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Research Article

Seasonal Changes in the Phytoplankton of the Northeastern Mediterranean (Bay of İskenderun)*

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Abstract: This study was carried out in the northern part of the Bay of İskenderun in the northeastern Mediterranean during the period 1994-1995. The quantitative and qualitative distribution of phytoplankton, the environmental factors that affect its distribution and the changes in succession over time were investigated. At each of the seven stations, monthly sampling was done from the surface and 10.0 m depth. In spring, the sampling was performed once every two weeks. In addition, the measurements of some physical and chemical parameters i.e. temperature, salinity, $(NO^-_3+NO^-_2)$-N and $PO4^-_3$-P were carried out.

At the end of the study, a total of 170 taxa from 5 algae classes, *Cyanophyceae, Dinophyceae, Prymnesiophyceae, Dictyochophyceae* and *Bacillariophyceae* were determined. *Bacillariophyceae* was found to be richer than the other groups in terms of abundance and species number and followed by *Dinophyceae*. *Cyanophyceae*, *Prymnesiophyceae* and *Dictyochophyceae* were represented by only one species each.

Key Words: Northeastern Mediterranean, Bay of İskenderun, phytoplankton, diversity, succession, physico-chemical parameters.

Kuzeydoğu Akdeniz'de (İskenderun Körfezi) Fitoplanktonun Mevsimsel Değişimi

Özet: Bu çalışma, İskenderun Körfezi'nin (Doğu Akdeniz) kuzey kesimindeki 1994-1995 yılları arasında sürdürülmüştür. Çalışmada fitoplanktonun nitel ve nicel dağılımı, çevresel faktörlerin bu dağılıma etkileri ve zaman içindeki değişimleri araştırılmıştır. Herbir istasyonda aylık ve bahar aylarında iki haftada bir olmak üzere yüzeyden ve 10.0 m derinlikten örneklemeler yapılmıştır. Ayrıca, sıcaklık, tuzluluk, $(NO^-_3+NO^-_2)$-N ve $PO4^-_3$-P gibi bazı fizikokimyasal parametrelerin de ölçümü yapılmıştır.

Çalışma sonunda *Cyanophyceae, Dinophyceae, Prymnesiophyceae, Dictyochophyceae* ve *Bacillariophyceae* olmak üzere 5 alg sınıfından 170 adet taksa saptanmıştır. *Bacillariophyceae* sınıfı tür sayısı ve yoğunluk olarak diğer sınıflardan daha zengin bulunmuş ve bunu *Dinophyceae* takip etmiştir. *Cyanophyceae, Prymnesiophyceae* ve *Dictyochophyceae* birer tür ile temsil edilmiştir.

Anahtar Sözcükler: Kuzeydoğu Akdeniz, İskenderun Körfezi, fitoplankton, çeşitlilik, süksesyon, fiziko-kimyasal özellikler.

Introduction

Many studies have been carried out on phytoplankton ecology in Turkish seas. Some important studies on this subject are those of Gökalp (1) in the Gulf of Edremit, Bodrum and İskenderun and Koray in the Bay of İzmir (2, 3). However, few studies have been carried out, on the phytoplankton composition and seasonal succession at the Northeastern Mediterranean coast of Turkey especially in the Bay of İskenderun which is a very important area for fisheries.

In this study, the temporal distribution of phytoplankton species were studied in relation to some physico-chemical parameters i.e. temperature, salinity and N/P ratios in the selected area of the Bay of Iskenderun.

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Materials and Methods

This study was carried out at the Bay of İskenderun, in the northeastern Mediterranean. The coast between Yumurtalık and the Toros Fertilizer Factory in the northern part of the bay was selected and a total of seven sampling stations in the shallow and deeper parts of the area were defined (Fig. 1). For species identification, from each sampling station horizontal samples were taken. For this aim, a standard plankton net with a 55µ mesh size and 40 cm diameter was used. After the haulings, plankton samples were placed in plastic jars, fixed with standard lugol solution and taken to the laboratory for microscopic examination. Samples were preserved in a refrigerator until species identifications. Before microscopic identifications, samples were treated against organic substances. Identifications of the species were done with phase-contrast and binocular research microscopes. The studies used for species identifications were Massuti and Margalef (4), Tregouboff and Rose (5), Brunel (6), Patrick and Reimer (7), Drebes (8), Vinyard (9), Vinyard (10), Cupp (11), Rampi and Bernhard (12), Rampi and Bernhard (13), Koray and Gökpınar (14), Gökpınar and Koray (15), Sournia (16), Ricard (17), Delgado and Fortuna (18).

Quantitative plankton sampling was done vertically with a nansen bottle. The samples were placed in two liter jars and fixed with standard lugol solution. Then formaldehyde was added until a concentration of 4%. Samples were precipitated and the upper layer was removed by siphoning and standard single drop methods were used for counting and also a Sedgwick-Rafter counting chamber for bigger phytoplankters. The results of countings were summarized as cells/l (19). Shannon-Wienner (H') diversity and Pielou evenness (J) indices were used for estimation of diversity and Pielou evenness (20). These formulas are:

$$H' = -\sum_{i=1}^{s} pi(\log_2 pi)$$

$$J = \frac{H'}{\log_2 S}$$

where pi , cell number of species; i, total cell number; S, species number.

The salinity and temperature measurements of each stations were made with a YSI model salinometer. The

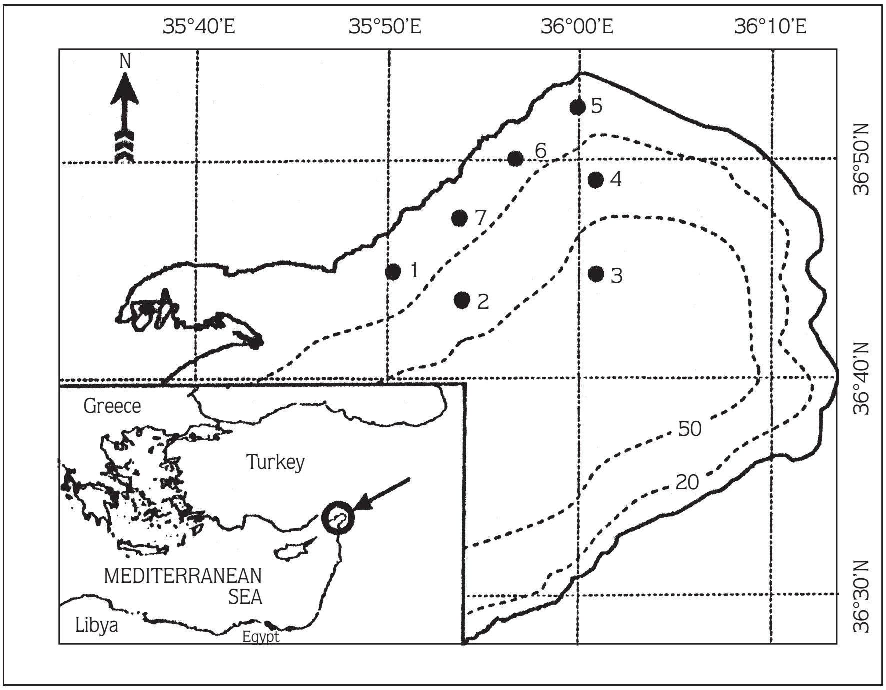

Figure 1. The sampling stations of the Bay of İskenderun.

analysis of inorganic nitrate and phosphate phosphorus was made according to the standard methods of Parsons et al. (21). N/P ratios were calculated from $(NO^-_3+NO^-_2)$-N and $PO4^-_3$-P values.

Results

Physico-chemical parameters

Temperature

During the research period, the mean temperature increased to the highest level in August (28.9±0.16°C) in surface water and decreased to the lowest in January (15.8±0.57°C) at 10 m depth (Fig. 2). There were no important differences between stations due to temperature. The number of phytoplankton species was poorer in August than in January. The species number of the class *Bacillariophyceae* was more than the class *Dinophyceae* in both August and January.

Salinity

Changes in salinity at the surface and 10.0 m depth during the research period showed that salinity reaches the highest level during the summer months. The highest mean salinity was measured in October as 39.02±0.04 %o at 10.0 m depth (Fig. 3). The lowest mean salinity was 37.9±0.43 %o in September at 10.0 m depth. During winter the salinity was lower and the

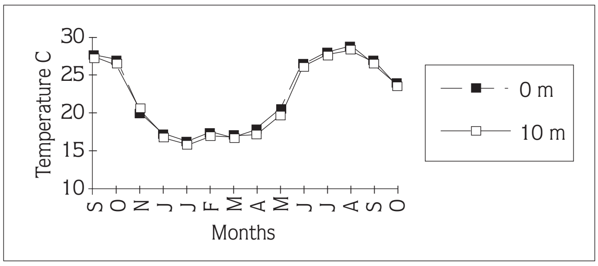

Figure 2. The annual cycle of seawater temperature in the Bay of İskenderun (˚C).

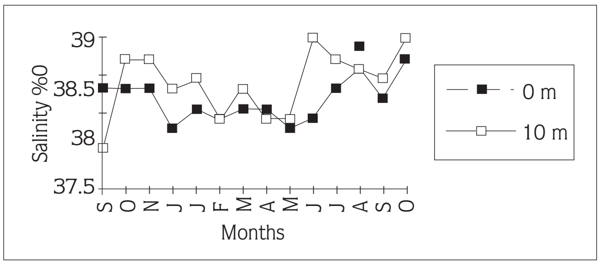

Figure 3. The annual cycle of salinity in the Bay of İskenderun (‰).

number of species was higher in the same period. Total species number was found to be lower during July and August in which the salinity increased to high levels.

N/P Ratio

The highest and lowest mean N/P ratios were found to be 8.09±2.96 at the surface in April and 1.38 ±1.05 at 10 m in July respectively (Table 1). Conspicuous differences were found among stations. Among the stations, the highest N/P ratio was calculated to be 21.2 at the surface at the 1st station in October, 1995. The lowest N/P ratio was calculated to be 0.09 at 10 m depth at the 5th station in October, 1995 and phytoplankton abundance increased at the same station.

Phytoplankton composition and its distribution

Members of five algae classes, *Cyanophyceae, Dinophyceae, Prymnesiophyceae, Dictyochophyceae* and *Bacillariophyceae* were determined during the research period (from September 1994 to October, 1995). Classes were represented as: 38 genera, 83 species, three varieties and two formas from *Bacillariophyceae*; 16 genera, 73 species, 25 varieties and two formas from *Dinophyceae;* one species from *Cyanophyceae;* one species from *Prymnesiophyceae*, one species from *Dictyochophyceae* (Table 2). A total of 170 taxa were determined from these algae classes. *Bacillariophyceae* was superior to the other classes in terms of diversity and abundance. The most common genera from *Bacillariophyceae* were *Cerataulina* H. Peragallo, *Chaetoceros* Ehrenberg, *Leptocylindricus* Cleve, *Rhizosolenia* (Ehrenberg) Brightwell, *Thalassiothrix* Cleve & Grunow and *Nitzschia* Hassall. *Chaetoceros* and

Table 1. The montly distribution of N/P means and ± standard deviations (n=7 for 0.0 m, n=6 for 10.0 m.).

	0 m	10 m
N/P ratios		
October 94	4.87±2.42	4.40±2.57
November	3.07±2.81	1.99±0.66
8 January	3.31±1.60	2.83±0.93
31 January	4.31±3.23	3.72±2.87
February	3.34±1.32	3.83±0.83
March	4.90±2.00	6.46±5.24
4 April	3.75±0.68	3.75±2.81
16 April	8.09±2.96	7.52±3.22
30 April	2.52±0.29	2.52±0.52
May	2.09±0.66	2.25±0.78
June	4.41±0.82	3.05±2.64
July	1.42±0.78	1.38±1.05
August	4.68±2.17	4.60±2.04
September	5.01±1.35	4.90±1.76
October 95	7.09±7.31	2.13±1.49

Table 2. The monthly distribution of phytoplankton species.

					M	O	N	T	H	S						
	S	O	N	J	J	F	M	A	A	A	M	J	J	A	S	O
	94															95
CYANOPHYCEAE																
Oscillatoria sp.	+	+	+	+	+	+		+						+	+	+
DINOPHYCEAE																
Amphisolenia bidentata Schröder		+	+	+	+	+	+	+			+					+
Amphisolenia truncata Kofoid end Michener															+	
Ceratium arietinum var. *arietinum*		+	+	+	+	+	+	+		+	+		+	+		+
Ceratium biceps Claparede et Lachm.			+	+	+	+	+	+	+	+	+	+	+			+
Ceratium breve var. *schmidtii*															+	
Ceratium breve var.*paralellum* (Schmidt) Jörgensen		+	+				+									
Ceratium candelabrum var *candeblabrum*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ceratium candelabrum var.*depressum*(Pouc)Jörgensen								+	+	+	+	+	+			
Ceratium carriense var. *carriense*				+	+			+								
Ceratium carriense var. *volans*		+	+	+	+	+	+		+		+		+			+
Ceratium concilians Jörgensen			+	+	+	+		+		+	+					
Ceratium contortum var.*contortum* (Gourret)Cleve			+	+	+	+	+									
Ceratium contortum var. *karstenii*(Pavillard)Sournia			+	+	+	+	+	+		+	+		+			+
Ceratium contrarium (Gourret)Pavillard					+						+	+	+			
Ceratium declinatum var. *majus* Jörgensen						+	+	+	+	+	+				+	
Ceratium euarcuatum Jörgensen		+	+	+	+	+	+	+	+	+	+		+			+
Ceratium furca var. *furca*			+	+	+	+	+	+	+	+	+	+				+
Ceratium fusus var. *fusus*		+	+	+	+	+	+	+		+	+	+	+		+	+
Ceratium gibberum var. *dispar* (Pouch.)Sournia						+										
Ceratium hexacanthum var.*contortum* Lemmermann						+	+	+			+	+				
Ceratium hexacanthum var. *hexacanthum*					+								+			
Ceratium horridum var.*denticulatum* Jörgensen			+				+	+	+	+						+
Ceratium horridum var. *horridum*				+		+					+	+				
Ceratium inflatum (Kofoid) Jörgensen	+	+	+	+	+	+	+	+	+	+	+		+		+	+
Ceratium kofoidi Jörgensen	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ceratium limulus Gourret				+	+											
Ceratium longirostrum Gourret		+		+	+	+	+				+					
Ceratium macroceros var.*gallicum* Kofoid	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+
Ceratium macroceros var. *macroceros*					+		+									
Ceratium massiliense var. *massiliense*			+			+	+	+	+	+	+	+	+			+
Ceratium pentagonum Gourret			+	+	+	+	+									+
Ceratium ranipes var. *palmatum*(Schröder)Cleve			+	+	+	+										
Ceratium.symetricum var.*orthoceras* Jörg.Grah.et Bronikovsky			+	+		+		+			+					
Ceratium symetricum var.*symetricum*		+	+	+	+		+		+	+						+
Ceratium teres Kofoid					+	+									+	+
Ceratium trichoceros (Ehrenberg) Kofoid		+	+	+	+	+	+	+	+	+	+	+	+	+		+
Ceratium tripos var. *atlanticum* (Ostenfeld) Paulsen	+	+		+		+	+	+	+	+	+	+	+	+	+	+
Ceratium tripos var.*pulchellum*(B.Schröder) Lopez																
f.*semipulchellum* Jörgensen				+			+	+	+	+	+	+			+	
f. *pulchellum*		+	+	+	+	+	+		+	+	+	+	+	+	+	+
Ceratocorys armata (Schütt) Kofoid														+		
Ceratocorys gourreti Paulsen						+									+	
Ceratocorys horrida Stein	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+
Dinophysis caudata Saville-Kent	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dinophysis doryphorum (Stein) Abé											+		+			

Table 2. Continued.

	S	O	N	J	J	F	M	A	A	A	M	J	J	A	S	O
	94															95
Dinophysis hastata Stein								+			+			+		
Dinophysis mitra (Schütt) Abé				+												
Diplopsalis lenticula Bergh			+				+						+			
Gonyaulax birostris Stein					+											
Gonyaulax diegensis Kofoid													+	+		
Gonyaulax monocantha Pavillard											+					
Gonyaulax polyedra Stein				+												
Gonyaulax spinifera (Claparede et Lachmann)Diesing	+							+	+	+			+	+	+	
Gonyaulax polygramma Stein	+	+		+	+	+					+			+	+	+
Gonyaulax turbynei Murray et Whitting															+	
Heteraulacus polyedricus(Pouchet)Drugg etLoeblich				+	+	+	+	+			+	+	+	+		
Heteraulacus sphaericus (Murrat et Whitting)LoeblichIII				+												
Kofoidinium velelloides Pavillard				+							+			+		
Ornithocercus quadratus Schütt		+	+		+	+					+	+		+		+
Oxytoxum scolopax Stein	+														+	
Oxytoxum sp.					+			+			+			+		+
Podolampas bipes Stein	+			+		+					+	+	+	+	+	+
Podolampas spinifera Okamura											+		+		+	
Prorocentrum compressum (Bailey) AbÈ ex Dodge				+												
Prorocentrum micans Ehrenberg		+	+		+	+		+	+	+	+	+		+	+	+
Protoperidinium brochi (Kofoid et Swezy) Balech				+	+	+		+					+	+		+
Protoperidinium claudicans (Paulsen) Balech						+	+	+					+			
Protoperidinium conicum (Gran)Balech	+						+	+	+	+	+	+	+	+	+	+
Protoperidinium depressum (Bailey)Balech							+			+	+	+	+	+		
Protoperidinium divergens (Ehrenberg)Balech	+		+	+		+	+	+	+	+	+	+	+	+	+	
Protoperidinium grande (Kofoid)Balech	+										+	+	+		+	
Protoperidinium globolus (Stein)Balech	+	+				+										
Protoperidinium leonis (Pavillard)Balech					+											
Protoperidinium oceanicum (Vanhöffen) Balech	+			+	+			+	+	+	+				+	+
Protoperidinium pallidum (Ostenfeld)Balech						+									+	
Protoperidinium mediterraneum (Kofoid)Balech	+			+	+	+	+	+	+	+	+	+	+		+	
Protoperidinium pedunculatum (Schütt)Balech					+											
Protoperidinium pyriforme (Paulsen) Balech					+						+					
Protoperidinium quarnerense (Schröder)Balech												+	+			
Protoperidinium steinii (Jörgensen)Balech																+
Pyrocystis fusiformis W.Thomson	+															
Pyrophacus horologium Stein	+										+	+	+	+	+	
Pyrophacus steinii (J.Schiller) Wall et Dale	+			+						+			+	+	+	
Spiraulax jollifei (Murray et Whitting) Kofoid				+								+	+			
PRYMNESIOPHYCEAE																
Halosphaeria viridis Schmitz				+	+											
DICTYOCHOPHYCEAE																
Dictyocha fibula Ehrenberg	+	+	+	+	+	+		+						+	+	+
BACILLARIOPHYCEAE				+												
Amphiprora gigantea Grunow			+	+	+	+	+								+	+
Asterionella japonica Cleve et Möller				+	+	+	+	+	+	+	+	+	+			
Asterolampra grevillei (Wallich) Greville		+	+	+		+	+	+								
Asterolampra marylandica Ehrenberg	+	+	+	+	+	+									+	+
Asteromphalus flabellatus (Brebisson)Greville															+	

Table 2. Continued.

	S 94	O	N	J	J	F	M	A	A	A	M	J	J	A	S	O 95
Bacteriastrum delicatulum Cleve	+					+	+	+	+	+	+		+		+	+
Bacteriastrum hyalinum Lauder		+	+	+	+		+					+	+	+		+
Campylodiscus sp.		+	+										+			
Cerataulina pelagica (Cleve) Hendey	+	+		+	+	+	+	+	+	+		+	+	+	+	+
Chaetoceros affine var.*willei* (Gran)Hustedt.	+			+	+	+	+	+	+	+		+	+	+	+	+
Chaetoceros anastomosans Grunow in VanHeurck											+					
Chaetoceros atlanticum Cleve				+	+	+	+	+	+		+			+		+
Chaetoceros coarctatum Lauder						+										
Chaetoceros compressum Lauder							+					+				
Chaetoceros constrictum Gran						+	+	+	+	+						
Chaetoceros costatum Pavillard								+	+	+		+				
Chaetoceros curvisetum Cleve			+		+	+	+					+		+	+	
Chaetoceros danicum Cleve								+	+	+						
Chaetoceros debile Cleve							+									
Chaetoceros decipiens Cleve	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
Chaetoceros didymum Ehrenberg																
var.*protuberans* (Lauder)Gran.et Yendo.								+	+	+			+	+		+
Chaetoceros diversum Cleve	+					+		+	+		+					
Chaetoceros gracile Schütt							+	+	+	+						
Chaetoceros laciniosum Schütt												+	+			+
Chaetoceros lorenzianum Grunow							+	+	+			+	+		+	
Chaetoceros messanense Castracane					+											
Chaetoceros peruvianum Brightwell												+			+	
Chaetoceros pseudocurvisetum Mangin					+	+	+	+	+	+	+	+	+	+	+	+
Chaetoceros rostratum Lauder							+	+	+	+	+					
Chaetoceros tetrastichon Cleve							+	+	+	+	+	+	+		+	+
Chaetoceros tortissimum Gran							+									
Climacosphaenia moniligera Ehrenberg							+	+		+	+		+	+		+
Coscinodiscus perforatus Ehrenberg		+	+													
Coscinodiscus radiatus Ehrenberg				+	+										+	
Coscinodiscus sp.	+	+	+	+	+	+		+						+	+	+
Cylindrotheca closterium (Ehren.)Lewin&Reimann			+		+		+				+		+	+	+	+
Dactyliosolen mediterraneus H. Peragallo							+	+							+	
Ditylum brightwellii (T.West)Grunow in Van Heurck				+												
Eucampia zoodiacus Ehrenberg				+	+	+		+	+				+			
Grammatophora sp.				+												
Guinardia flaccida (Castracane) H.Peragallo	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Gyrosigma balticum (Ehrenberg) Rabenhorst													+			
Gyrosigma spenceri (Quekett.) Griffith et Henfery			+	+	+											
Gyrosigma sp.		+	+	+	+					+				+		
Gyrosigma tenuissumum (W.Smith)Griff. et Henfrey	+											+	+	+	+	+
Helicotheca thamesis (Shrubsole)Ricard	+		+	+	+											
Hemiaulus membranaceus Cleve			+			+							+	+		
Hemiaulus hauckii Grunow in Van Heurck	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+
Lauderia borealis Gran		+														
Leptocylindricus danicus Cleve	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+
Leptocylindricus minimus Gran									+	+	+	+	+	+	+	+
Licmophora abbreviata Agardh				+	+	+	+	+					+	+	+	+
Lithodesmium undulatum Ehrenberg				+	+	+	+			+			+			
Melosira sulcata (Ehrenberg)Kützing			+													

Table 2. Continued.

	S 94	O	N	J	J	F	M	A	A	A	M	J	J	A	S	O 95
Navicula sp.	+	+	+		+	+										
Nitzschia longissima(Brebis.in Kützing.) Ralf in Prit.			+	+	+	+	+	+	+		+	+	+		+	
Nitzschia paradoxa Grunow in Cleve et Grunow	+	+	+	+	+	+		+		+			+		+	
Nitzschia sigma (Kützing)W. Smith		+	+	+			+	+	+				+		+	+
Nitzschia sp.	+		+							+						
Odontella mobiliensis (Bailey) Grunow	+	+	+	+	+						+		+	+	+	+
Pleurosigma elongatum W. Smith																
Pleurosigma normanii Ralfs in Pritchard.	+	+	+	+	+	+	+						+	+	+	+
Pleurosigma sp1.						+										
Pleurosigma sp 2.															+	
Podocystis sp.					+				+				+			+
Pseudonitzschia pungens (Grunow ex Cleve) Hasle	+	+	+	+	+	+	+	+	+		+		+	+	+	+
Rhabdonema adriaticum Kützing				+	+	+	+	+	+	+		+				+
Rhizosolenia alata . f.*gracillima* (Cleve)Gran	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rhizosolenia alata .f. *indica* (H.Peragallo.)Gran	+	+	+	+	+	+	+	+	+	+	+			+	+	+
Rhizosolenia calcar-avis Schultze	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rhizosolenia castracanei H.Peragallo				+												
Rhizosolenia fragilissima Bergon														+	+	
Rhizosolenia imbricata var.*shrubsolei*(Cleve)Schütt.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rhizosolenia robusta Norman in Pritchard	+	+		+	+	+	+	+	+	+	+	+	+	+	+	
Rhizosolenia setigera Brightwell	+				+		+	+	+	+	+		+			
Rhizosolenia stolterfothii H. Peragallo	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rhizosolenia sytliformis Brightwell	+	+	+												+	+
Skeletonema costatum (Greville) Cleve			+	+	+		+	+	+	+	+			+		
Striatella unipunctata (Lyngbye)Agardh					+											+
Surirella fastuosa Shrubsole	+		+		+											
Synedra ulna (Nitzsch.) Ehrenberg	+	+														
Thalassionema nitzschioides Hustedt	+		+	+	+		+	+			+					+
Thalassiothrix fraunfeldii Grunow	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+
Thalassiothrix mediterranea Pavillard		+	+									+	+	+	+	+

Rhizosolenia were represented as 22 and nine species respectively.

Cerataulina pelagica (Cleve) Hendey, *Guinardia flaccida* (Castracane) H .Peragallo and *Pseudonitzschia pungens* (Grunow ex Cleve) Hasle from *Bacillariophyceae* were very important in terms of abundance and they were responsible for phytoplankton blooms during the research period. *Thalassiothrix fraunfeldii* Grunow, *Hemiaulus hauckii* Grunow, *Rhizosolenia calcar-avis* Schultze and *R. stolterfothii* H. Peragallo were not very abundant but existed in all sampling periods.

Dinophyceae were the second important class after *Bacillariophyceae* in terms of species distribution and abundance. *Ceratium* Schrank, *Protoperidinium* Bergh, *Prorocentrum* Ehrenberg and *Dinophysis* Ehrenberg were the most abundant genera from *Dinophyceae.* A total of 27 *Ceratium* species were determined and the genus *Ceratium* was represented with the highest number of species. *Cyanophyceae, Dictyochophyceae* and *Prymnesiophyceae* were represented with only one genus and species.

In all stations, an increase in phytoplankton abundance was determined at the end of January and April in general. But local increases in cell numbers were determined in August and October (Figs. 4, 5). An increase in phytoplankton abundance in January was because of *Cerataulina pelagica* bloomings from the class *Bacillariophyceae.* The increase in phytoplankton abundance in April was mostly because of *Cerataulina pelagica* and *Chaetoceros atlanticum* that reached 66.300 cells/ l and 6040 cells/l in abundance respectively. Apart from these increases, local increases were also determined especially at stations near the coast line. Especially at the 5th station, *Pseudonitzschia* *pungens* exhibited frequent bloomings in August and October. The abundance of this species reached 320.480 cells/l in August, 380.000 cells/l in October. The taxa from *Dinophyceae* were determined at all stations while the abundance of them was low compared with *Bacillariophyceae.*

The increase in abundance of *Dinophyceae* was determined only in May due to *Prorocentrum micans* Ehrenberg (Fig. 4). In this period, the abundance of *P. micans* reached 6460 cells/l at the 5th station.

The monthly changes in diversity indices are shown in Figs. 6 and 7. Shannon-Wienner diversity (H') in surface waters were found to be between 0.10 and 2.96. Evenness indices (J) were evaluated as 0.04 and 0.84 in surface waters. The highest values were observed in February because the species number did not show important changes but cell numbers were decreased.

During the research period, the lowest H' and J values in surface waters were found in August. The abundance of *Pseudonitzschia pungens* increased especially at the 5th station in August. In October, cell numbers of *Pseudonitzschia pungens* increased and thus diversity indices decreased again (Fig. 6). Diversity indices calculated for 10 m depth were found lower than for surface waters. The highest values at 10 m depth were found in February. The lowest values were found in August and October for Shannon-Wienner diversity and Pielou evenness indices (Fig. 7).

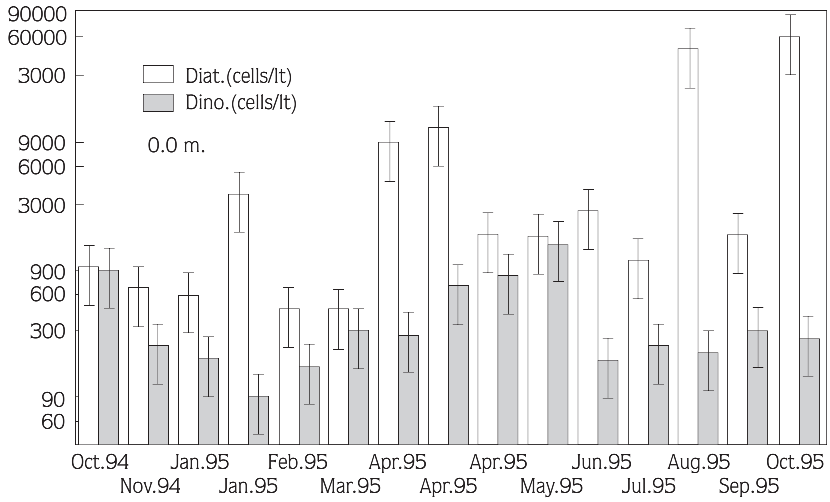

Figure 4. The monthly changes in the mean cell numbers of diatoms and dinoflagellates at surface water (mean cell concentrations and standard deviations).

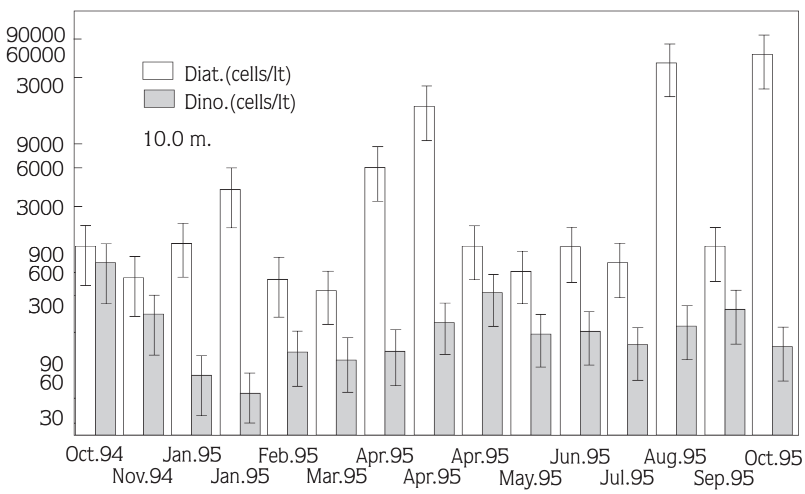

Figure 5. The monthly changes in the mean cell number of diatoms and dinoflagellates at 10 m depth (mean cell concentrations and standard deviations)

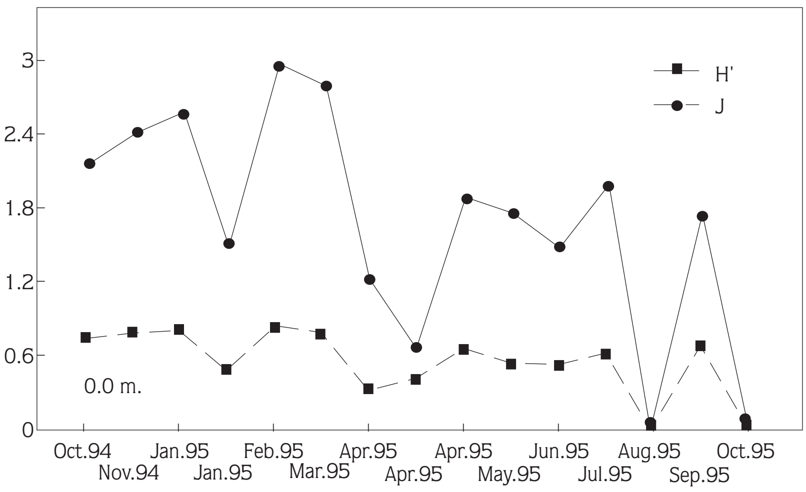

Figure 6. The monthly changes in Shannon-Wienner diversity (H') and Pielou evenness (J) indices of phytoplankton species at surface.

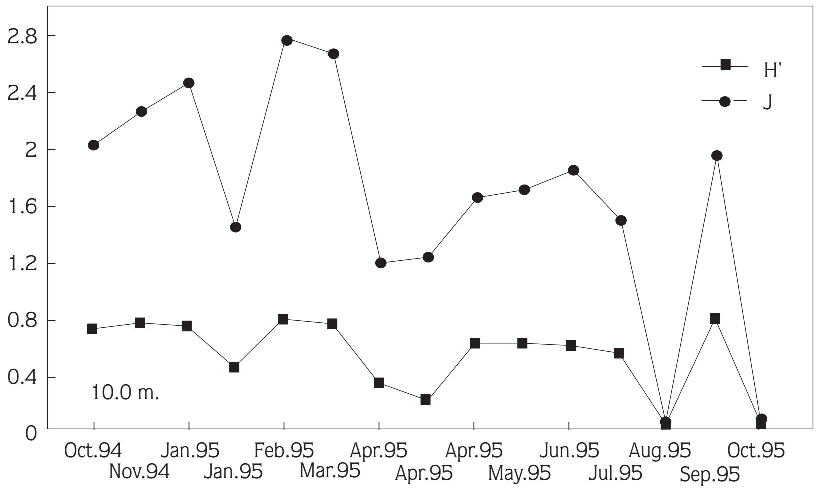

Figure 7. The monthly changes in Shannon-Wienner diversity (H') and Pielou evenness (J) indices of phytoplankton species at 10 m.

Discussion

At the end of the study, the phytoplanktonic members of algae from five classes, *Cyanophyceae, Dinophyceae, Prymnesiophyceae Dictyochophyceae* and *Bacillariophyceae* were determined. Among them the members of *Bacillariophyceae* were generally dominant during the research period. When species number and abundance are taken into consideration, the members of this class were abundant especially in nutrient-rich shallow stations. It is well known that because of coastal inputs, İskenderun Bay is more productive than the other regions of the northeastern Mediterranean which has oligothropic waters in terms of nutrients and primary production. Yılmaz et al. (22) reported that, primary productivity in İskenderun Bay is two to four times higher than that of the open sea. However, the mean N : P ratios observed were below the theoretical assimilation ratio (15:1) during the whole sampling period.

Phytoplankton composition and abundance were found to be different due to the location of stations. At the coastal stations, diversity and abundance of diatoms were higher than those of dinoflagellates. It was stated by Azov (23) that diatoms were found to be higher, when compared with the dinoflagellates at neritic stations on the Israeli coast.

In terms of qualitative distribution of phytoplankton, it can be said that most of the species identified in the present study consist of phytoplanktonic algae reported in different regions of the Mediterranean before. Most of the identified taxa were neritic, temperate and subtropic species. Also oceanic species were determined. Lakkis and Lakkis (24) studied the coast of Lebanon and stated that the phytoplankton of this region is cosmopolitan, temperate and tropical, distributed in all temperate and subtropical seas in general.

In the present study, an increase of phytoplanktonic organisms was detected at the end of January and in the middle of April. It is considered that, especially *Árataulina pelagica* was responsible for the phytoplankton increase in January. Koray (3) reported that this species was one of the widespread species in İzmir Bay, Aegean Sea. The phytoplankton increase in April was caused by *C. pelagica* and *Chaetoceros atlanticum* . In addition some stations near the coast have nutrient-rich waters and some local increases were determined at these stations (especially at the 5th stations) in August and October as a result of bloomings of *Pseudonitzschia pungens.* The abundance of this species in August and October reached 320.480 cells/l and 380.000 cells/l respectively. A low diversity index value was found during the same period. On the other hand, the lowest phytoplankton abundance was determined in February and March.

Species of the genera *Chaetoceros*, *Rhizosolenia, Brightwell* and *Hemiaulus hauckii, Thalassiothrix fraunfeldii, Ceratulina pelagica, Leptocylindricus danicus* Cleve were common during the whole research period. Species from the genus *Chaetoceros* were observed almost in all stations and their abundance was high in coastal stations. Therefore, it was considered that the members of the genus *Chaetoceros* were important in terms of diversity and abundance. *C. decipiens* Cleve, *C. atlanticum, C. affine* were widespread species. Among them, *C. atlanticum* was the most abundant species. *C. decipiens* and *C. atlanticum* are known as oceanic species (2). It was thought that these species were transferred with water circulation from the open sea and they can adapt to coastal waters. Indeed, the species belonging to the genus *Chaetoceros* were the most abundant diatom species in Gökova Bay (Koray et al., 25), at Levantine Basin and the coast of Israeli (23).

Species from the genus *Rhizosolenia* were the second most important species after the genus *Chaetoceros* in terms of the species richness. In present study, a total of nine species from the genus *Rhizosolenia* were identified. This number is lower than that reported by Kıdeyş et al. (28) and Koray (3). These studies were carried out at the Erdemli coast, the Northeastem Mediterranean and İzmir Bay in which 15 and 14 species and varieties belonging to the genus *Rhizosolenia* were reported respectively. *R. robusta* Norman, *R . alata, R. calcar-avis, R. stolterfothii* were the most common species. Among them, *R. alata* is known as a cosmopolitan, oceanic and neritic species (26). *R. calcar-avis* is considered a characteristic species of nutrient poor oligotrophic waters (27). In the present study, species from *Rhizosolenia* were represented with at least a few species in each sampling period, but they never increased very much in any period.

Hemiaulus hauckii was considered one of the common species in this study. This species was identified in almost all stations during the research period but it never reached high abundance. This species is considered as characteristic species of nutrient-poor oligothropic waters. In addition, it was stated that *H. hauckii* continued to exist in waters after spring blooms (27). Therefore, it is clearly observed that there is a similarity between these opinions and the results obtained in the present research.

Ceratium was the most common and abundant genus in *Dinophyceae.* In this study, a total of 27 species were identified from the genus *Ceratium* , which is smaller than that given by Koray and Gökpınar (14). He studied İzmir Bay and a total of 28 species were identified from the same genus. In the present study it is observed that, *Ceratium kofoidi* Jörgensen, *C. trichoceros* (Ehrenberg) Kofoid, *C. candelabrum, C. furca* var. *furca* from the genus *Ceratium* were the most common species. The members from the genus *Protoperidinium* were the second after the genus *Ceratium* in terms of species number. A total of 15 species were identified belonging to the genus *Protoperidinium* . Five species were recorded by Koray et al. (25) from this genus in Gökova Bay, a number smaller than that obtained from the present study. In this study, *Protoperidinium divergens* (Ehrenberg) Balech was the most abundant species of the genus. *Prorocentrum micans* from *Dinophyceae* is usually described as cosmopolitan, eurythermic and euryhaline because of its very wide distribution (27). In the present study, this species was also common. In general, the numbers of the dinoflagellat species were found to be low at coastal stations, but high in deep stations. Azov (23) stated that dinoflagellat abundance was higher in pelagic stations. On the other hand, the increase in dinoflagellat abundance in phytoplankton blooms did not reach the level of the increase in diatome abundance during the same period. In phytoplankton blooms after nutrient rich periods in coastal waters, diatoms were found to be dominant.

The *Cyanophyceae* class was represented by only one species. *Oscillatoria* sp. from *Cyanophyceae* was identified rarely and its abundance were always at a quite low level during the research period. It was observed during all the periods except the end of spring and the beginning of summer.

Dictyocha fibula Ehrenberg was the only species from *Dictyochophyceae.* Two species belonging to *Dictyocha* Ehrenberg were also reported by Kıdeyş et al. (28) at the Erdemli coast, Northeastern Mediterranean. However, the abundance of this species was generally low during the research period in present study.

If the physical and chemical data are taken into consideration, the lowest temperature was recorded in January, which is the time when the phytoplanktonic organisms increased. Cell numbers of phytoplankton were found to be low except at the 5th station in August, which is the time that highest temperature was measured and the high salinity levels was recorded in summer conditions. According to Smayda (29), Braarud and Mclachlan stated that wide salinity ranges are good conditions for growth of phytoplankton species. However, because of the euryhaline nature of the phytoplankton and the modest seasonal fluctations in the salinity, salinity does not appear to be a significant regulatory factor in phytoplankton succession (29). In the present study N/P ratios were also found to be low. The highest and lowest mean N/P ratios were estimated in April and July respectively. April is the time of the phytoplankton abundance increased. In general, N/P ratios were relatively high during the period when phytoplankton abundance increased.

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