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AVAILABLE PLANKTONIC ORGANISMS AS FOOD FOR THE FISHES IN THE BOSPORUS AREA

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Özet:
Fiziksel-oseanografik ve biyolojik data, programın içerdiği diğer ölçümlerin yanısıra, Osenografik database programı (Hidro-QL) çerçevesince toplanmıştır. Bu çalışma, Boğaziçi akıntı sisteminde kirlenme ve balıkçılık çerçevesince çevrevresel faktörleri irdelemek amaçlı olarak gerçekleştirilmiştir.
Söz konusu bölgedeki plankton komunite dinamikleri, bölgeye düşük tuzluluk içeren Karadeniz'den taşınan yüklü miktarda besleyici materyal ile sıkı bağlantılıdır. Plankton takxasındaki zenginlik yine Karadeniz kökenli besleyici mayeryalin primer besin zincirini özellikle Boğaziçi'nin Karadeniz bağlantısı bölgesinde ciddi bir şekilde desteklemesinin sonucudur.
Bu çalışmadaki sonuçlar (Artuz. I*. et al.*) çalışmaları ve elde edilen sonuçlar ile paralellik göstermektedir. Ancak aynı sonuçlar, Istanbul Atıksu Master Plan Revizvonu ve uygulama kriterlerinde öngörülen saptama ve değerler ile ciddi anlamda çelişmektedir.
Buna gore; söz konusu derin deşarjın yarattığı kirlilik Boğaziçi ağızlarında iki yönde ciddi bir şekilde kısıtlayıcı etmen olarak ortaya çıkmaktadır ve bölgenin çoğrafi yapısına bağlı olarak gelişen dikey yöndeki akıntılar sonucu, (upwelling) söz konusu kirlenme yüzey sularında biotada değişikliklerine ve yörede döl veren balıkların gelişimine ciddi bir şekilde ket vurmaktadır.

Anahtar kelimeler: Boğaziçi, plankton, zoo-plankton, fito-plankton

Abstract:
Physical and biological data were collected as part of the Oceanographical database program (Hydro-QL program), a multidisciplinary study of the Sea of Marmara and Turkish straits, among other things, to understand the environmental factors affecting the pollution and fishery.
Concluded that the plankton community dynamics on this strait (in the Bosphorus strait) are dominated by coupling with the Black Sea with low salinity as a local estuary and the dynamics of Bosphorus strait.
The richness of plankton taxa in Bosphorus region exists, because the Black Sea is the area of origin of the primary source of dissolved plant nutrients and particulate organic matter supporting plankton-based food chains of the Black Sea entrance of Bosphorus. For the past 4 years, the author has studied the interactions between the physical, chemical, and biological regimes of the Bosphorus region.
The results are in agreement with those of (Artuz. I*. et al.*) for the zone over the thermocline layer (Black sea originated layer) of the 10- to 25m depth.
However, the results from studies of the below thermocline layer (Mediterranean originated layer) contrast sharply with the conclusions of the Master Plan of marine outfalls for the Istanbul Metropolitan area have been performed for the World Health Organization supported by UNDP.
The argument is based on two characteristics of the physical regime of the strait and their observed effect on the biota.
First, owing to marine outfall discharge, pollution restricts the plankton circulation on convergence and divergence direction within several kilometres following the both entrances of Bosphorus.
Second, upwelling at the shelf break points of Bosphorus basin is a major source of plant nutrients that sustains and enhances biota and fish development in the upper layers.

Key words: Bosphorus, plankton, zoo-plankton, phyto-plankton

Materials and methods

The project area is marked as 4 sub-regions they are tabulated in fig. 1.

The plankton samples were collected 4 times a year, during the period between 2000-2004.

In order to collect the plankton samples, plankton net is used in 60cm.Ø and 155 µ mesh size.

The drift procedure of the plankton net is as follows;

a) Vertical drifts was done in each station from bottom to surface,

b) Horizontally drifting was done between the stations of each sub-region in layers 0.5, 5, 10,15, 25, 35 and bottom.

Also the samples were preserved in 35% Formol solution. The material was observed with a binocular with a magnification range 24x to 1000x. For the salinity and temperature measurements the WTW digital in-situ measurement units were used, each with 100m. prob. cord.

But the salinity and temperature values are indicated as average and seasonal.

RESULTS AND DISCUSSION

Project areas:

Project area I.: This area is selected as the Black Sea entrance of Bosphorus including the part of the Black Sea

Project area II.: This area is selected as the main strait (Body) of Bosphorus.

Project area II.: This area is selected as southern part of Bosporus including the "Golden Horn" region.

Project area II.: This area is selected as southern end of Bosporus including the part of the Sea of Marmara. The project areas are shown in fig. 1.

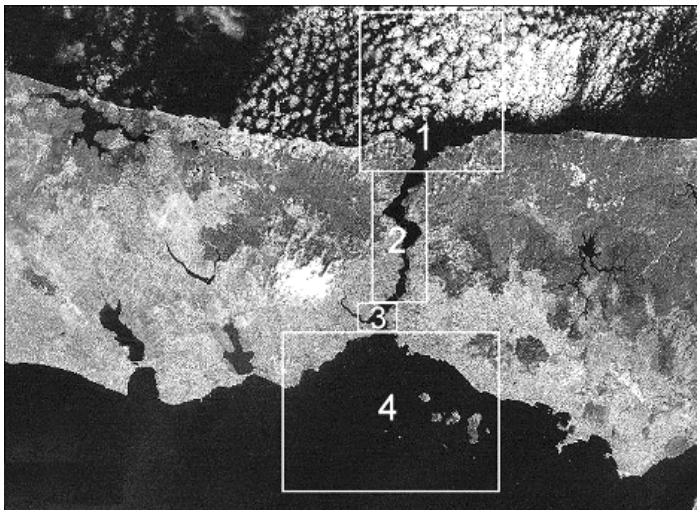


Fig.1. Indication of project areas in Bosphorus region.

A list of the most common zoo- and phytoplankton species found in different layers of the waters of the Bosphorus area is given below.

The percentage of distribution of the plankton in the different layers is tabulated in the following table.

% distribution of the planktonic organisms in the sub-regions of the Bosphorus area. (No information is available for sub region III)

Sub-regions: Layers	I	II	IV	Total
Surface to thermocline	36	18	16	23
At the thermocline	55	63	59	59
Below the thermocline	9	19	25	18

As it is seen from this table, the greatest plankton diversity occurs at the thermocline ranging from 59% to 63%. Besides the concentration of the planktonic biomass at this layer, most of the pelagic fishes of the area are also concentrating around this plankton rich layer.

The surface plankton community of the Bosphorus area is under considerable influence from the dominant Black Sea populations, but below the thermocline the plankton community has typical Mediterranean character.

ZOOPLANKTON:

In the pelagic food chain of the waters of the Bosphorus area the most important group of zooplankton are the copepods. In the area they compose over 50% of the total zooplankton biomass. A list of the recorded zooplankton groups and species are given below:

Narcomedusae:
Solmundella bitentaculata (Quoy and Gaimard, 1833)
Scyphomedusae:
Aurelia aurita (Linnaeus, 1758)
Rhizostoma pulmo (Macri, 1778)
Siphonophora:
Muggiaea kochi (Will, 1844)
Ctenophora:
Pleurobrachia rhodopis (Chun, 1880)
Polychaeta:
Tomopteris helgolandica Greeff, 1879
Cladocera:
Evadne nordmanni Lovén, 1836
Evadne spinifera P. E. Müller, 1867
Penilia avirostris Dana, 1849
Podon intermedius Lilljeborg, 1853
Podon polyphemoides (Leuckart, 1859)
Pseudevadne tergestina (Claus, 1877)
Copepoda :
Acartia clausi Giesbrecht, 1889
Anomalocera patersoni Templeton, 1837
Calanus helgolandicus (Claus, 1863)
Calanus styliremis Giesbrecht, 1888
Calocalanus tenuis Farran, 1926
Centropages kroeyeri Giesbrecht, 1892
Centropages ponticus Karavaev, 1894
Centropages typicus Krøyer, 1849
Clausocalanus arcuicornis (Dana, 1849)
Clausocalanus furcatus Brady, 1883
Clytemnestra rostrata (Brady, 1883)
Clytemnestra scutellata Dana 1848
Corycella rostrata Claus, 1863
Ctenocalanus vanus Giesbrecht, 1988
Cyclopina gracilis Claus, 1863
Diaixis hibernica (A. Scott, 1896)
Eucalanus crassus Giesbrecht, 1888
Euchaeta marina (Prestandrea, 1833)
Euterpina acutifrons (Dana, 1849)
Haloptilus acutifrons (Giesbrecht, 1892)
Labidocera brunescens (Czerniavsky)
Macrosetella gracilis (Dana, 1847)
Metridia lucens Boeck, 1865
Oithona nana Giesbrecht, 1892
Oithona plumifera Baird, 1843
Oithona similis Claus, 1866
Oncaea curta Sars, 1916
Oncaea longiseta Shmel, 1968
Oncaea notopus Giesbr., 1891
Oncaea obscura Farran, 1908
Paracalanus parvus (Claus, 1863)
Pontella mediterranea (Claus, 1863)
Pseudocalanus elongatus (Boeck, 1865)
Sapphirina. maculosa Giesbrecht. 1892
Urocorycaeus furcifer (Claus, 1863)
Chaetognatha:
Sagitta bipunctata Quoy and Gaimard, 1828
Sagitta megalophthalma (Dallot and Ducret, 1969)
Sagitta setosa (Mueller, 1847)
Copelata:
Fritillaria formica Fol, 1874
Fritillaria pellucida (Busch, 1851)
Oikopleura dioica Fol, 1872
Oikopleura fusiformis Fol, 1872
Oikopleura longicauda (Vogt, 1854)

PHYTOPLANKTON:

Phytoplankton is the largest source of primary production in the area. Species composition and biomass production change seasonally.

A list of the recorded groups and species of the area are given below:

Dynoflagelata:
Ceratium fusus (Ehrenberg, 1834)
Ceratium furca (Ehrenberg, 1836)
Ceratium lineatum Ehrenberg - Belloc 1894
Ceratium karsteni Pavillard, 1907
Ceratium tripos Nitzsch, 1817
Gonyaulax polygramma Stein, 1883
Noctiluca miliaris Suriray, 1836
Prorocentrum micans Ehrenberg, 1833
Diatomeae:
Chaetoceros affinis Lauder, 1864
Chaetoceros gracilis Schütt 1895
Chaetoceros calcitrans (Paulsen)
Chaetoceros radians Schütt, 1895
Cerataulina bergonii H. Peragallo, 1892
Coscinodiscus concinnus Wm. Smith 1856
Coseinodiscus marginatus Ehrenberg, 1838
Coscinodiscus radiatus Ehrenberg, 1841
Leptocylindrus danicus Cleve, 1889
Rhizosolenia calcar-avis Schultze, 1858
Rhizosolenia delicatula Cleve 1900
Rhizosolenia styliformis Brightwell 1858
Thalassionema nitzschioides Grunow, 1862
Thalassiothrix frauenfeldii Grunow 1880
Ciliata:
Favella ehrenbergi (Claparède & Lachmann, 1858)

Apart from the species listed above, a large number of eggs and larvae of various pelagic and bottom invertebrates and fish are found mixed with the coastal plankton, especially in the summer. Among them the most abundant are anchovy eggs (sub-region I) the larvae of Lamellibranchiata (*Mytilus galloprovincialis*) and the eggs and larvae of different Copepoda and Crustacea. As in the other regions of the Mediterranean waters, zooplankton of the Bosphorus area play an important role on the fish nutrition. Among the food plankton organisms following species are the most important from this point of view:

Calanus helgolandicus
Pseudocalanus elongatus
Acartia clausi
Penilla avirostris
Sagitta setosa (is only eaten by a limited number of fish such as Sprat, Anchovy and young Horse Mackerel)

The comparison between the edible and inedible forms of zooplankton are shown in the following table and their biomass for the western part of the Black Sea (sub-region I.) is tabulated.

Biomass comparison of edible and inedible forms of fish food plankton.

Plankton composition	Biomass mg/m^3	
	spring	autumn
Edible(fish-food) forms	68	200
Inedible forms	114	344
Total zooplankton biomass	172	544

Several groups of plankton can be distinguished in the waters of the Bosphorus area by the type of their seasonal occurrence. The first group is the permanently occurring plankton, distributed throughout the seasons. The species of this group is usually adapted to the surface water mass i.e. 0-50m. Their distribution is not greatly affected by the variations of temperature (eurytherm species).

This group is represented by the following species in the Bosphorus area:

Oithona nana
Acartia clausi
Paracalanus parvus
Oikopleura dioica
Idothea algirica
Noctiluca miliaris

Although *N. miliaris* may be found throughout the seasons, its relative abundance in the plankton fluctuates considerably during the year.

It is scarce in winter and multiplies intensively in the beginning of summer and causes the formation of the tomato-soup coloured **red-tide** at the surface of the Sea of Marmara. The second group is composed of cold water stenothermal forms.

The representatives of this group are found in winter at all depths in sub-region I, but in sub-region II and IV, they are found only in the cold water mass above the thermocline.

The representatives of this cold stenothermal group and the upper temperature limits for their distribution are given in the table below.

Stenothermal species of Plankton in the Bosphorus area with upper temperature limits for distribution

Species	Upper temp. limits ºC
Sagitta setosa	**10-11**
Pleurobrachia pileus	**12 - 13**
Pseudocalanus elongatus	**13**
Calanus helgolandicus	**13**
Oithona nana	**14**

With the warmth of spring they sink down to the thermocline and disappear gradually from the upper (surface) layers. They can not penetrate into the layers below the thermocline since below this depth the temperature conditions are constant in the sub-regions II – IV and it is around 14ºC. Only *Oithona nana* may pass this boundary. The third group develops only in summer (warm stenotherms). With the warming-up they occupy the surface layers of the Bosphorus area and with cooling they become gradually scarce and in the winter disappear completely. This group is represented by the following species:

Centropages kroeyeri
Evadne nordmanni
Evadne spinifer
Podon polyphaemoides

Both entrances of Bosphorus are the primary spawning locations for many commercially important fishes such as Horse mackerel (*Trachurus sp*.) and Bluefish (*Pomatomus saltatrix*) and have been heavily fished in recent years

(Artüz.M.L.2002) reported a decrease in large predator abundance (primarily *Pomatomus saltatrix* and *Sarda sarda*) and attributed this change to increased fishing activity and decreased species diversity in this region.

The influence on fishing activity will be difficult to assess in determining a natural community and the current patterns of pelagic fish community structure may have been greatly altered by human activity through fishing and waste water discharges of the Istanbul Metropolitan area of during the past 20 years.

Rates of primary production will vary through the year and are dependent on a number of factors including the presence of nutrient salts and light availability, in turn influenced by physical mixing processes. Breakdown of the thermocline in winter months and strong winds allow nutrients in deep colder water by precipitating the surface layers. This coupled with increased light in early spring leads to a bloom of phytoplankton. As the thermocline becomes fully re-established in summer months and wind-induced mixing of the water layers is reduced, phytoplankton growth depletes the levels of available nutrients in the

surface-layer. Phytoplankton growth is therefore quickly inhibited following the initial spring bloom. Therefore, during summer months high standing stocks of phytoplankton tend to persist only in regions where physical mixing processes maintain a relatively high upward flux of nutrients Zooplankton grazing is also a limiting factor in phytoplankton blooms. The size and timing of phytoplankton blooms in the Bosphorus, north part of Sea of Marmara and Black Sea entrance of the Bosphorus will vary from year to year depending on local weather and oceanographic conditions of the related Seas.

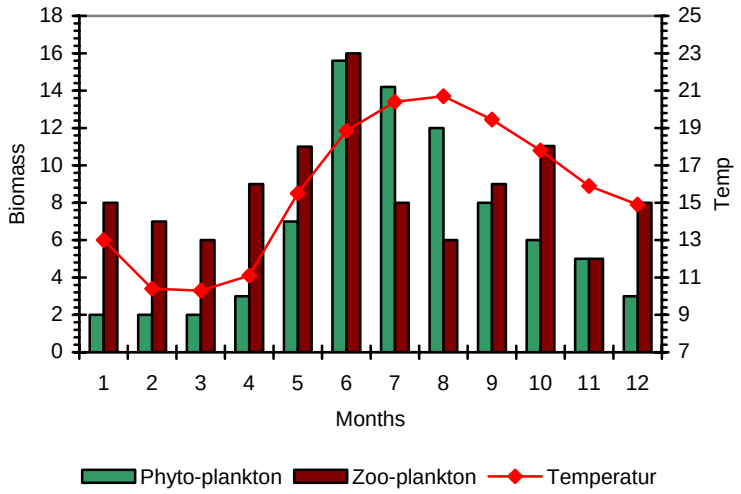
In the surface layers of project areas I. and II (also partly III), the spring bloom generally peaks in May with a sharp decline in June followed by a steady increase and fairly consistent standing crop until September after which there is a sudden decrease to the winter minimum.

Zooplankton also shows seasonal cycles in abundance and these follow closely to the spring increases and winter decreases of phytoplankton (i.e. food availability).

Zooplankton also show seasonal and vertical migrations and seasonal geographical abundance is linked to both over-wintering stocks and food availability.

The average level of fluctuations of both project areas of zoo-and phyto- plankton depending the water temperature is shown in chart 1.

Chart 1.The average level of fluctuations of zoo-and phyto- plankton communities depending the water temperature.



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