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Comparison of the mesozooplankton composition the southwestern Black Sea, Sea of Marmara and eastern Aegean Sea.

Güneybatı Karadeniz, Marmara ve Doğu Ege Denizi mesozooplankton kompozisyonlarının mukayesesi

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Abstract

In the Black Sea, a total of 98 zooplankton species were determined. Copepods constituted 80% of the total biomass of zooplankton species in the spring. This ratio varied seasonally; 60% in the summer, 68% in the fall, and 72% in the winter. The dominant species were *Calanus helgolandicus, Paracalanus parvus, Pseudocalanus elongatus, Centropages ponticus, Acartia clausi, Oithona similis and O. minuta*.

In the Sea of Marmara, 17 Copepod species constituted over 75% of the total zooplankton biomass on the average for all the seasons. *Acartia* species were the most dominant. Other dominant species were from the genera *Centropages*, *Pseudocalanus*, *Metridia*, and *Paracalanus*, respectively .

In the northern Aegean Sea, seasonal percentage of Copepod species in the total zooplankton taxa were determined as follows; 50% in the fall, 84% in the winter, 83% in the spring and 58% in the summer. The similar figures for the southern Aegean Sea were 75% in the fall, 73% in the winter, 88% in the spring, and 74% in the summer.

Key words: Black Sea, Sea of Marmara, Aegean Sea, Zooplankton, Copepod.

Introduction

The zooplankton plays a significant role in the productivity of the marine environment. It is an important food source available to fish, fish larvae and cephalopods. Copepods, that account for more than the half of the proportion of the zooplankton, are important to determine the productivity of the sea.

The research area covers three ecologically different marine environments continuously interacting with each other. The Black Sea organisms have three different origins related to water characteristics; sarmatic remnant of brackish water, fresh water and Mediterranean water coming from the Aegean Sea via the Straits undercurrent (Greze and Fedorina, 1979). The Sea of Marmara, a small intercontinental basin with a total volume of 3378 km^3, carries the less saline Black Sea (17-18 ppt) water into the Aegean Sea in the upper layer and the more saline Mediterranean Sea water (39 ppt) into the Black Sea in the lower layer via Turkish Straits. The Aegean Sea has four different water characteristics; the less saline cold surface water coming from the Black Sea, the Atlantic water coming via Gibraltar, the eastern Mediterranean middle depth water and deep water. Therefore, Aegean Sea is rich in species diversity and poor in biomass.

Southern winds drive low salinity surface waters of Black Sea to the Northern Aegean in winter, then flowing back through the Greece coast they reach to southern Aegean. In summer, it flows from Çanakkale strait to the Southern Aegean because of the northern winds. Furthermore, colder and higher salinity waters of the deeper Black Sea also move between the Aegean and Eastern Mediterranean. Hydrodynamic conditions play an effective role in this movement (Yüce, 1992).

The movement of different water masses in the study area determines the geographical and seasonal distribution of copepods. Salinity and temperature are also important parameters affecting this distribution.

Many workers have completed important studies on the zooplankton species of Black Sea, Sea of Marmara and Aegean Sea. The principal ones can be taken as: Nikitin, 1949; Greze and Fedorina, 1979; Benli, 1987; Ergün, 1994; Gücü, 1994;

Arashkevich *et.al.*, 1998; Beşiktepe *et.al.*, 1998; Beşiktepe and Ünsal, 2000; Kideys *et al.*, 2000 for the Black Sea, Demir, 1958-59; Cebeci and Tarkan, 1990 for Sea of Marmara and Pauvlova, 1966; Kimor and Berdugo, 1967; Moraitou-Apostolopoulou, 1972-74-76 and 1977; Özel, 1992 for the Aegean Sea.

Materials and Methods

Zooplankton sampling was carried out with R/V K. Piri Reis in the Black Sea and the Aegean Sea, and with R/V Arar in the Sea of Marmara. The samples were taken seasonally as vertical hauls from bottom to surface (Fig.1) using a Bongo Net with 200 μm mesh size in 1986-1990.

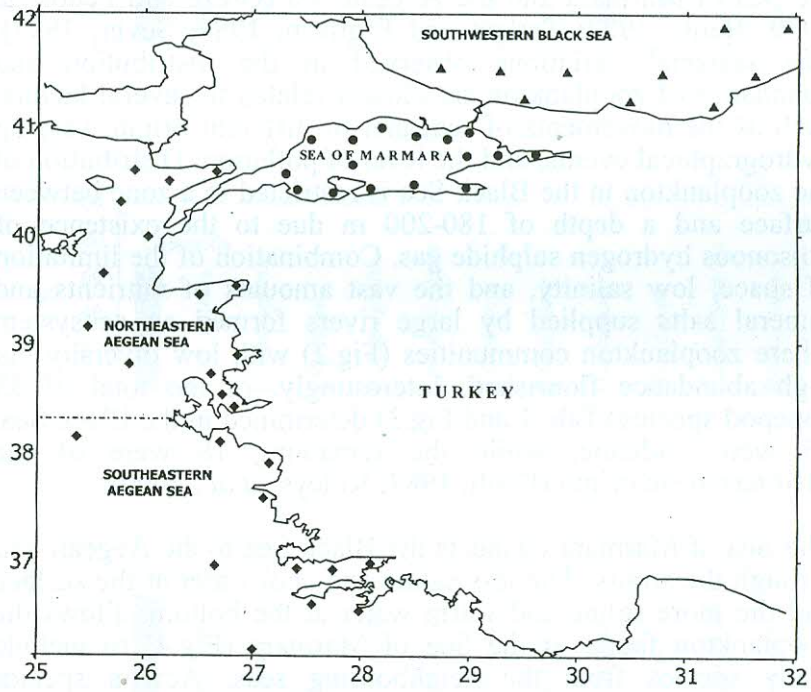

Figure 1. Sampling stations

The zooplankton samples taken from the collector were transferred to 5 L PVC jars and kept in 4% formaline solution. Collected samples were transferred to parallel lined (0.5 cm interval) petri holders via 1/10 sampling method by using a VMZ Olympus stereo binocular microscope.

Result and Discussion

The primary productivity in the Aegean Sea is about 12-18 fold poorer than the Black Sea. However, the northern Aegean Sea is more productive than the southern Aegean Sea because of the nutrient rich Black Sea water flow from the Strait of Dardanelles.

Compared to all other zooplankton groups, copepods were determined to be the dominant zooplankters in the Black Sea, the Sea of Marmara and the Aegean Sea (Greze and Fedorina, 1979; Benli, 1987; Tarkan and Ergüven, 1988; Sever, 1997). The seasonal variations observed in the distribution and abundance of zooplankton are closely related to several factors, such as the movements of seawater of different origin, varying hydrographical events, and the level of pollution. Distribution of the zooplankton in the Black Sea is restricted to a zone between surface and a depth of 180-200 m due to the existence of poisonous hydrogen sulphide gas. Combination of the limitation of space, low salinity, and the vast amounts of nutrients and mineral salts supplied by large rivers formed an ecosystem where zooplankton communities (Fig.2) with low diversity but high abundance flourished. Interestingly, of the total of 33 copepod species (Tab. 1 and Fig.3) determined in the Black Sea, 15 were endemic, while the remaining 18 were of the Mediterranean origin (Benli, 1987; Kideys, *et.al.,* 2000).

The Sea of Marmara connects the Black Sea to the Aegean Sea through the straits. The less saline and cool water at the surface and the more saline and warm water at the bottom, allows the zooplankton fauna of the Sea of Marmara (Fig.4) to include many species from the neighbouring seas. Acartia species dominate the zooplankton in the Sea of Marmara in the spring, while in the winter (Fig.5), *Centropages typicus*, *Calanus* spp. and

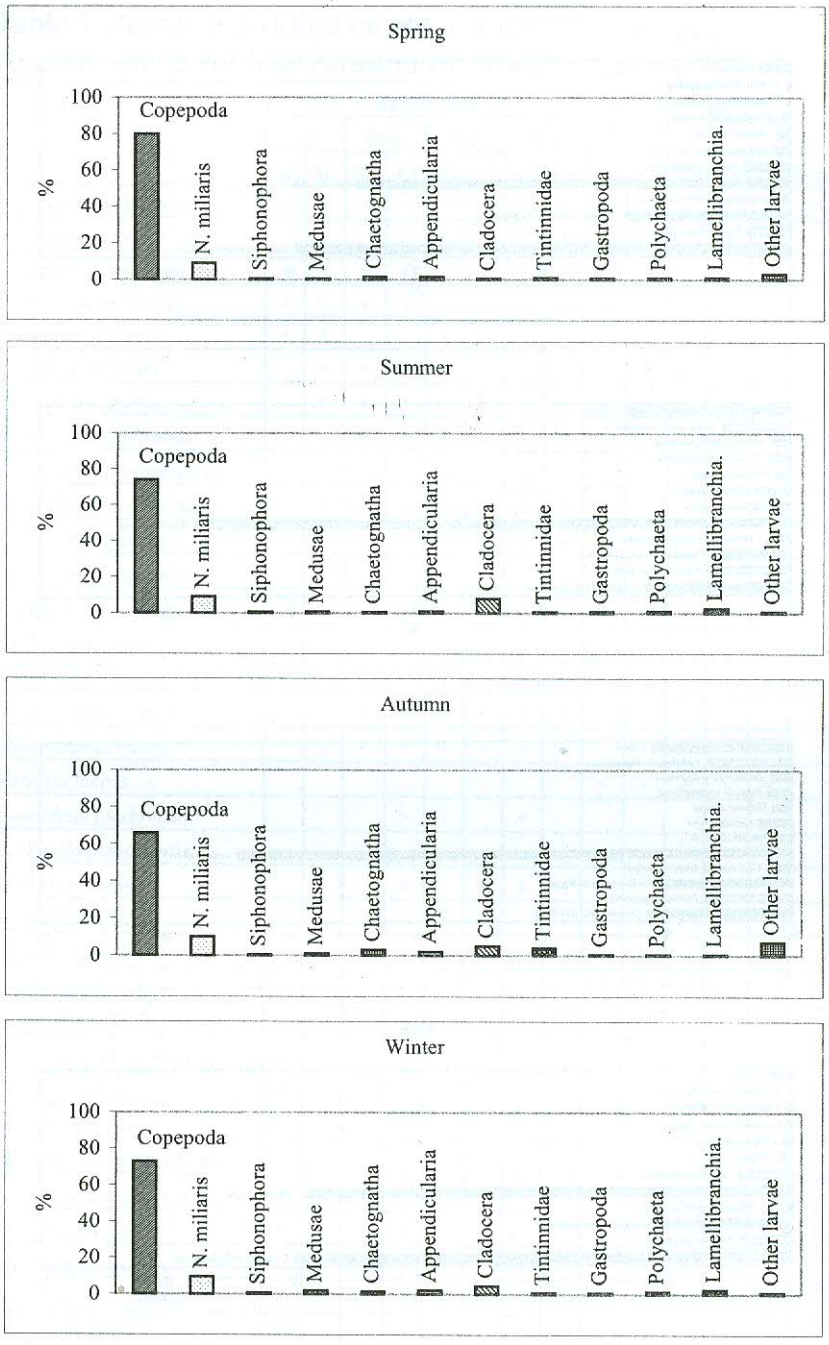

Figure 2. Seasonal percentage distribution of zooplankton groups in the Black Sea.

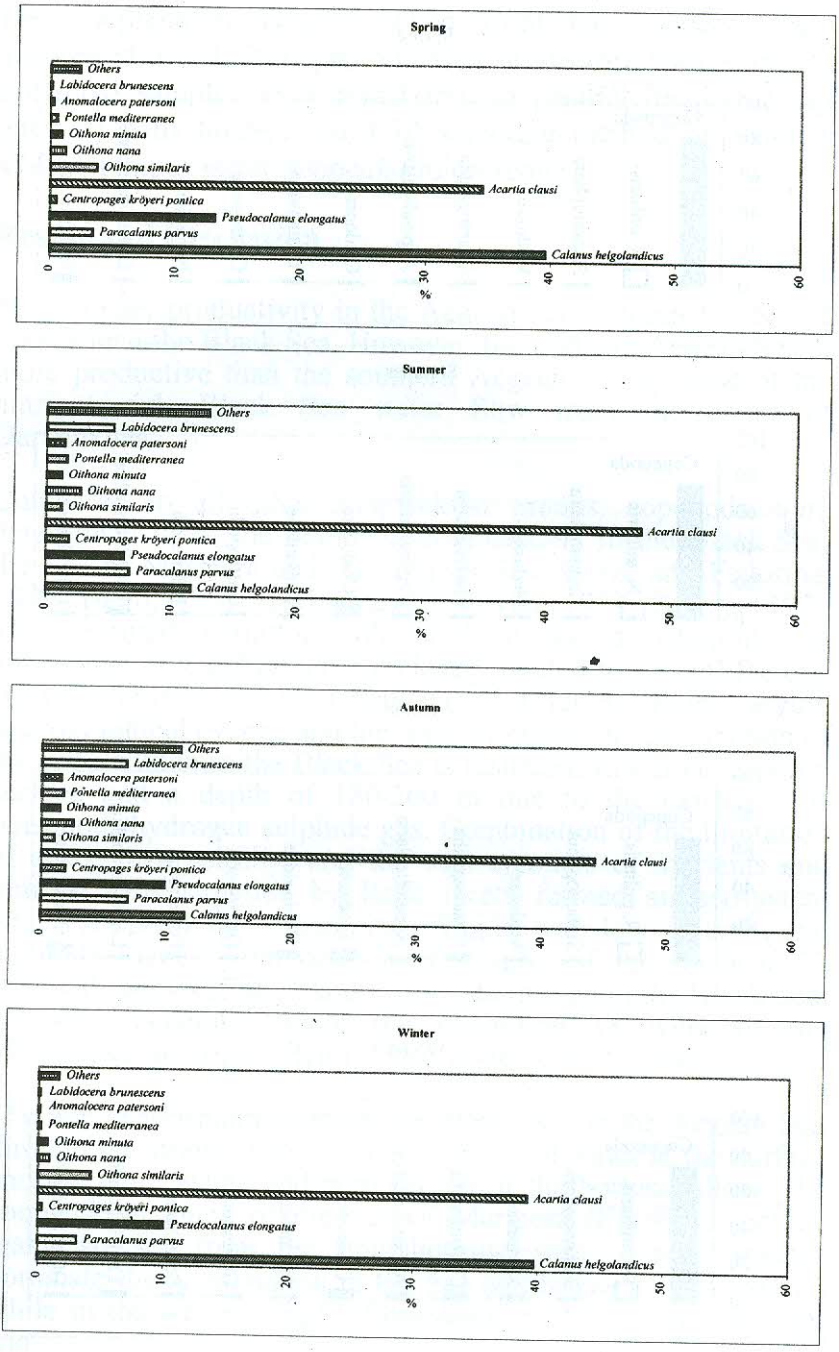

Figure 3. Seasonal percentage distribution of Copepod species in the Black Sea.

Table 1. Seasonal distribution of common copepod species of Aegean Sea,Sea of Marmara and Northwestern Black Sea.

	Aegean Sea								Sea of Marmara		Black Sea			
	Spr		Sum		Aut		Win							
	NA	SA	NA	SA	NA	SA	NA	SA	Spr	Win	Spr	Sum	Aut	Win
Calanus helgolandicus	+	+	+		+				+	+	+			+
Neocalanus gracilis		+			+			+	+	+		+		
Neocalanus tenuicomis	+	+	+	+	+	+	+	+						
Nannocalanus minor	+	+	+	+	+	+	+	+						
Eucalanus attenuatus	+	+			+				+			+		
Mecynocera clausi		+	+	+	+	+	+	+	+	+		+		
Calocalanus pavo		+	+	+	+	+	+	+	+	+		+	+	
Calocalanus styliremis		+	+	+	+	+	+	+						
Ischnocalanus plumulosus		+	+		+	+	+	+						
Calocalanus contractus		+				+	+	+						
Paracalanus parvus	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Paracalanus pygmaeus	+	+	+		+									
Pseudocalanus elongatus					+	+	+	+	+		+			+
Paracalanus nanus	+	+		+	+		+	+						
Clausocalanus arcuicomis	+	+	+	+	+	+	+	+	+	+		+	+	
Clausocalanus furcatus	+	+	+	+	+	+	+	+						
Ctenocalanus vanus	+	+	+	+	+	+	+	+						
Metridia lucens									+	+	+	+	+	
Euaetideus giesbrechti				+	+		+							
Euchirella messinensis		+						+						
Euchaeta marina		+		+		+	+	+						
Euchaeta acuta		+				+		+						
Phaenna spinifera				+	+	+								
Xanthocalanus agilis		+		+										
Scolecithricella abyssalis		+		+										
Scolecithricella dentate	+		+		+	+								
Diaixis pygmoea	+			+		+								
Temora stylifera	+	+	+	+	+	+			+	+		+	+	
Pleuromamma abdominalis	+	+		+		+					+	+	+	+
Pleuromamma gracilis	+	+		+		+				+	+	+		
Centropages typicus	+	+	+	+	+				+	+				
Centropages kroyeri				+	+		+		+		+	+	+	
Centropages violaceus	+	+	+		+	+								
Isias clavipes	+			+	+									
Lucicutia flavicomis	+	+			+	+			+		+			
Lucicutia clausi		+		+		+								
Heterorhabdus papilliger	+													

	Aegean Sea								Sea of Marmara		Black Sea			
	Spr		Sum		Aut		Win							
	NA	SA	NA	SA	NA	SA	NA	SA	Spr	Win	Spr	Sum	Aut	Win
Heterorhabdus spinifrons		+		+		+								
Euterpina acutifrons	+		+		+		+			+		+	+	
Clytemnestra scutellata	+													
Clytemnestra rostrata	+				+									
Oncaea venusta	+	+	+	+	+	+		+						
Oncaea mediterranea	+	+	+	+	+	+	+	+	+	+				
Oncaea media	+	+	+	+	+	+	+	+						
Lubbockia squillimana	+			+		+		+						
Lubbockia aculeate		+				+								
Sapphirina angusta		+	+											
Sapphirina nigromaculata	+				+	+								
Copilia mediterranea	+		+	+	+	+								
Copilia quadrata	+								+					
Copilia rostrata	+				+									
Corycaeus (A.)typicus	+	+	+		+	+	+	+	+			+		
Corycaeus (O.) giesbrechti			+	+	+	+		+						
Corycaeus (D.) brehmi	+	+	+	+	+	+		+						
Corycaeus (U.) furcifer	+	+	+	+	+	+	+	+	+	+		+	+	
Corycella (F.) rostrata	+	+	+	+	+	+	+	+	+			+	+	
Haloptilus longicornis	+	+	+	+	+	+	+	+						
Candacia varicans		+	+											
Candacia armata	+	+	+	+	+									
Candacia aethiopica	+					+	+							
Anomalocera patersoni	+								+	+	+	+	+	+
Pontella mediterranea	+								+	+		+	+	
Pontella labiancoi	+								+	+				
Pontellina plumata	+		+		+									
Lapidocera brunescens									+	+		+	+	
Lapidocera wollastoni	+		+		+									
Acartia clausi	+	+		+	+	+	+	+	+	+	+	+	+	+
Acartia latisetosa	+		+			+				+	+			
Acartia negligens		+	+	+		+	+		+	+				
Mormonilla minor			+	+										
Oithona helgolandica	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Oithona nana	+	+			+		+		+		+	+	+	+
Oithona plumifera	+	+	+	+	+	+	+	+						
Microsetella rosea	+				+							+	+	
Microsetella norvegica	+		+		+									
Macrosetella gracilis		+		+					+	+		+	+	

Paracalanus parvus are somewhat more dominant (Tarkan and Ergüven, 1988).

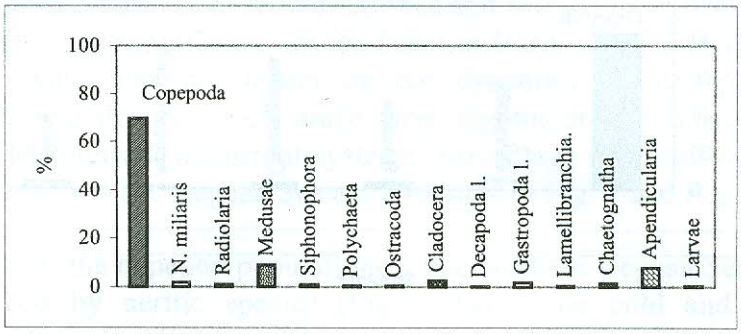

Figure 4. Percentage distribution of zooplankton groups in the Sea of Marmara.

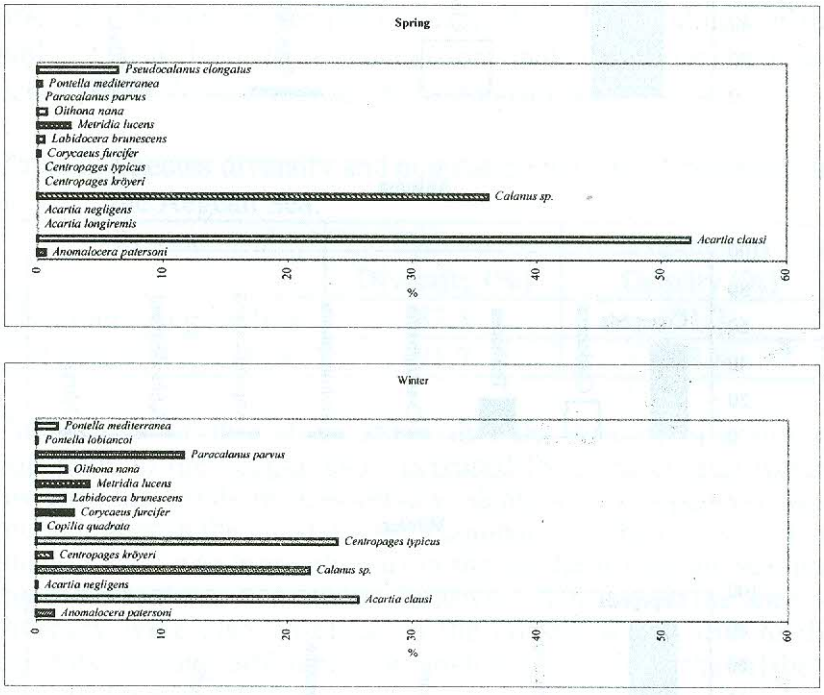

Figure 5. Percentage distribution of Copepoda species in the Sea of Marmara in the spring and winter season.

Seasonal zooplankton composition of the Aegean Sea is shown in Fig. 6.

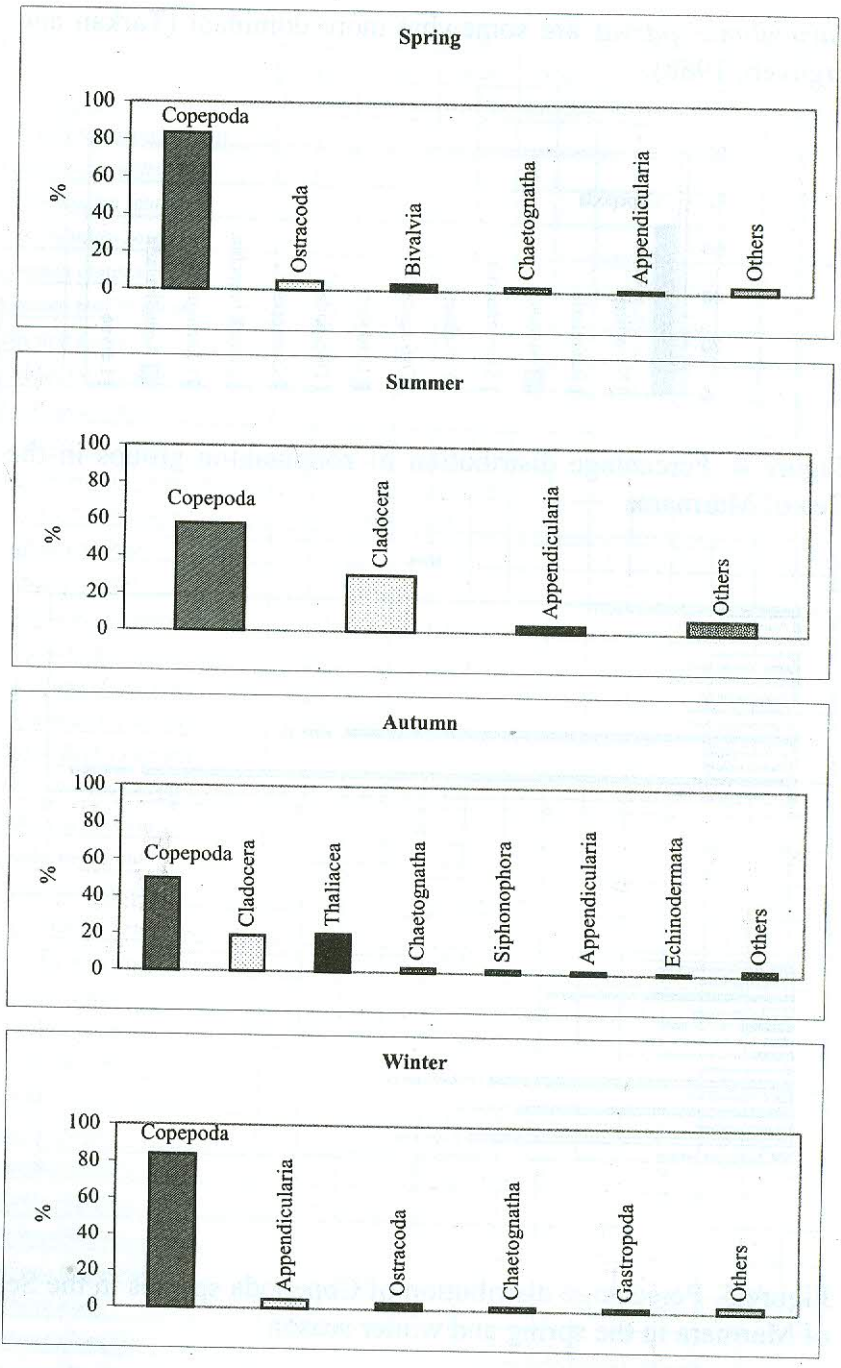

Figure 6. Seasonal percentage distribution of zooplankton groups in the North Aegean Sea

The distribution and concentration of copepods, that favour the surface zone, or waters close to the surface in the Aegean Sea are considerably affected by the cool and low salinity Black Sea surface water outflow from the Strait of Dardanelles. The Black Sea water has no impact on the dynamics of the species favouring deeper waters since these regions are influenced by the Mediterranean current systems. Percentage compositions of copepods in the Aegean Sea are presented in Fig. 7 and Fig. 8.

Most of the copepod populations in the northern Aegean Sea are formed by neritic species (Fig.7) that prefer cold and low salinity waters (Such as *Temora stylifera, Centropages typicus*). A table illustrating the species diversity and population density of copepods in the southern (Fig.9) and northern Aegean Sea is presented below (Sever,1997; Özel,1992). The findings in the table 2 can lead to a conclusion that there are two bio ecologically distinct regions in the Aegean Sea.

Table 2. Species diversity and population density of copepods in the Aegean Sea.

Region	Species Diversity (%)	Population Density (%)
Southern Aegean Sea	87.5	71.2
Northern Aegan Sea	91.7	28.8

The results of this study show that the species diversity of copepods in the zooplankton increased from the coastal waters towards the offshore. Conversely, densities of copepods were much higher in the coastal waters compared to the offshore. This phenomenon was more obvious in the southern Aegean Sea than the other regions. Sometimes, however, increases in the species diversity were also observed in the coastal waters due to the currents carrying different zooplankton groups from the offshore towards the coast.

Hitherto, a total of 120 Copepod species have been determined in the Aegean Sea (Pavlova, 1966). Although the majority of these species are of Atlantic and the Indopacific origin, several endemic species originated from the Black Sea and the Mediterranean are

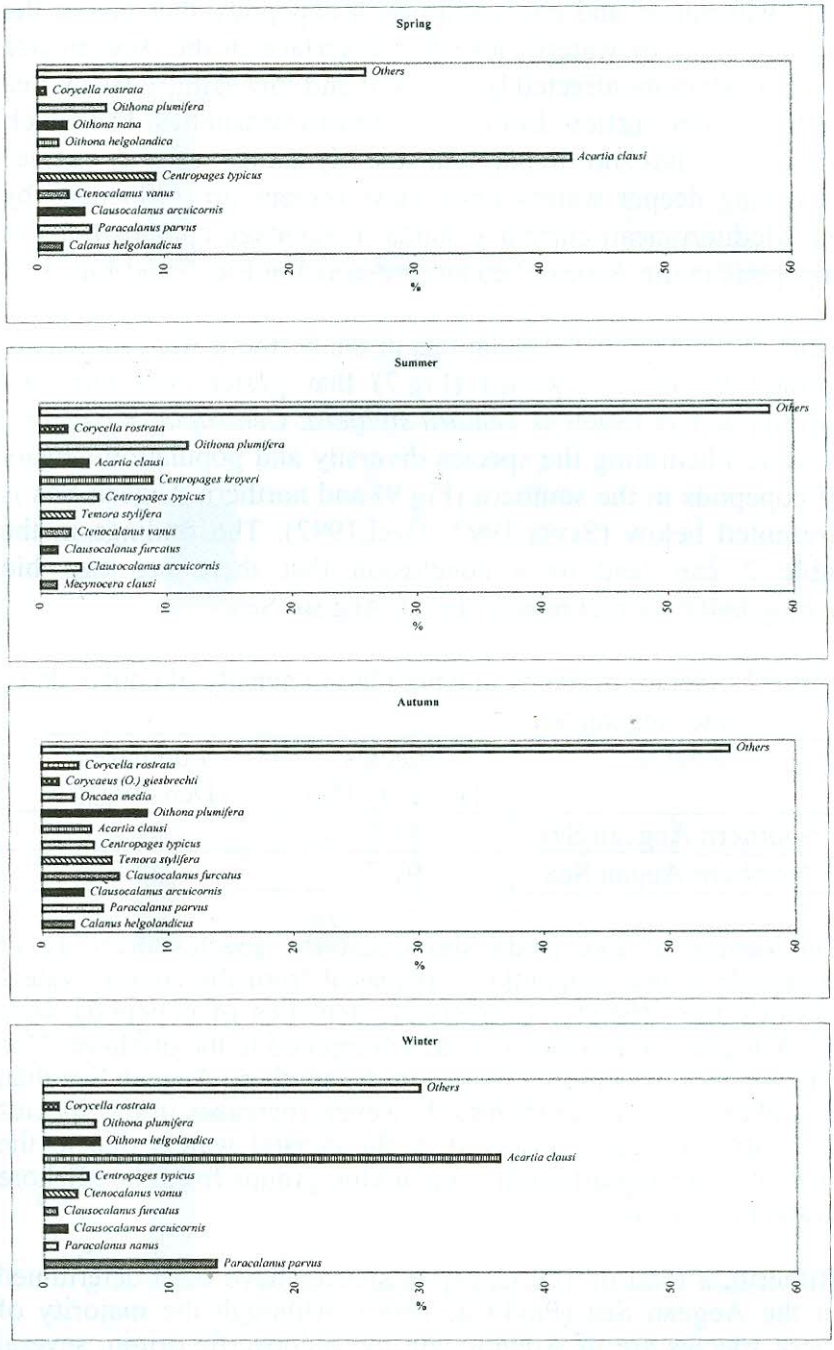

Figure 7. Seasonal percentage distribution of Copepod species in the North Aegean Sea

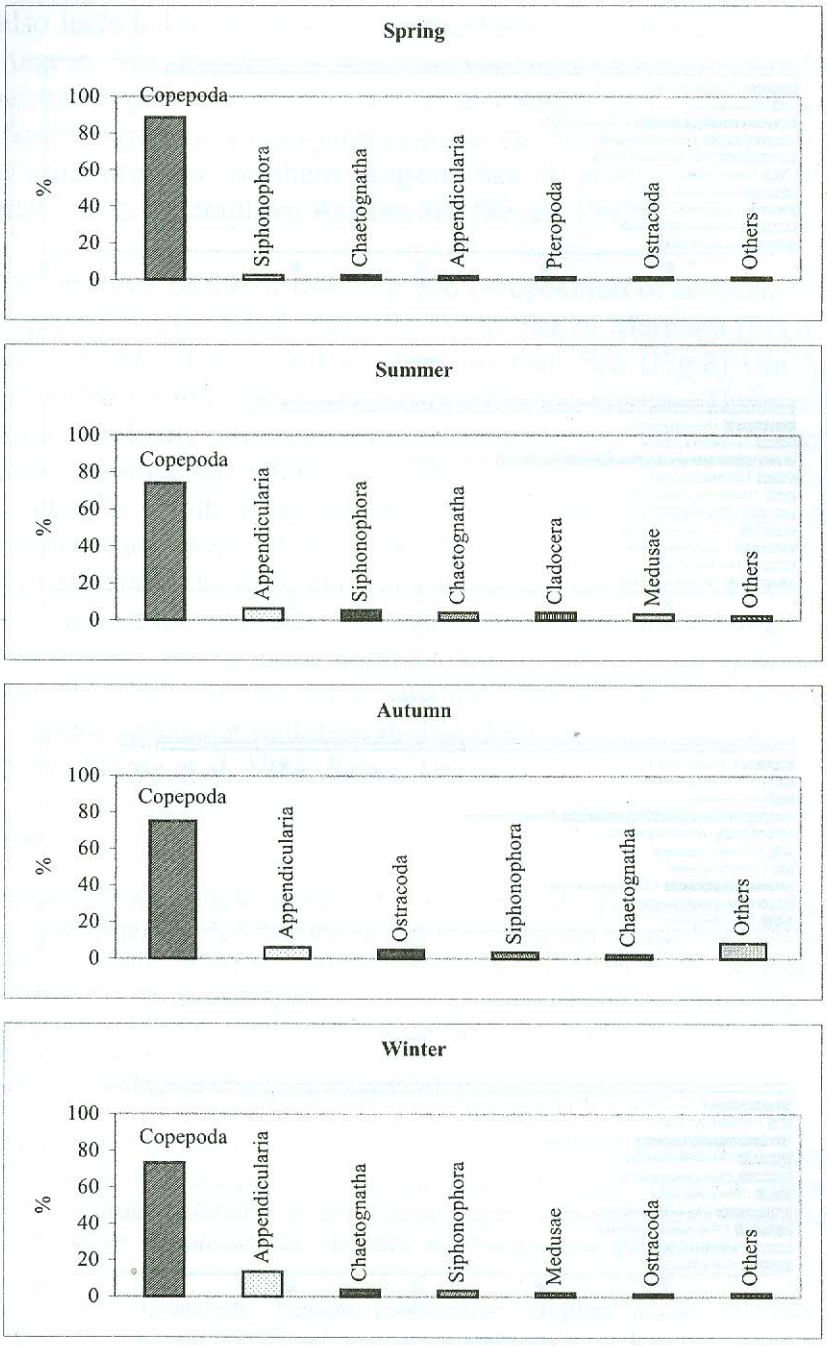

Figure 8. Seasonal percentage distribution of zooplankton groups in the South Aegean Sea

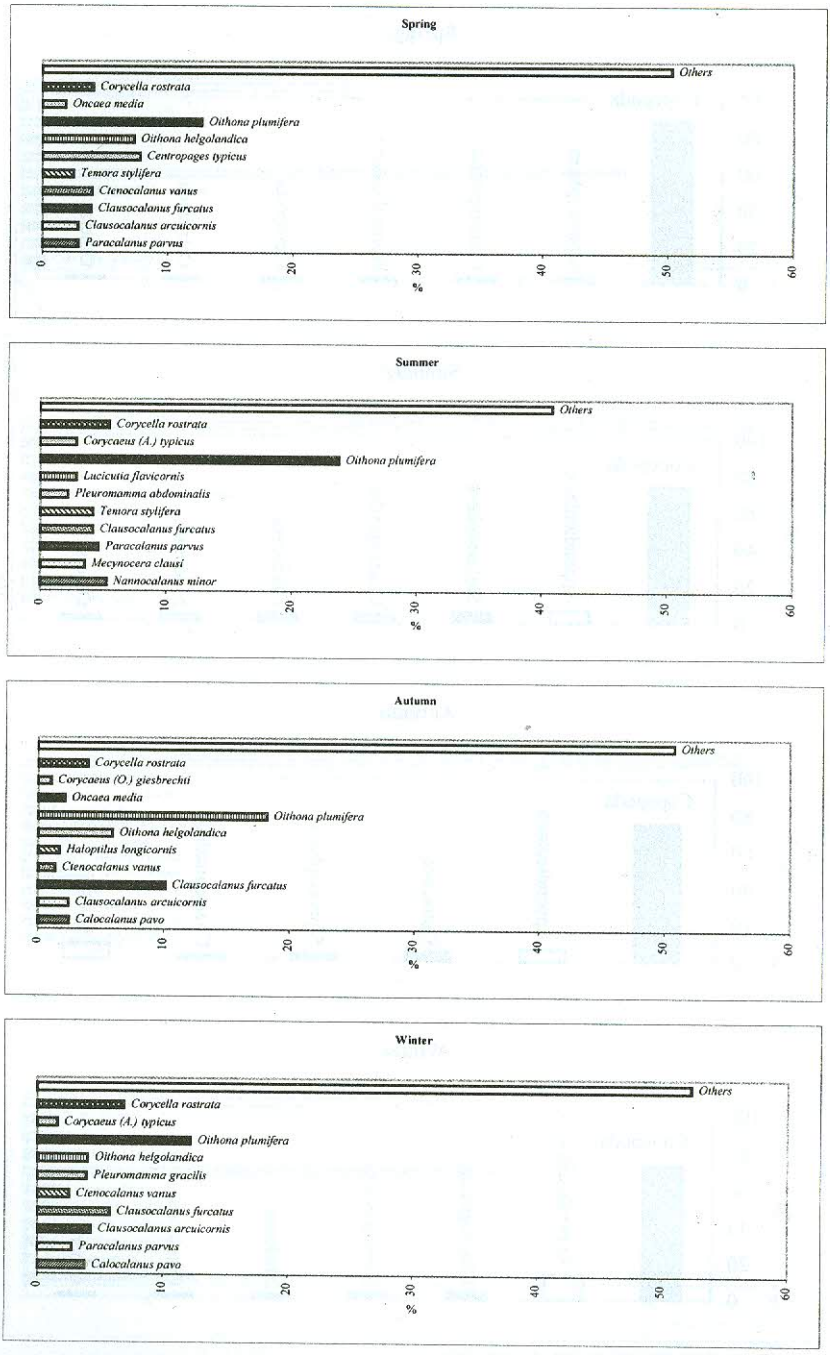

Figure 9. Seasonal percentage distribution of Copepod species in the South Aegean Sea

also included in the Aegean zooplankton fauna. In the northern Aegean Sea, the part of the copepod populations formed by neritic major species that prefer less saline and cold waters; *Temora stylifera*, *Centropages typicus* etc. In terms of density of populations, the northern Aegean Sea is proportionly 40 % richer than the southern Aegean Sea (Sever, 1997).

The analysis of the distribution and composition of zooplankton suggests that the Black Sea (Fig.2), the Sea of Marmara (Fig.4), the northern (Fig.6) and southern Aegean Sea (Fig.8) can be classified as four bio ecologically different regions. However, these markedly different regions continuously influence each other through the straits, and also due to the meteorological conditions. Both geographical and seasonal distributions of zooplankton were determined to a large extent by the movements of the different water masses in the studied areas. In all these four regions, two species, *Acartia clausi* that is distributed densely in the polluted waters, and *Temora stylifera*, that lives only in the clean offshore waters, can be used as indicator species in pollution studies (Moraitou-Apostolopoulou, 1974;. Ianora et.al. 1984; Sever, 1997).

Özet

Karadeniz, 98 zooplankton türü ile temsil edilmektedir. Zooplankton grupları içinde Copepoda türleri, İlkbaharda toplam zooplankton bioması'nın %80'ini oluşturmaktadır Mevsimsel olarak bu oran yaz aylarında %60 , Sonbahar aylarında % 68, ve Kış aylarında % 72'si olarak değişiklik göstermektedir. Zooplankton türleri içinde sırasıyla *Calanus helgolandicus, Paracalanus parvus, Pseudocalanus elongatus, Centropages ponticus, Acartia clausi, Oithona similis and O. minuta* yaygın türler olarak bulunmuştur.

Marmara Denizi'ndeki toplam zooplankton'un mevsim ortalamalarına göre % 76.2'sini 17 Copepoda türü oluşturmaktadır. Bu türler içinde en yaygın olanı Acartia türleridir. Genel olarak diğer dominant türler sırasıyla *Centropages*, *Pseudocalanus*, *Metridia*, and *Paracalanus* gelmektedir.

Kuzey Ege Denizinde Toplam zooplankton grupları içinde belirlenen Copepoda türlerinin mevsimsel oranları sonbaharda %50, Kış döneminde % 84, ilkbaharda % 83 ve yaz döneminde % 88 bulunmuştur. Güney Ege Denizinde, Kuzey'e benzer oranlarda sonbaharda % 75, Kış döneminde % 73, ilkbaharda % 88 ve Yaz döneminde % 74 olarak gözlenmiştir.

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