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The Effects of Pollution on the Distribution of Phytoplankton in the Surface Water of the Golden Horn

Haliç Yüzey suyunda Kirlenmenin Fitoplankton Dağılımına Olan Etkileri

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Abstract

In this study, to reach the interactions between pollution and phytoplankton at the Golden Horn, the surface water samples collected at January-December 1995 period are investigated to aspect the phytoplankton qualitative and quantitatively. During the study period, 24 phytoplankton species (16 diatoms and 8 dinoflagellates) were determined. At the entrance of the Golden Horn (Station 1) 22 species were determined but at the inner part (Station 5) only 8 species were determined in the whole of the year. The phytoplankton quantity (2 x 103 cells/L on an average) were in low concentrations in general and reached the highest value (146 x 106 cells/L) at July. During that increase Leptocylindrus minimus, a member of centric diatoms, was dominant with 95% ratio. Dinoflagellate species concentration reached the highest value (1679 cells/L) when Noctulica scintillans, a member of this group, was dominant with 93% ratio at November. According to the results of this study, the surface water phytoplankton community of the Golden Horn is quite poor at the point of species and individual quantity. That is explained; the phytoplankton species and individual quantity decrease from the entrance to inner side of the Golden Horn vice versa pollution increase at the same direction during this study period.

Key words: The Golden Horn, Phytoplankton, Pollution

Introduction

It is known that there were biological activity and natural fish stocks when the Golden Horn was not polluted so much like those days. However the pollution took a sharp increase after 1950s' with an increase at discharged domestic and industrial pollutants because of the rising industrialization and urbanization along the Golden Horn. That caused a tendency to diminish the biological activity at the Golden Horn. Several projects were developed to stop that pollution but none of them could be applied until 1995.

The Golden Horn is; a typical shore system called Estuary, lengthening to northwest-southeast direction, approximately 7 km length, having maximum 700 m wideness and variable depth value between 1 m at northwest tip and maximum 42 m at the southeast part, connected Kağıthane and Alibey Creeks with northwest end and sea with the southeast part of it (Güçlüer and Doğusal, 1976).

Primary production is the first step of the food chain that begins from single cellular livings to organized ones. Primary production is energy transformation from solar energy to chemical energy by active pigments especially chlorophyll a. Phytoplankton is responsible for primary production at aquatic environment. The carbonic compounds produced by phytoplankton are the basin of the food chain (Lederman, 1983; Aruga, 1965).

In this study, surface (0.5 m) phytoplankton cells were counted directly and biomass concentrations were tried to find out. At that point of view, the primary producer phytoplankton community was studied qualitatively and quantitatively where all the biological life were nearly stopped with increasing pollution.

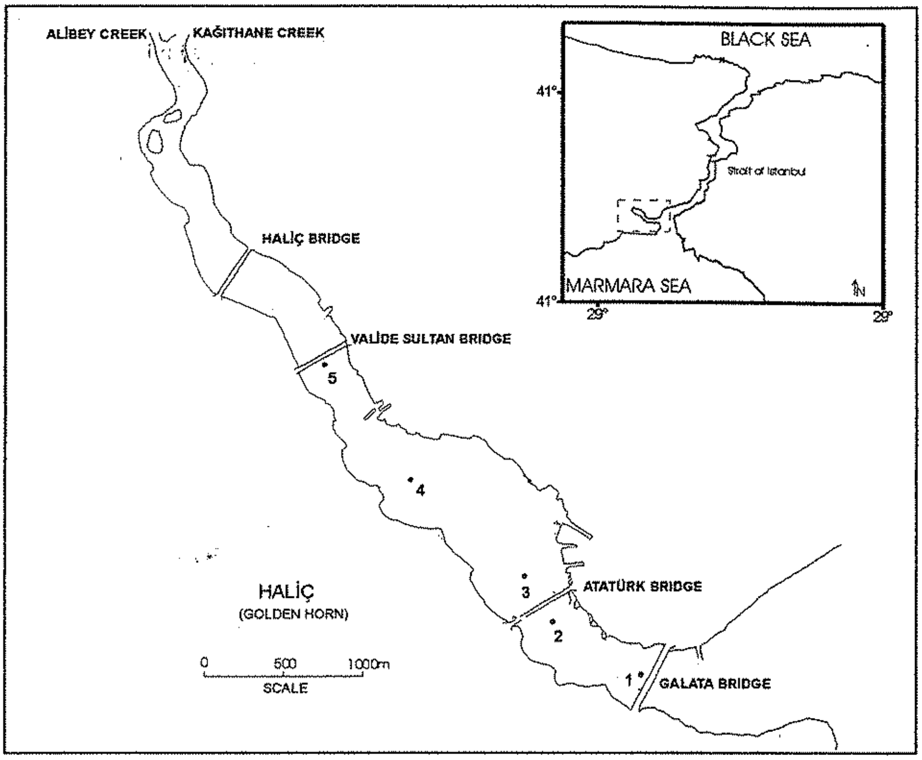

Figure 1. Sampling stations in the research area.

Material and Method

In this study, surface water samples (0.5 m) were collected monthly along the middle line of the Golden Horn (Figure 1) for one year between January and December 1995. As from the 5th station to inner parts, water samples could not be collected because of the shallowness (sometimes less than 1 meter) and the intensity of suspended solid mater. 50 liters of water samples which were collected from surface water by PVC containers having 5 liters capacity were filtered by a miniature phytoplankton net, diameter 25 cm, pore size 55 µm, like Hensen net. Than, the filtered water samples were fixed with 40% formaldehyde being the final concentration 4% and stored in 300 cc of plastic containers (Throndsen, 1978). Quantitative measurement was done by light microscope (Olympus CH-2) using Sedgewick Rafter counter chamber with 'phytoplankton direct counting system' (Guillard, 1978). Qualitative measurement, when species identification was needed, a few drops of concentrated sample was put on a slide and covered with cover glass. This preparation was observed for species identification with light microscope at 40x and 100x magnifications.

Shannon-Wiener index (H') was used (Zar, 1984) to estimate the species diversity statistically.

The references used for species identification: Rehakova (1974), Ricard and Dorst (1987), Gerhard (1974), Tréqouboff and Rose (1957), Priddle and Fryxell (1985).

Results

During the study period, 24 phytoplankton species (16 diatoms and 8 dinoflagellates) are determined. 1st and 2nd stations have relatively better water quality and phytoplankton species composition shows better richness. 3rd, 4th and 5th stations having more polluted and poor qualified water have low phytoplankton species diversity and low cell intensity rapidly in turn in order. Some of the most found species are in diatoms Coscinodiscus sp., Leptocylindrus minimus, Pseudonitzschia delicatissima, Pseudosolenia calcar-avis, Rhizosolenia hebetata, Thalassiosira sp., in dinoflagellates Ceratium furca, C. fusus, C. tripos and Dinophysis caudata, Noctulica scintillans and Protoperidinium granii (Table 1).

During this study period, phytoplankton distribution was at low ratio quantitatively. The whole of the year (except July) phytoplankton had quite low concentration (approximately 2000 cells/L) but it increased rapidly at July (Station 3rd, 146x103 cells/L). In this increase diatoms were dominant, Leptocylindrus minimus (a centric diatom) is the dominant species. This situation arise from that this species can multiply rapidly, build up a chain colony and it has got the advantage of using environmental conditions. Diatom species are dominant at July, August, September, and dinoflagellate species are dominant at May, June and November (Table 2).

Table 1. The distribution of phytoplankton species at the stations.

Bacillariophyceae (Diatomea)	1	2	3	4	5
Biddulphia alternans (Bailey) Van Heurck	*	*			
Chaetoceros criophilus Castracane		*		*	
Coscinodiscus sp.	*	*	*	*	*
Ditylum brightwellii (T. West) Grunow *in* Van Heurck	*	*			
Fragilariopsis cylindrus (Grunow) Krieger in Helmcke & Krieger	*	*			
Leptocylindrus minimus Gran	*	*	*	*	*
Melosira sp.	*	*			
Navicula granii (Jorgensen) Gran 1908	*	*		*	
Pseudo-nitzschia delicatissima (P. T. Cleve) Heiden	*	*	*	*	
Pseudo-nitzschia seriata (Cleve) H. Peragallo	*				
Pseudosolenia calcar-avis (Schultze) Sundröm	*	*	*	*	
Rhizosolenia hebetata f. hebetata Bailey	*	*	*	*	*
Rhizosolenia setigera Brightwell			*		*
Rhizosolenia styliformis Brightwell	*	*			
Thalassiosira sp.	*	*	*	*	*
Thalassionema nitzschioides (Grunow) Mereschkowsky	*	*	*		
Total Diatomea	14	14	8	8	5
Dinophyceae (Dinoflagellata)					
Ceratium arietinum Cleve	*	*	*		
Ceratium furca (Ehrenberg) Claparede &Lachmann	*	*	*	*	
Ceratium fusus (Ehrenberg) Dujardin	*	*	*	*	
Ceratium tripos (O.F. Müller) Nitzsch	*	*	*	*	*
Dinophysis acuminata Claparede et Lachmann	*			*	
Dinophysis caudata Saville-Kent	*	*	*	*	*
Noctiluca scintillans (Macartney) Kofoid	*	*	*	*	
Protoperidinium granii (Ostenfeld *in* Paulsen) Balech	*	*	*		*
Total Dinoflagellate	8	7	7	6	3
Total Phytoplankton	22	21	14	14	8

It attracts attention that at the entrance of the Golden Horn (Station 1 and 2) phytoplankton cell number is higher than the inner parts. This displays that environmental conditions in the entrance of the Golden Horn (Stations 1 and 2), flourish phytoplankton growth with higher interaction with Bosphorus and better water quality. Leptocylindrus minimus, a diatom, is measured being dominant with %95 ratio in July phytoplankton bloom (Table 2). It attracts attention that from the 2nd station to the inner parts, species diversity and cell number decreases sharply that is parallel to pollution increase. Noctulica scintillans, a dinoflagellate, is found being dominant at the 2nd station at November.

In this study, diatom concentration is generally measured lower than 103 cells/L except some periods at the Golden Horn. Coscinodiscus sp. and Thalassiosira sp. are measured with the most at the months having so lower phytoplankton concentration. At the July phytoplankton

bloom, diatom species are measured with the highest concentration level (146 x 103 cells/L) at station 3. Dinoflagellate concentration stays at low . level the whole of the year. Dinoflagellate concentration reaches the highest level (approximately 1679 cells/L) at November at Station 2. It is shown that Noctulica scintillans is dominant at that period (Table 2).

Conclusion

This study is proceeded when the pollution level of the Golden Horn was maximum; especially sediment of the inner parts spreads toxic gases that cause odor. Phytoplankton can be used an indicator of pollution for aquatic environments and this study deal with the distribution of the phytoplankton qualitatively and quantitatively at the period of January-December 1995 at the Golden Horn. There are some hydrographic studies in the past but studies about phytoplankton are very rare at the Golden Horn. At that point of view, the importance of this study can be understood clearly.

Table 2. The values of phytoplankton abundance, dominance and diversity index.

Stations	Month (1995)	Abundance (cells/L)	Dominant Species	DominanceRatio (%)	Diversity Index (H')
1	Jan.	280	*Thalassiosira* sp.	57	1.154
	Mar.	312	*Coscinodiscus* sp.	85	0.536
	Apr.	518	*Ceratium fusus*	36	1.730
	May	363	*Noctulica scintillans*	79	0.846
	June	925	*Dinophysis caudata*	18	2.070
	July	36686	*Leptocylindrus minimus*	88	0.557
	Aug.	2210	*Leptocylindrus minimus*	37	1.752
	Sept.	527	*Rhizosolenia hebetata*	55	1.470
	Oct.	430	*Protoperidinium granii*	33	1.594
	Nov.	1672	*Thalassionema nitzschioides*	28	2.028
	Dec.	2289	*Thalassiosira* sp.	52	1.271
2	Jan.	50	*Ceratium furca*	100	0
	Mar.	192	*Coscinodiscus* sp.	100	0
	Apr.	369	*Ceratium tripos*, *Coscinodiscus* sp.	90	0.965
	May	289	*Noctulica scintillans*	76	1.094
	June	759	*Noctulica scintillans*	33	1.810
	July	80997	*Leptocylindrus minimus*	95	0.244
	Aug.	1188	*Coscinodiscus* sp.	53	1.472
	Sept.	119	*Rhizosolenia hebetata*	100	0
	Oct.	400	*Protoperidinium granii*	40	1.679
	Nov.	1679	*Noctulica scintillans*	93	0
	Dec.	640	*Thalassionema nitzschioides*	50	1.343
3	Jan.	0		0	0
	Mar.	0		0	0
	Apr.	0		0	0
	May	153	*Noctulica scintillans*	100	0

	June	76	*Protoperidinium* sp.	50	1.040
	July	146002	*Leptocylindrus minimus*	95	0.243
	Aug.	1100	*Coscinodiscus* sp.	64	0.988
	Sept.	39	*Rhizosolenia hebetata*	100	0
	Oct.	40	*Rhizosolenia calcar-avis*	100	0
	Nov.	95	*Noctulica scintillans*	54	1.171
	Dec.	231	*Thalassionema nitzschioides*	100	0
4	Jan.	648	*Thalassiosira* sp.	58	0.960
	Mar.	190	*Coscinodiscus* sp.	80	0.500
	Apr.	0		0	0
	May	0		0	0
	June	40		100	0.693
	July	94590	*Leptocylindrus minimus*	95	0.250
	Aug.	259	*Coscinodiscus* sp.	64	0.989
	Sept.	31	*Rhizosolenia hebetata*	100	0
	Oct.	80		25	1.386
	Nov.	80	*Noctulica scintillans*	50	1.040
	Dec.	171	*Thalassiosira* sp.	100	0
5	Jan.	212	*Thalassiosira* sp.	78	0.562
	Mar.	35	*Protoperidinium granii*	100	0
	Apr.	60	*Rhizosolenia hebetata, Ceratium tripos*	100	0.693
	May	0		0	0
	June	18	*Ceratium tripos*	100	0
	July	3552	*Leptocylindrus minimus*	97	0.159
	Aug.	50	*Coscinodiscus* sp.	65	0.641
	Sept.	34	*Rhizosolenia hebetata*	66	0.693
	Oct.	40	*Dinophysis caudata, P. granii*	100	0.693
	Dec	0		0	0

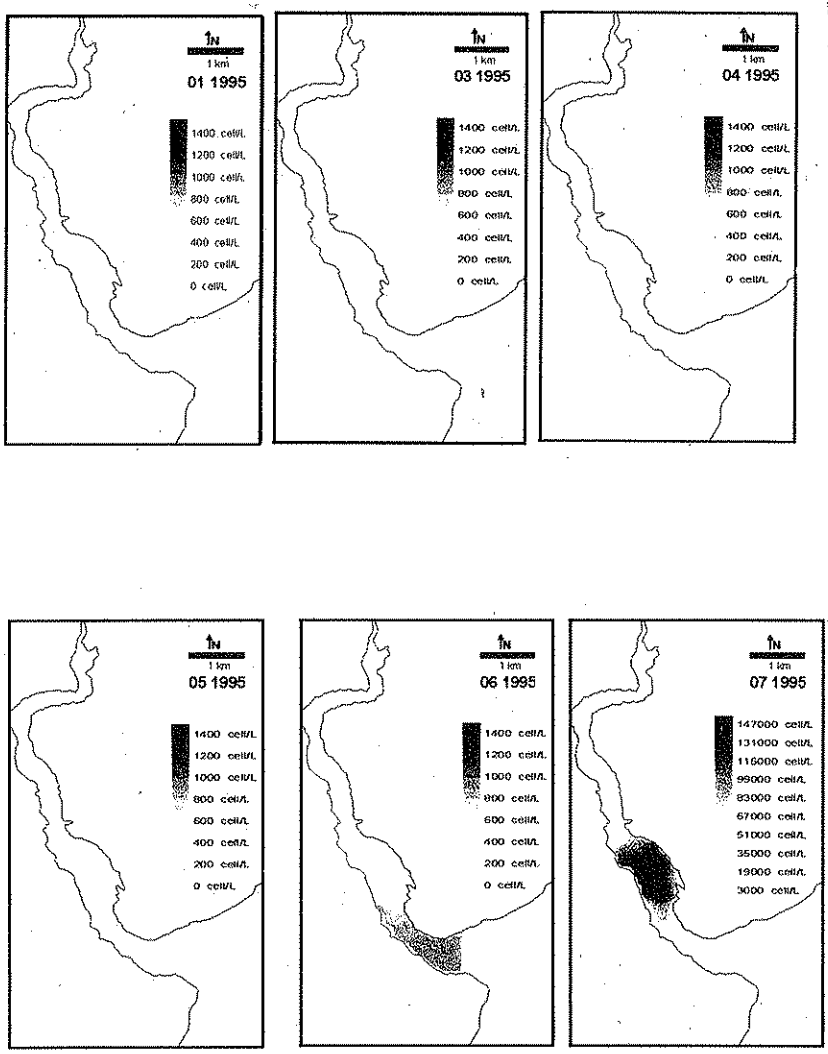

Figure 2. The distribution of phytoplankton community at the surface water of the Golden Horn versus time.

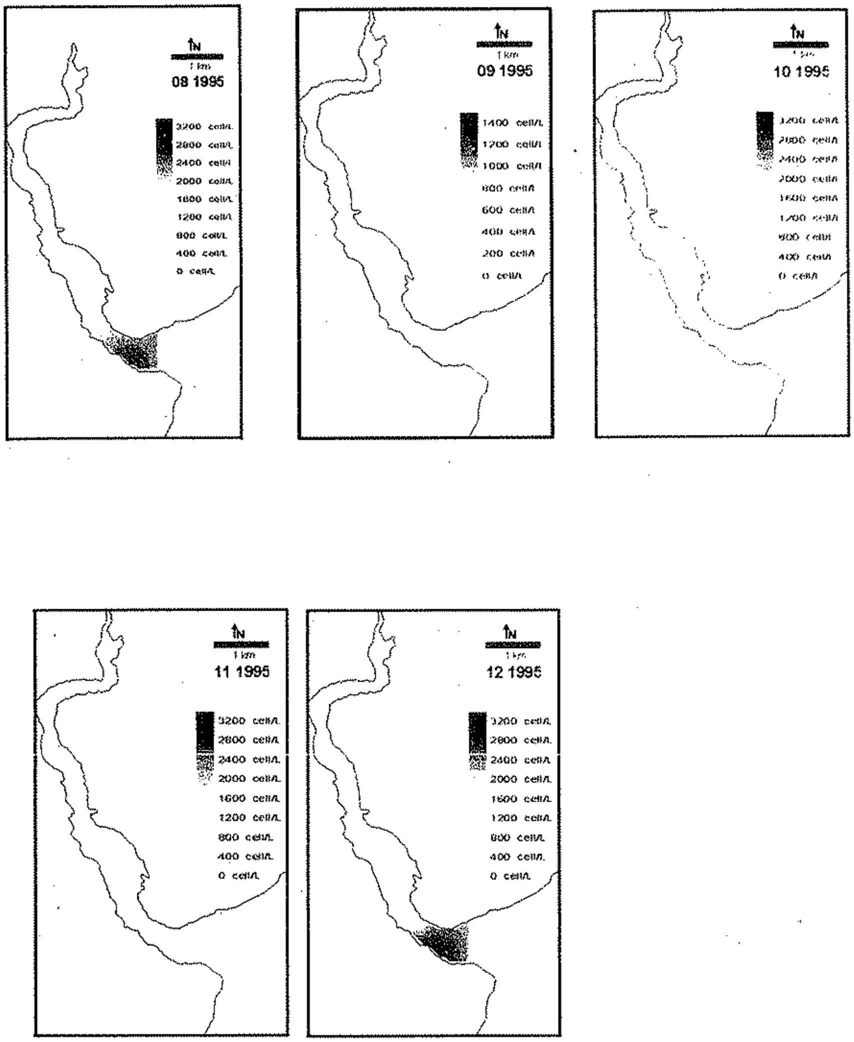

Figure 2. The distribution of phytoplankton community at the surfaçe water of the Golden Horn versus time.

Distribution of phytoplankton at the Golden Horn was studied by Uysal (1987) in the past. In that study, water samples were collected from 10, 20 and 30 meters depth bi-monthly between 1985 and 1987. Sampling started from 10 meters depth because of the intensity of suspended solid mater and pollution at the surface water. In the whole study period, it is found that centric diatoms were dominant with approximately %74 ratios on diatom species. At the January 1986 phytoplankton bloom, Nitzschia delicatissima, Chaetoceros decipiens, Rhizosolenia setigera and Nitzschia longissima species took an important function. Rhizosolenia setigera and Nitzschia delicatissima species were found continuously. The most found dinoflagellate species belonged to Ceratium (Uysal, 1987).

In this study carried out in 1995, qualitative distribution of phytoplankton is examined and similar to quantitative data, species diversity decreases to the inner parts of the Golden Horn. This decrease shows a parallel behavior to the increase of pollution to the inner part. In the whole study period, totally 22 phytoplankton species are found at station 1, but at the station 5 only 8 species identified (Table 1). According to the counting results, centric diatoms are dominant on pennate species with %75 ratio. At that point of view, the study of 1995 has similar results to previous study carried out by Uysal (1987). There is also a similarity on the frequently found species. However this study consists of only heavily polluted surface water samples and that is why the cell number of phytoplankton is lover than previous study.

At the Golden Horn surface water, the quantity of phytoplankton decreases with the pollution along the inner sides vice versa. The surface water circulation at the entrance of the Golden Horn (Station H1) increases the interaction with the Bosphorus water. This situation causes an increase at light penetration through water at the entrance of the Golden Horn, which flourishes phytoplanktonic activity. It attracts attention that the July phytoplankton bloom intensifies in the middle parts of the Golden Horn (Station 3). This situation indicates that water mass of the middle part, which has relatively low surface water circulation because of the Unkapanı Bridge's pontoon system, has suitable conditions for accumulation of phytoplankton (Figure 2).

According to these results, the inner parts of the Golden Horn had shallow water depths, sometimes less than 1 m, and insufficient surface water circulation in 1995. In the Golden Horn having intensive suspended solid mater, toxic gases and aquatic environment with anoxic conditions, phytoplankton growing is limited. This environment having lack of the primary production and disturbed ecological equilibrium affects biological life negatively. Thus; the Golden Horn has serious ecological problems and this study plays an important role on the rehabilitation study.

Özet

Bu çalışmada, Haliç'teki kirliliğin fitoplanktonla olan ilişkilerini tespit etmek amacıyla, Ocak-Aralık 1995 döneminde yüzey suyundan alınan su örneklerindeki fitoplankton kalitatif ve kantitatif olarak incelenmiştir. Çalışma dönemi boyunca 16 diyatom ve 8 dinoflagellat olmak üzere toplan 24 fitoplankton türü saptandı. Haliç girişinde (İst.1) yıl boyunca toplam 22 türe rastlanırken, iç kesimlerde (İst.5) sadece 8 tür saptanmıştır. Kantitatif açıdan oldukça düşük değerlerde (ort. 2 x 103 hücre/L) bulunan fitoplankton Temmuz ayında en yüksek yoğunluğa (146 x 106 hücre/L) ulaşmıştır. Bu çoğalmada sentrik diyatomlardan Leptocylindrus minimus türü %95 oranında baskın çıkmıştır. Bir dinoflagellat türü olan Noctulica scintillans'ın %93 oranında baskın olduğu Kasım ayında dinoflagellat grubu en yüksek yoğunluğa (1679 hücre/L) ulaşmıştır. Bu çalışmanın sonuçlarına göre 1995 yılında Haliç yüzey suyundaki fitoplankton kommunitesi, tür ve birey sayısı yönünden oldukça fakir bir yapı sergilemektedir. Yine aynı dönemde Haliç'in girişinden iç kesimlere doğru gidildikçe kirlilik artışına paralel olarak fitoplankton tür ve birey sayısının azaldığı ifade edilmektedir.

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