generation. Similar results have been reported in the Black Sea (Mutlu 2001).

Mutlu (1999, 2001, 2009) noticed that when *M. leidyi* was predominantly present, *A. aurita* were rare, and *vice versa*. *A. aurita* and *M. leidyi* inhabit the same layer and compete for the same planktonic food (Mutlu 1999, 2001). After the decrease of *M. leidyi* in autumn 2002, the biomass and abundance of *A. aurita* sharply increased, probably due to the decrease of *M. leidyi* in that season.

The maximum size of *Beroe ovata* collected in Izmit Bay was larger than that reported for its native regions and the Black Sea. *B. ovata* reaches 115 mm near the Atlantic coasts of North America (Mayer 1912) and 162 mm in the Black Sea (Shiganova *et al.* 2001). Shiganova and Malej (2009) reported that the maximum length of *B. ovata* in the Adriatic Sea was 160 mm. The reason for the size differences between locations is not clear.

Small individuals of *M. leidyi* (<10 mm) were observed throughout the year, and mean lengths of individuals increased from summer to spring, when large individuals dominated the population. Mutlu (1999) found that large individuals were abundant in summer in the Black Sea.

Coexistence of small (<10 mm) and larger individuals suggested that reproduction of *P. pileus* in the Black Sea occurred from winter to summer. Similar size occurrences were noted in the Black Sea (Mutlu and Bingel 1999; Mutlu 2009).

The mean values of size of *A. aurita* in the Black Sea were smallest in spring 2001, increasing rapidly in autumn 2002 and declining again in winter. The same trend was found in the Kiel Bight, Germany (Schneider and Behrends 1994). However, the reduction in size in the Black Sea occurred in a season earlier than in Izmit Bay (Mutlu 2009).

Gelatinous macrozooplankton in the Black Sea influence the zooplankton community (Shiganova 1998; Kideys and Romanova 2001). This conclusion is in agreement with results from the Marmara Sea (Shigonova *et al.* 1995; Isinibilir *et al.* 2004). In Izmit Bay, zooplankton abundance may have been affected by predation pressure of gelatinous zooplankton, especially *M. leidyi*. There is a negative correlation (P<0.01) between chlorophyll a and zooplankton biomass as well as between zooplankton and *Mnemiopsis* quantities. Previous studies (Purcell 1985; Tsikhon-Lukashina *et al.* 1991; Mutlu and Bingel 1999; Mutlu 1999; 2001) stated that many gelatinous macrozooplankton, especially *M. leidyi*, feed on copepoda, cladocera and meroplankton.

In conclusion, I suggest that there is a relationship between the decrease in the amount of zooplankton and gelatinous macrozooplankton. Furthermore, distribution of gelatinous macrozooplankton may be affected by some physical parameters.

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İzmit Körfezi'nde (Kuzey-doğu Marmara Denizi) jelimsi makrozooplanktonun bolluğu ve mevsimsel dağılımı

Özet

Bu çalışmada, Temmuz 2001-Kasım 2002 yılları arasında *Mnemiopsis leidyi*, *Beroe ovate, Pleurobrachia pileus* ve *Aurelia aurita*'nın İzmit Körfezinde ki dağılımı incelenmiştir. *Mnemiopsis leidyi* İzmit Körfezi'nde her mevsim bulunurken, *Beroe ovate* sadece yaz ve sonbahar aylarında görülmüştür (en yüksek ortalama bolluğu Eylül 2001'de 120.9 ± 250.5 ind.m^{-3}). İzmit Körfezinde *Beroe ovata*'nın bolluğunun artışı *M. leidyi*'nin biyomasında hızlı bir düşüşe neden olmuştur. *Pleurobrachia pileus* sadece Şubat-Haziran 2002 döneminde görülmüştür. *Aurelia aurita* her mevsim İzmit Körfezi'nde tespit edilmiştir. *M. leidyi*'nin küçük bireyleri (<10 mm) yıl boyunca İzmit Körfezi'nde bulunmuş ve ortalama uzunlukları bahar aylarında artış göstermiştir.

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