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Ecological and Geographical Distributions of the Planktonic Protista in the Southern Parts of the Black Sea (Neritic Waters of Sinop Peninsula, Turkiye)

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Özet: Karadeniz'in Güney Bölgelerindeki (Sinop Yarımadası Kıyısal Suları) Planktonik Protista Türlerinin Ekolojik ve Çoğrafik Dağılımları. Bu çalışmada, Ağustos-1995 ve Temmuz-1996 periyodunda, belirlenen 210 taksa planktonik protista (fitoplankton + protozooplankton) türünün taksonomik analizleri ile birlikte ekolojik ve coğrafik dağılımları irdelenmiştir. Taksonomik analizler sonucunda 1 tür Cyanophyceae, 89 taksa Dinophyceae, 1 tür Prymnesiophyceae, 5 taksa Dictyochophyceae, 94 taksa Bacillariophyceae, 1 tür Euglenophyceae, 1 tür Acantharea ve 18 tür Ciliata ayırt edilmiştir. Bu çalışmada, ayrıca, türlerin coğrafik dağılımlarına göre 76 taksa (total'in % 36.2'si) kosmopolit, 30 taksa (total'in % 14.3'ü) boreal, 18 taksa (total'in % 8.6'sı) arkto-boreal, 58 taksa (total'in % 27.6'sı) boreal-tropikal, 5 taksa (total'in % 2.4'ü) tropikal, 2 taksa (total'in % 0.9'u) subtropikal, 18 taksa (total'in % 8.6'sı) tropikal-subtropikal, 1 tür (total'in % 0.5'i) boreal-ponti-kaspian-endemik ve 2 taksa (total'in % 0.9'u) global dağılımı belli olmayan tür ayırt edilmiştir. Ekolojik dağılımlarına göre de, 194 taksa (total'in % 92.4'ü) denizel, 9 taksa (total'in % 4.3'ü) denizel-acısu, 6 taksa (total'in % 2.8'i) acısu, 1 tür (total'in % 0.5'i) acısu-tatlısu kökenli tür ayırt edilmiştir. Seçilen örnekleme, pelajik örnekleme tipi olmakla birlikte, numunelerde 179 taksa (total'in % 85.2'si) pelajik orjinli tür ile birlikte 31 taksa (total'in % 14.8'i) bentik orjinli tür ayırt edilmiştir. Bu çalışmada, ekolojik ve coğrafik gruplarla birlikte planktonik protista türlerinin bir listesi de verilmektedir.

Anahtar kelimeler: Karadeniz, planktonik protista, fitoplankton, biyo-coğrafya

Abstract

In this study, ecological and geographical distributions together with taxonomical analysis of 210 planktonic protista (phytoplankton + protozooplankton) species fixed in the neritic waters of Sinop peninsula in the Southern part of the Black Sea between August-1995 and July-1996 were exposed. In the result of taxonomical analysis, one species of Cyanophyceae, 89 taxa of Dinophyceae, 1 species of Prymnesiophyceae, 5 taxa of Dictyochophyceae, 94 taxa of Bacillariophyceae, 1 species of Euglenophyceae, 1 species of Acantharea and 18 species of Ciliata were idendified. According to the geographical distributions, 76 taxa (36.2 % of total) are cosmopolitan, 30 taxa (14.3 % of total) are boreal, 18 taxa (8.6 % of total) are arcto-boreal, 58 taxa (27.6 % of total) are boreal-tropical, 5 taxa (2.4 % of total) are tropical, 2 taxa (0.9 % of total) are subtropical, 18 taxa (8.6 % of total) are tropical-subtropical, one species (0.5 % of total) is boreal-ponticaspian-endemic, 2 species (0.9 % of total) in global distribution is non clarified. According to the ecological distributions of the species, it was found that 194 taxa (92.4 % of total) are marine species, 9 taxa (4.3 % of total) are marine-brackishwater species, 6 taxa (2.8 % of total) are brackishwater species, one taxa (0.5 % of total) is brackish-freshwater species. Despite the fact that the pelagic net sampling was used, benthic originated species in 31 taxa (14.8 % of total) were found along with 179 taxa (85.2 % of total) in pelagic originated species among the samples. A list of planktonic protista species together with their ecological and geographical characteristics was prepared.

Keywords: Black Sea, planktonic protista, phytoplankton, bio-geography.

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Introduction

This investigation on the ecological and geographical analysis of planktonic protista species has been realized for the first time in the Southern Black Sea. However, the phytoplankton of the northern Black Sea e.g. Soviet, Romanian and Bulgarian waters has been studied by many researchers (e.g. Belegorskaya and Kondratieva, 1965; Bologa, 1985/1986; Dimitrova-Konaklieva, 1991).

According to Skolka and Bodeanu (1978), from the taxonomic point of wiev, Black sea phytoplankton comprise 1200 species, containing 63 % diatoms, 16 % dinoflagellates and 21 % species belonging to other phyla. Of these, 85 % are marine and brackish-water species, largely euryterm and euryhaline species, and 15 % are species of fresh-water origin. They show a characteristic regional distribution and ecological grouping.

The Black Sea receives 87 % of the fresh water volume from its north-western part which is shallow. The rivers reduce surface salinity and contribute large amounts of nutrients and detritus. These factors create a displaceable extensive freshened region, with reduced transparency and an increased phytoplankton crop in north-western part of the Black Sea (Bologa, 1985/1986). In open waters and the southern part of the basin, hydrological properties are more stable than other areas and the phytoplankton crop is much smaller (Bologa, 1985/1986; Benli, 1987; Tuncer and Feyzioğlu, 1990; ; Feyzioğlu and Tuncer 1994; Uysal and Sur, 1995; Feyzioğlu, 1996; Türkoğlu, 1998).

The Black Sea is an inter-continental sea, situated between $40^{o}\ 54^{\xi}$ - $46^{o}\ 38^{\xi}$ N latitude and between $27^{o}\ 27^{\xi}$ - $41^{o}\ 41^{\xi}$ E longitude with a total area of 413,490 km^2 and a water volume of 537,000 km^3. It contains a north-east orientated depression, with a maximum dept of 2,258 m. However, the mean depth is only 1,27 m because of the wide continental shelf along the north-western part of the basin (Serpopianu, 1973; Degens and Petrol, 1974). Although a major shelf area exists in the nortwestern part of the sea, comprising 27 % of the total area of the Black Sea. The shelf areas, especially in the south eastern region are very narrow. However, shelf of the Sinop peninsula is some more wide than other shelfs of the Southern Black Sea (Sorokin, 1986). A permanent halocline exists in a depth of 80-160 m. Below the halocline, hydrogen sulphide is apparent (Tuğrul *et al*., 1992).

Here, the result of the studies on the ecological and geographical analysis on the planktonic protista species in the neritic waters of Sinop peninsula in the Southern part of the Black Sea are presented. A list of the planktonic protista species together with ecological and geographical groups is also presented.

Materials and Methods

In this study, the samples were collected with a 55 µm. plankton net and Hydro-Bios Universal Series Water Sampler (5 lt.) from the sampling stations (A1, A2, A3, A4, B1, B2, B3 and B4) in the neritic waters of the Sinop peninsula in the Southern part of the Black Sea situated between 41^0 59^{ξ} - 42^0 01^{ξ} N latitude and 35^0 08^{ξ} - 35^0 09^{ξ} E longitude (Fig. 1) and were collected monthly intervals between the August-1995 and July-1996.

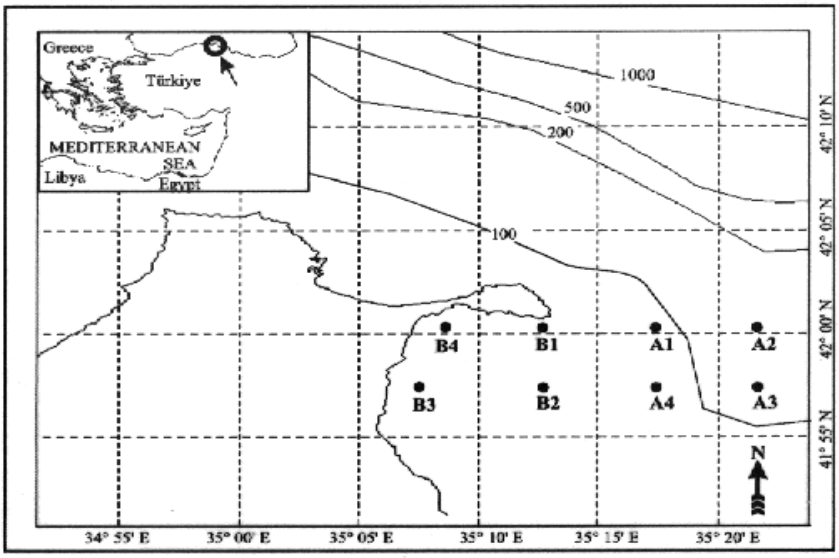


Fig. 1. The sampling stations

Qualitative samples were fixed with formaldehyde (final concentration of 2-4 %) and quantitative samples were fixed with lugol (for 5 lt, 12.5 cc) were preserved at 2-4 ^oC in a refrigerator pending microscopic examination. Quantitative samples were taken over monthly periods from surface water (0.5 m) in fixed sampling points. During the investigations, 150 qualitative and 120 quantitative samples were collected.

For enumeration of the microplankton species, Uterhmohl sedimentation chambers, Neubauer and Sedgwick-Rafter counting slides were applied in combination according to organism dimension (Hasle, 1978; Guillard, 1978; Venrick, 1978). The water column was also sampled with Nansen bottles to determine temperature, salinity, pH and conductivity and this parameters were measured with water quality checker of a U-10 model Horiba.

The ecological and geographical algal groups were defined according to Margalef's system for ecological and phytogeographical regionalization of the global ocean (Margalef, R., 1961; Margalef, R., 1965).

Results And Discussion

Hydrography of the Research Area

The temperatures in the homogenous layer varied between 20-25 ^{o}C in summer. However, the maximum temperature (25 ^{o}C) observed in summer has continued in a short period (July and August). After August, temperature started to decrease until March (6.0 ^{o}C) and then increased until July. The winter temperatures varied between 6-12 ^{o}C (Fig.2).

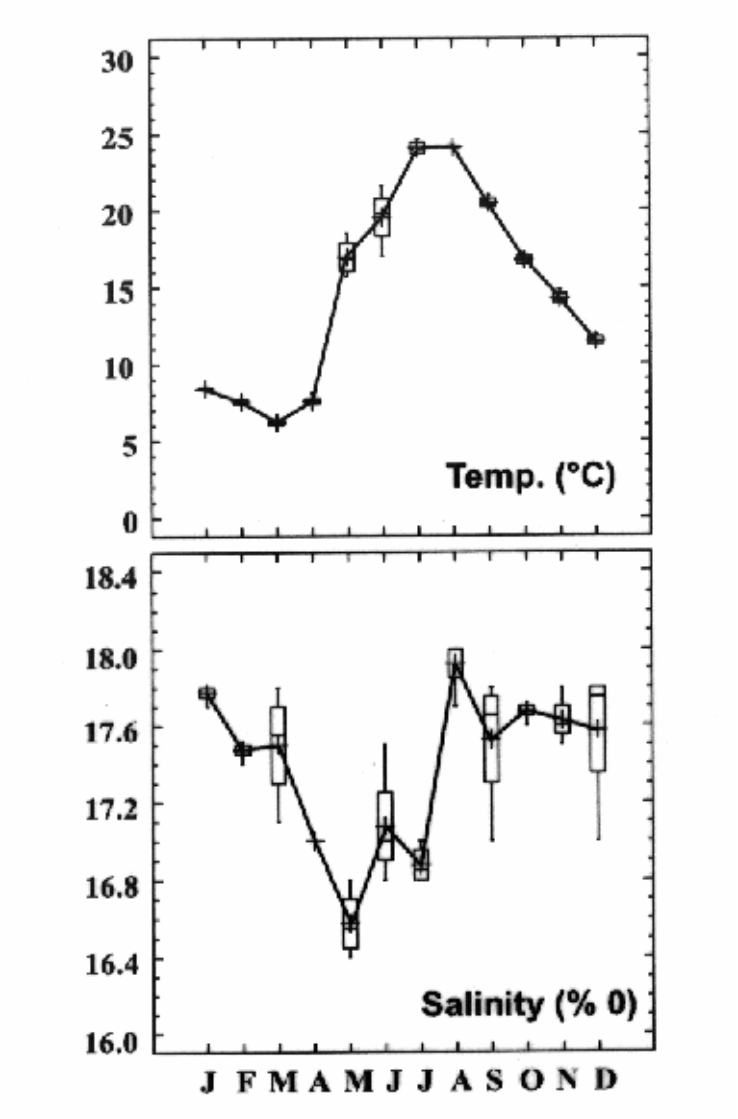


Fig 2. Statistical results on the annual cycles of temperature (^{o}C) and salinity (%0) in the neritic waters of the Sinop peninsula in the southern Black Sea. Rectangles represent 95 % confidence intervals of means (n = 80). Minimums-maximums are shown with lines in perpendicular in the rectangles.

Above the halocline, the salinity varies between S= 16.4-18.6 ppt in the neritic waters of the Sinop peninsula. The lowest salinity in May was due to heavy spring rains and effect of fresh water inputs.

The seasonal cycle of pH in the neritic waters of the Sinop peninsula showed a major peak with 8.91 in May and a minor peak with 8.31 in August. Although variations were not evident, after the minor peak, pH started to decrease until February (mean: 6.90) and then to increase until May (8.91) (Fig.3).

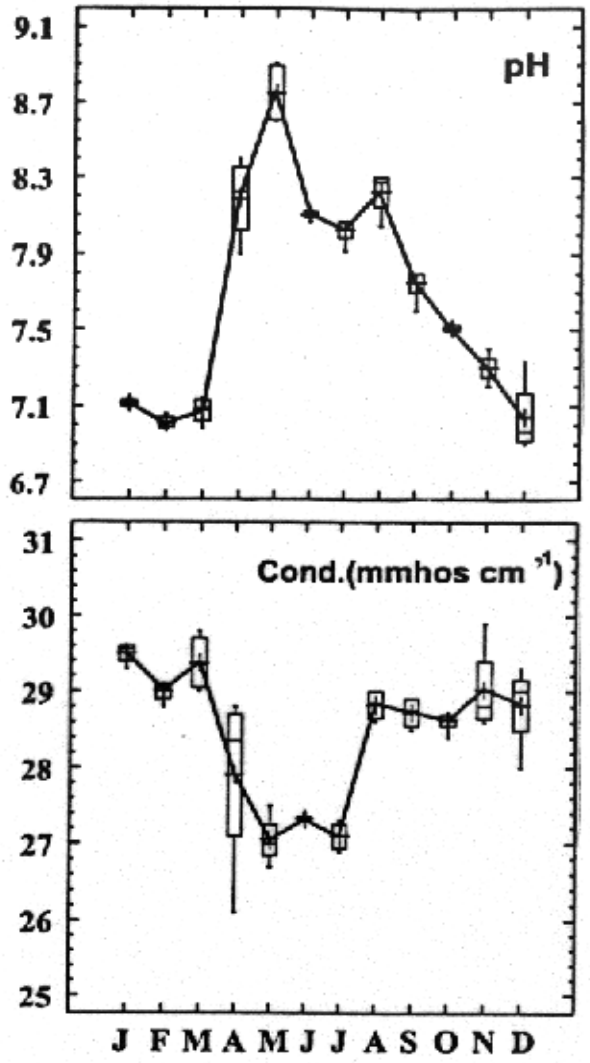


Fig 3. Statistical results on the annual cycles of pH and conductivity (mmhos cm^{-1})in the neritic waters of the Sinop peninsula in the southern Black Sea. Rectangles represent 95 % confidence intervals of means (n = 80). Minimums-maximums are shown with lines in perpendicular in the rectangles.

The surface conductivity of the neritic waters of the Sinop peninsula varied between 29.0-29.8 mmhos cm^{-1} in winter. The summer conductivity varied between 26.9-29.0 mmhos cm^{-1}, while the conductivity fall down to 26.1 mmhos cm^{-1} in spring, due to lowest salinity (Fig.3).

Ecological and geographical distribution of the planktonic protista

It was distinguished ecological and phytogeographical groups, and prevailing fields of a total of 210 taxa of the planktonic protoctista species sampled between August-1995 and July-1996 in the neritic waters of the southern Black Sea (Tab.1).

Table 1. The list of the planktonic protista from the neritic waters of the Sinop peninsula in the southern part of the Black Sea, between August-1995 and July-1996

SPECIES	EG	FG	PF
CYANOPHYCEAE			
Oscillatoria sp.	M-b	C	PBm,h
DINOPHYCEAE			
Ceratium belone Cleve	M-p	T	P
Ceratium biceps Claparade *et* Lachmann	M-p	T-ST	P
Ceratium carriense Gourret			
var. *volans* (Cleve) Sournia	M-p	T-ST	P
Ceratium compressum Gran	M-p	T-ST	P
Ceratium declinatum (Karsten) Jörgensen			
f. *majus* Jörgensen	M-p	T-ST	P
f. *normale* Jörgensen	M-p	T-ST	P
Ceratium furca (Ehrenberg) Claparede *et* Lachmann			
var. *eugrammum* (Ehrenberg) Schiller	M-p	C	PBm
var. *furca* (Ehrenberg) Sournia	M-p	C	PBm
Ceratium fusus (Ehrenberg) Dujardin			
var. *fusus* (Ehrenberg) Dujardin	M-p	C	PBm
var. *schuetti* Lemmermann	M-p	C	P
var. *seta* (Ehrenberg) Schiller	M-p	C	PBm
Ceratium hexacanthum (Rampi) Sournia			
var. *pavillardi* (Rampi) Sournia	M-p	T-ST	P
Ceratium horridum (Cleve) Gran			
var. *denticulatum* Jörgensen	M-p	B	P
var. *horridum* (Sournia) Grun	M-p	B-T	P
Ceratium incisum (Karsten) Jörgensen	M-p	T	P
Ceratium inflatum (Kofoid) Jörgensen	M-p	T-ST	P
Ceratium kofoidii Jörgensen	M-p	ST	P
Ceratium lineatum (Ehrenberg) Cleve	M-p	B-T	P
Ceratium longirostrum Gourret	M-p	?	P
Ceratium massiliense (Karsten) Jörgens.			
var. *armatum* (Karsten) Jörgens.	M-p	B-T	P
Ceratium teres Kofoid	M-p	T-ST	P
Ceratium tripos (O. F. Müller) Nitzsch			
var. *atlanticum* (Ostenfeld) Paulsen	M-p	B-T	PBm
var. *pulchellum* f. pulchellum	M-p	B-T	PBm
Ceratium strictum (Okamura and Nishikawa) Kofoid	M-p	?	P
Dinophysis acuminata Claperede *et* Lachmann	M-p	B	P

Dinophysis acuta Ehrenberg		M-p	B	P
Dinophysis caudata Saville-Kent		M-p	B-T	P
Dinophysis diegensis Kofoid		M-p	B-T	P
Dinophysis fortii Pavillard		M-p	B-T	P
Dinophysis hastata Stein		M-p	B-T	P
Dinophysis infundibula Schiller		M-p	B-T	P
Dinophysis parvula (Schütt) Balech		M-p	B-T	P
Dinophysis punctata Jörgensen		M-p	B-T	P
Dinophysis rotundata Claperede *et* Lachmann		M-p	B	P
Dinophysis rudgei (Murray *et* Whitting) Abé		M-p	B	P
Dinophysis sacculus Stein		M-p	B	P
Diplopsalis lenticula Bergh		MB-p	C	P
Gonyaulax birostris Stein		M-p	B-T	P
Gonyaulax diacantha Meunier (Schiller)		M-p	B-T	P
Gonyaulax diegensis Kofoid		M-p	B	P
Gonyaulax monocantha Pavillard		M-p	B-T	P
Gonyaulax polyedra Stein	q	M-p	B-T	PBm
Gonyaulax polygramma Stein		M-p	B-T	P
Gonyaulax spinifera (Claparede *et* Lachmann) Diesing	q	M-p	B-T	P
Gymnodinium nelsoni		M-p	B-T	P
Gymnodinium splendes Lebour		M-p	B-T	P
Heterocapsa triquedra (Ehrenberg) Stein	q	M-p	A-B	P
Noctiluca scintillans (Macartney) Kofoid		M-p	C	P
Oxytoxum adriaticum Schiller		M-p	B	P
Oxytoxum brunelli Rampi		M-p	C	P
Oxytoxum compressum Kofoid		M-p	B	P
Oxytoxum diploconus Stein		M-p	C	P
Prorocentrum aporum (Schiller) Abé	q	M-p	B-T	P
Prorocentrum balticum (Lohmann) Loeblich III	q	M-p	A-B	P
Prorocentrum compressum (Bailey) Abé	q	M-p	B-T	PB,m
Prorocentrum cordatum (Ostenfeld) Dodge		B-p	B	PB,h
Prorocentrum dentatum Stein		M-p	B-T	P
Prorocentrum maximum (Gourret) Schiller		M-p	B-T	P
Prorocentrum micans Ehrenberg	q	M-p	C	PB,h
Prorocentrum minimum Schiller	q	M-p	B-T	P
Prorocentrum pyriforme (Schiller) Hasle		M-p	B	P
Prorocentrum rotundatum Schiller		M-p	B-T	P
Prorocentrum scutellum Schiller		M-p	C	P
Prorocentrum triestinum Schiller	q	M-p	B-T	P
Protoceratium aerolatum Kofoid		M-p	B-T	P
Protoceratium reticulatum (Clap & Lach.) Butsch		M-p	B	PBm
Protoperidinium brevipes Paulsen		M-p	C	P
Protoperidinium brochi (Kofoid *et* Swezy) Balech		M-p	C	P
Protoperidinium claudicans (Paulsen) Balech		MB-p	C	P
Protoperidinium conicoides Paulsen		M-p	C	P
Protoperidinium conicum (Gran) Balech				
var. *conicum* (Gran) Ost. *et* Sch.		M-p	C	P
var. *concavum* Matz.		M-p	C	P
Protoperidinium depressum (Bailey) Balech	q	M-p	C	P
Protoperidinium diabolus Cleve		M-p	T-ST	P
Protoperidinium divergens (Ehrenberg) Balech		M-p	C	P
Protoperidinium globolus (Stein) Balech		M-p	B-T	P
Protoperidinium grande (Kofoid) Balech		M-p	T	P
Protoperidinium granii (Ostenfeld *in* Paulsen) Balech	q	MB-p	C	P
Protoperidinium longipes Balech	q	M-p	T-ST	P
Protoperidinium marielebourae (Paulsen) Balech		M-p	B-T	P
Protoperidinium pellucidium (Bergh) Balech		MB-p	C	P
Protoperidinium pentagonum Gran		M-p	B-T	P
Protoperidinium punctulatum (Paulsen) Balech		M-p	C	P

Protoperidinium pyriforme (Paulsen) Balech		M-p	C	P
Protoperidinium steinii (Jörgensen) Balech		M-p	B-T	PB,m
Protoperidinium subinerme (Paulsen) Balech		M-p	A-B	P
Pyrocystis elegans Pavillard		M-p	B-T	P
Pyrophacus horologium Stein		M-p	B-T	P
Scripsiella trochoidea (Stein) Loeblich III	q	M-p	A-B	PBm
PRYMNESIOPHYCEAE				
Emiliania huxlei (Lohmann) Hay *et* Möller		M-p	C	PBm,h
DICTYOCHOPHYCEAE				
Dictyocha fibula Ehrenberg				
var. *messanensis* (Haeckel *in* Peters) Lemm.		M-p	C	PBm,h
var. *pentagona* Schulz		M-p	C	PBm,h
Dictyocha polyactis Ehrenberg		M-p	B	PBm,h
Dictyocha speculum Ehrenberg		M-p	C	PBm,h
Octactis octonaria (Ehrenberg) Hovasse	q	M-p	B-T	PBm,h
BACILLARIOPHYCEAE				
Achnanthes longipes Agardh		M-b	C	PBm,h
Amphora arcus Greg.		M-b	A-B	PBm,h
Amphora costata W. Smith		M-b	B-T	Bm,h
Amphora lineolata Ehrenberg		B-b	C	Bm,h
Auricula insecta Grunow		B-b	C	PBm,h
Asterionella japonica Cleve *et* Müller		M-p	C	P
Bacillaria paradoxa Gmelin		M-b	C	PBm,h
Bacteriastrum delicatulum Cleve		M-p	B-T	P
Bacteriastrum hyalinum Lauder		M-p	C	P
Biddulphia sp.		M-p	C	P
Cerataulina pelagica (Cleve) Hendey	q	M-p	B	P
Chaetoceros affine Lauder		M-p	C	P
Chaetoceros breve Schütt		M-p	ST	P
Chaetoceros compressum Lauder		M-p	C	P
Chaetoceros constrictum Gran		M-p	B	P
Chaetoceros curvisetum Cleve		M-p	C	P
Chaetoceros danicum Cleve	q	M-p	C	P
Chaetoceros debile Cleve		M-p	B	P
Chaetoceros decipiens Cleve		M-p	A-B	P
Chaetoceros didymum Ehrenberg				
var. *protuberans* (Lauder) Gran *et* yen.		M-p	T-ST	P
Chaetoceros gracile Schütt		M-p	C	P
Chaetoceros holtalicum Schütt		M-p	A-B	P
Chaetoceros laciniosum Schütt		M-p	T-ST	P
Chaetoceros lorenzianum Grunow		M-p	B-T	PBm
Chaetoceros messanense Castracane		M-p	T-ST	P
Chaetoceros pseudocurvisetum Mangin		M-p	B-T	P
Chaetoceros sociale Lauder		M-p	A-B	PBm
Chaetoceros subsecundum (Grunow) Hustedt		M-p	A-B	P
Chaetoceros tortissimum Gran		M-p	B-T	P
Chaetoceros vistulae Apstein		MB-p	B	P
Chaetoceros wighami Brightwell		M-p	A-B	P
Climacosphenia elongata Bailey		M-b	C	PBm
Cocconeis scutellum Ehrenberg		M-b	C	PBm,h
Coscinodiscus centralis Ehrenberg		M-p	B-T	PBm
Coscinodiscus concinnus W. Smith		M-b	A-B	PBm
Coscinodiscus granii Gough		M-p	B-T	PBm
Coscinodiscus lineatus Ehrenberg		M-b	C	Bm
Coscinodiscus marginatus Ehrenberg		M-b	B-T	PBm
Coscinodiscus perforatus Ehrenberg				
var. *pavillardi* (Forti) Hustedt		M-p	B	PBm
Coscinodiscus radiatus Ehrenberg		M-b	C	PBm,h
Cylindrotheca closterium	q	M-b	C	PBm,h

Ditylum brightwelli (T. West) Grunow *in* Van Heurck	q	M-p	B-T	PBm
Grammatophora marina (Lyngbye) Kützing		M-b	C	PBm,h
Guinardia flaccida (Castracane) H. Peragallo		M-b	T-ST	PBm
Hemiaulus hauckii Grunow *in* Van Heurck		M-p	B-T	P
Lauderia sp.		M-p	T	P
Leptocylindrus danicus Cleve		M-p	C	PBm
Leptocylindrus minimus Gran		M-p	B-T	PBm
Licmophora abbreviata Agardh		M-b	C	Bm,h
Licmophora gracilis (Ehrenberg) Grunow		M-b	C	PBm,h
Licmophora flabellata Agardh		M-b	C	PBm,h
Licmophora paradoxa (Lyngbye) Agardh		M-b	A-B	Bm,h
Melosira borreri Greville		M-b	B-T	Bm,h
Navicula crabro Ehrenberg		MB-b	B-T	PBm,h
Navicula lanceolata Agardh (Kütz)		BF-b	C	Bm,h
Navicula pennata A. Schmidt		B-b	B-pce	PBm,h
Navicula zostereti Grunow		MB-b	B	Bm
Nitzschia longissima (Brebisson *in* Kützing) Ralfs *in* Pritchard	q	M-b	B	Bh
Nitzschia paradoxa Grunow *in* Cleve *et* Grunow		MB-b	B-T	Bh
Nitzschia sigma (Kützing) W. Smith		B-b	C	PBm,h
Pleurosigma angulatum (Quekett) W. Smith		M-b	C	Bm,h
Pleurosigma spenceri Sm.		MB-b	C	Bm,h
Pseudo-nitzschia delicatissima (P.T.Cleve) Heiden *in* Heiden and Kolbe	q	M-p	C	PBm,h
Pseudo-nitzschia pseudodelicatissima (Hasle) Hasle		M-p	C	P
Pseudo-nitzschia pungens (Grunow *ex* P. T. Cleve) Hasle	q	M-p	C	P
Pseudo-nitzschia seriata (P.T. Cleve) H.Perag. *in* H.& M. Perag.		M-b	C	PBm,h
Rhabdonema adriaticum Kützing		M-b	C	PBm,h
Rhizosolenia alata Brightwell f. *gracillima* (Cleve) Gran		M-p	C	P
Rhizosolenia calcar-avis Schultze	q	M-p	B-T	P
Rhizosolenia delicatula Cleve		M-p	T	P
Rhizosolenia fragilissima Bergon		M-p	C	P
Rhizosolenia imbricata Brightwell var. *shrubsolei* (Cleve) Schröder		M-p	B	P
Rhizosolenia setigera Brightwell		M-p	B	P
Rhizosolenia stolterfothii H. Peragallo		M-p	C	P
Skeletonema costatum (Greville) Cleve		M-p	C	PBm,h
Stephanopyxis palmeriana (Greville) Grunow		M-p	T-ST	P
Stephanopyxis turris (Greville) Ralfs *in* Pritchard		M-p	T-ST	P
Striatella delicatula Kützing		M-b	C	PBm,h
Striatella interrupta (Ehrenberg) Heiberg		M-b	B	PBm,h
Striatella unipunctata (Lyngby) Agardh		M-b	C	PBh
Synedra affinis Grunow var. *gracilis* Grunow		B-b	B-T	PBm,h
Synedra undulata (Bailey) Gregory		M-b	C	PBm,h
Thalassionema nitzschioides Hustedt	q	M-p	C	PBm,h
Thalassiosira allenii Takano		M-p	A-B	P
Thalassiosira anguste-lineata (A. Schmidt) G. Fryxel *et* Hasle		M-p	C	PBm
Thalassiosira decipiens (Grunow *in* Van Heurck) Jörgensen		M-p	B-T	PBm,h
Thalassiosira eccentrica (Ehrenberg) Cleve		M-p	A-B	PBh
Thalassiosira gravida Cleve		M-p	A-B	PBm,h
Thalassiosira nordenskioeldii Cleve		M-p	A-B	PBm,h
Thalassiosira rotula Meunier	q	M-p	T-ST	PBm,h
Thalassiosira subtilis (Ostenfeld) Gran		M-p	T-ST	P
Thalassiothrix frauenfeldii Grunow		M-p	C	P
Thalassiothrix longissima Cleve *et* Grunow		M-p	A-B	P
Thalassiothrix mediterranea Pavillard		M-p	B-T	P
EUGLENOPHYCEAE				

Eutreptiella sp.		M-p	B	P
ACANTHAREA				
Hexaconthicum asteroconthion Haeckel		M-p	B-T	P
CILIATA				
Codonella aspera Kofoid *et* Campbell		M-p	B	P
Coxliella annulata (Daday) Brandt		M-p	B-T	P
Dictyocysta mitra Haeckel		M-p	B	P
Favella azorica (Cleve) Jörgensen		M-p	A-B	P
Favella campanula (Schmidt) Jörgensen		M-p	B-T	P
Favella ehrenbergi (Claparede *et* Lachmann) Jörgensen		M-p	C	P
Favella serrata (Möbius) Jörgensen		M-p	C	P
Helicostomella subulata (Ehrenberg) Jörgensen		M-p	B-T	P
Metacylis joergensenii (Cleve) Kofoid *et* Campbell		M-p	C	P
Metacylis mereschkowskii Kofoid et Campbell	q	M-p	C	P
Metacylis morchella		M-p	B	P
Petalotricha ampulla (Fol) Kent		M-p	C	P
Stenosemella nivalis (Meunier) Kofoid *et* Campbell	q	M-p	B	P
Stenosemella ventricosa Claperede *et* Lachmann	q	M-p	B	P
Tintinnopsis beroidea Stein	q	M-p	B	P
Tintinnopsis campanula (Ehrenberg) Daday		M-p	B	P
Tintinnopsis compressa (Daday) Laackmann		M-p	C	P
Tintinnopsis cylindrica Daday		M-p	C	P

EG : Ecological group	**FG : Phyto-geographycal group**	**PF : Prevailing field**
M **:** Marine species	C**:** Cosmopolite species A-B**:** Arcto-boreal species	P **:** Pelagial
B **:** Brackishwater species	B**:** Boreal species (pce: ponti-caspian endemism)	B **:** Benthal
BF**:** Brackish-freshwater species	B-T**:** Boreal-tropical species T-S**:** Tropical-subtropical species	m **:** Mobil substratum
b **:** Benthic-originated species	ST **:** Subtropical species	
p **:** Pelagic originated species	B-pce**:** Boreal-ponti caspian endemic species	h **:** Hard substratum
	?**:** species with a global distribution non clarified	

From the taxonomic point of view, one species (0.48 %) **Cyanophyceae**, 89 taxa (42.4 %) **Dinophyceae** (15 genera, 73 species, 14 varieties and two formas), one species (0.48 %) **Prymnesiophyceae**, five taxa (2.38 %) **Dictyochophyceae** (two genera, three species and two varieties), 94 taxa (44.8 %) **Bacillariophyceae** (34 genera, 91 species, two varieties and one forma), one species (0.48 %) **Euglenophyceae**, one species (0.48 %) **Acantharea** and 18 taxa (% 8.57) **Ciliata** (nine genera and 18 species) were identified in the neritic waters of the Sinop peninsula in the Southern part of the Black sea (Tab.1).

Among the diatoms, the following genera are richest in species: *Chaetoceros* spp (20 taxa), *Thalassiosira* spp (8 taxa), *Coscinodiscus* spp and *Rhizosolenia* spp (7 taxa), *Pseudo-nitzschia* spp, *Licmophora* spp and *Navicula* spp (4 taxa) *Nitzschia* spp and *Striatella* spp (3

taxa), among the dinoflagellate – *Ceratium* spp (24 taxa), *Protoperidinium* spp (20 taxa), *Prorocentrum* spp and *Dinophysis* spp (12 taxa), *Gonyaulax* spp (7 taxa) and *Oxytoxum* spp (4 taxa), among the Ciliata – *Tintinnopsis* spp (4 taxa), *Favella* spp (4 taxa), *Metacylis* spp (3 taxa) and *Stenosemella* spp (2 taxa) (Tab.1).

In the result of this study, four ecological groups which are marine, marine-brackish, brackish and brackish-fresh water were distinguished (Tab.2). However, most of the marine species recorded in research area are euryterm and euryhaline ones. It can be said that, Black Sea has been inhabited by the most euryhaline and euryterm forms of the Mediterranean flora and fauna. As stated by Skolka (1977), the development and dynamics of brackish-water phytoplankton depend on several environmental factors among which the most important seems to be the rivers flows.

Table 2. Ecological distribution (%) of taxonomic groups in the planktonic protista and their prevailing fields in the southern Black Sea

TAXSONOMIC	**ECOLOGICAL GROUP**								**PREVALING FIELD**					
GROUP	**M**		**MB**		**B**		**BF**		**p**		**b**		**TOTAL**	
	no	%	**no**	%	**no**	%	**no**	%	**no**	%	**no**	%	**no**	%
CYANOPHYCEAE	1	100	–	–	–	–	–	–	–	–	1	100	1	0.48
DINOPHYCEAE	84	94.4	4	4.5	1	1.1	–	–	89	100	–	–	89	42.4
PRYMNESIOPHYCEAE	1	100	–	–	–	–	–	–	1	100	–	–	1	0.48
DICTYOCHOPHYCEAE	5	100	–	–	–	–	–	–	5	100	–	–	5	2.38
BACILLARIOPHYCEAE	83	88.3	5	5.3	5	5.3	1	1.1	64	65.9	30	34.1	94	44.8
EUGLENOPHYCEAE	1	100	–	–	–	–	–	–	1	100	–	–	1	0.48
ACANTHAREA	1	100	–	–	–	–	–	–	1	100	–	–	1	0.48
CILIATA	18	100	–	–	–	–	–	–	18	100	–	–	18	8.57
TOTAL	194	92.4	9	4.3	6	2.8	1	0.5	179	85.2	31	14.8	210	100

M: marine-water, **MB:** marine and brackish-water, **B:** brackish-water, **BF:** brackish and fresh-water, **p:** pelagic originated species, **b:** benthic originated species

Most of the species identified are generally neritic forms, however, probably as a result of transportation processes, some species that are known to be oceanic such as *Chaetoceros danicum* Cleve (2.7 x 10^6 cells l^{-1} in January), *Pseudo-nitzschia delicatissima* (P.T. Cleve) Heiden *in* Heiden and Kolbe (9.0 x 10^7 cells l^{-1} in April), also demonstrated extensive bloom in winter and spring period, respectively. As stated by Smayda (1958), the intense blooming of species like these in neritic waters undoubtedly suggest that the concept of neritic versus oceanic species in phytoplankton may be unclear approachment. On the other hand, it is possible to find some tychopelagic (benthic oriented) forms among diatoms such as *Achnanthes longipes* Agardh, *Amphora lineolata* Ehrenberg, *Auricula insecta* Grunow, *Bacillaria paradoxa* Gmelin, *Climacosphenia elongata* Bailey, *Cocconeis scutellum* Ehrenberg, *Coscinodiscus radiatus* Ehrenberg, *Grammatophora marina* (lyngbye) Kützing, *Guinardia flaccida* (Castracane) H. Peragallo, *Licmophora abbreviata* Agardh, *Rhapdonema adriaticum* Kützing, *Melosira borreri* Greville, *Navicula lanceolata* Agardh (Kützing), *Nitzschia longissima* (Brebisson *in* Kützing) Ralfs *in* Pritchard, *Pleurosigma angulatum* (Quekett) W. Smith, *Striatella delicatula* Kützing, *Synedra undulata* (Bailey) Gregory (see Tab.1) but these species were recorded rarely in the samples. However, extensive bloom of diatom *Cylindrotheca closterium* (7.4 x 10^6 cells l^{-1}) which is a tychopelagic species formed in the pelagic system of Sinop bay occurred in July. As stated by Sournia (1982) and Koray (1987), the reason why sporadic occurrences of these species in the samples is that the materials had been collected from the upper layers of the limit of euphotic zone. That is also why the knephoplanktonic species, which were identified and discussed as a shade flora in phytoplankton.

In the result of geographical distribution of species, 6 geographical groups were distinguished in the neritic waters of Sinop peninsula in the southern part of the Black Sea (Tab. 3). If the presented species list is examined in terms of the geographical distribution of the species, then it can be said that, generally, most of the species are boreal (boreal, arcto-boreal and boreal-tropical species) and cosmopolite ones (Tab.1 and 3).

The most of the blooming species are generally boreal-tropical and arcto-boreal among the dinoflagellates and cosmopolite forms among the diatoms. The extensive blooms of the species that are known to be arcto-boreal forms such as *Prorocentrum balticum* (Lohmann) Loeblich III (9.0 x 10^6 cells l^{-1} in July), *Heterocapsa triquedra* (Ehrenberg) Stein (6.2 x 10^5 cells l^{-1} in March) and *Scripsiella trochoidea* (Stein) Loeblich III (7.8 x 10^5 cells l^{-1} in June) belong to dinoflagellates were observed in several periods of the year. Examples of sudden

changes in community structures due to climatic variability, changes in the strength of currents or due to sudden extreme events, such as extremely cold winters or high wave action triggered by strong storms are well known in the North Sea and Atlantic Ocean (Colebrook, 1986 and Taylor *et al*., 1992).

Table 3. Geographical distribution of the planktonic protista in the southern Black Sea

TAXONOMIC	**GEOGRAPHYCAL GROUP**														
GROUP	**C**		**B**		**A - B**		**B - T**		**T - ST**		**B-pce**		**?**		**TOT**
	no	%	**no**	%	**no**	%	**no**	%	**no**	%	**no**	%	**no**	%	**no**
CYANOPHYCEAE	1	100	–	–	–	–	–	–	–	–	–	–	–	–	1
DINOPHYCEAE	23	25.9	11	12.4	4	4.5	35	39.3	14	15.7	–	–	2	2.2	89
PRYMNESIOPHYCEAE	1	100	–	–	–	–	–	–	–	–	–	–	–	–	1
DICTYOCHOPHYCEAE	3	60.0	1	20.0	–	–	1	20.0	–	–	–	–	–	–	5
BACILLARIOPHYCEAE	41	43.6	10	10.6	13	13.8	18	19.1	11	11.7	1	1.1	–	–	94
EUGLENOPHYCEAE	–	–	1	100	–	–	–	–	–	–	–	–	–	–	1
ACANTHAREA	–	–	–	–	–	–	1	100	–	–	–	–	–	–	1
CILIATA	7	47.0	7	29.5	1	5.9	3	17.6	–	–	–	–	–	–	17
TOTAL	**76**	36.2	**30**	14.3	**18**	8.6	**58**	27.6	**25**	11.9	**1**	0.5	**2**	0.9	**210**

C: cosmopolite, **B:** boreal, **A-B:** arcto-boreal, **B-T:** boreal-tropical, **T-ST:** tropical-subtropical, **B-pce:** boreal-ponti caspian endemic, **?:** species with a global distribution non clarified

The other extensive blooms of planktonic protista in the neritic waters of the southern Black Sea were occurred by boreal species such as *Stenosemella nivalis* (Meunier) Kofoid *et* Campbell (1.2 x 10^5 cells l^{-1} in April), *Stenosemella ventricosa* Claperede *et* Lachmann (2.0 x 10^4 cells l^{-1} in March) and *Tintinnopsis beroidea* Stein (4.0 x 10^4 cells l^{-1} in December) among the Ciliata, *Cerataulina pelagica* (Cleve) Hendey (1.0 x 10^5 cells l^{-1} in January), *Nitzschia longissima* (Brebisson *in* Kützing) Ralfs in Pritchard (5.2 x 10^6 cells l^{-1} in January) among the diatom, boreal-tropical species such as *Gonyaulax polyedra* Stein and *Gonyaulax spinifera* (Claparede et Lachmann) Diesing (4.0 x 10^4 cells l^{-1} in August), *Prorocentrum aporum*

(Schiller) Abe (9.6 x 10^5 cells l^{-1} in December), *Prorocentrum compressum* (Bailey) Abe (4.6 x 10^5 cells l^{-1} in July), *Prorocentrum minimum* Schiller (2.0 x 10^5 cells l^{-1} in August), *Prorocentrum triestinum* Schiller (1.2 x 10^5 cells l^{-1} in March) among the dinoflagellates; *Ditylum brightwelli* (T. West) Grunow *in* Van Heurck (7.6 x 10^5 cells l^{-1} in March), *Rhizosolenia calcar-avis* Schultze (1.7 x 10^6 cells l^{-1} in August) among the diatoms and *Octactis octonaria* (Ehrenberg) Hovasse (6.0 x 10^4 cells l^{-1} in March) among the silicoflagellates.

The extensive blooms of phytoplankton in the neritic waters of the southern Black sea were also generally occurred by cosmopolitan species. Of the individual species the most significant among the diatoms are *Pseudo-nitzschia delicatissima* (P.T.Cleve) Heiden *in* Heiden and Kolbe (9.0 x 10^7 cells l^{-1} in April), *C. closterium* (7.4 x 10^6 cells l^{-1} in July), *Chaetoceros danicum* Cleve (2.7 x 10^6 cells l^{-1} in January) and *Pseudo-nitzschia pungens* (Grunow *ex* P. T. Cleve) Hasle (1.2 x 10^6 cells l^{-1} in August). Among the dinoflagellata, the most important are *Prorocentrum micans* Ehrenberg (7.2 x 10^5 cells l^{-1} in August), *Protoperidinium granii* (Ostenfeld *in* Paulsen) Balech (4.8 x 10^5 cells l^{-1} in March), *Protoperidinium depressum* (Bailey) Balech (4.0 x 10^4 cells l^{-1} in March) and among the prymnesiophyte the most important is *Emiliania huxleyi* (Lohmann) Hay *et* Möller (5.9 x 10^6 cells l^{-1} in July).

Many planktonic protista species blooming in the sub-tropical areas such as Izmir Bay (Koray, 1984; 1987a; 1987b; 1988; 1990; 1995; Koray and Gökpınar, 1983; Koray and Özel, 1983; Koray and Büyükışık, 1988), Gökova Bay (Koray *et al*., 1994) and north eastern mediterrenean (Kıdeys *et al*., 1989) are very rare both qualitatively and quantitavely in the southern Black Sea (see, Tab. 1), due to the low temperature (see, Fig. 2). Tropical-subtropical species such as *Ceratium belone* Cleve*, Ceratium hexacanthum* var. *Pavillardi* (Rampi) Sournia*, Ceratium incisum* (Karsten) Jörgensen, *Ceratium carriense* var. *volans* (Cleve) Sournia, *Ceratium compressum* Gran, *Ceratium teres* Kofoid, *Protoperidinium diabolus* Cleve, *Chaetoceros breve* Schütt, *Chaetoceros didymum* var. *protuberans* (Lauder) Gran *et* Yen., *Chaetoceros laciniosum* Schütt, *Chaetoceros messanense* Castracane, *Stephanopyxis turris* (Greville) Ralfs *in* Pritchard growth in warm waters were recorded in samples, but these species are very rare in the neritic waters of the Sinop peninsula in the southern part of the Black Sea. However, the alternation of warm with cold climate epoch made, it is possible for many species of the cold waters of the Atlantic ocean to migrate in to the warm mediterranean sea. As stated by Zahit and Sur (1995), the degree of mixing of warmer water plankton with

those which thrive in colder waters will be discussed below, with reference to the meandering nature of the boundary current of the southern Black Sea.

In the open Black Sea the average air temperature decreased after 1986, was extremely low in 1987 increased in 1988 and thereafter decreased till 1994 (Ovchinnikov and Osadchy, 1994). As stated by Mee (1992) and Zaitsev (1992), it could be suggested that reason of sudden changes in the phytoplankton community structure of the Black Sea in last decade may be due to climatic variability and eutrophication as a major forcing function for phytoplankton, especially in the north-west shelf area of the Black Sea. In the north-west area of the Black Sea, for example, the extensive blooms in the phytoplankton populations were due to eutrophication as a result of increase of nutrients, due to input of domestic waste waters by Danube (Bologa, 1985/1986).

The boreal-ponti caspian endemic group is only represented by one species, benthic diatom *Navicula pennata* A. Schimidt (Tab.1). But, the north-west section of the Black sea with the lowest salinity such as inlets and river mouths are inhabited by caspian relict flora and fauna. Members of the fresh-water algae inhabite into these parts of the Sea and also become abundant in the section (Dimitrova-Konaklieva, 1991). However, both the central Black Sea and the neritic waters of the southern section is inhabited by the most euryterm and euryhaline forms of the mediterranean flora and fauna.

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