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DISTRIBUTION OF PHYTOPLANKTON INFRONT OF ROSETTA NILE BRANCH (EGYPT)

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ABSTRACT

Quantitative and qualitative estimations of the phytoplankton community infront of Rosetta Nile Branch (Egypt) have been carried out for four seasons. The release of fresh water in the winter increased the numbers of phytoplankton to an average of 94990 cell/l. The summer sustained the lowest standing crop (265 cell/l), due to the development of thermal stratification and nutrient depletion from the photic zone. The community was composed mainly of diatoms which constituted numerically about 99.7% of the total population. Among the diatoms recorded, only 8 species appeared as dominant forms. The estimated diversity was reversely related to the degree of daminance of certain species rather than to the number of the total species contributing the standing crop. The average annual value of the phytoplankton standing crop along the Rosetta section amounted to 27054 cell/l. This relatively high value was due to the freash water discharged into the area.

INTRODUCTION

As a result of the Nile flood regulation after the construction of the High Dam in 1966, most of the flood water is retained behind the Dam. The amount of the fresh water discharged into the sea through Edfina Barrage is nowadays comparatively small and is confined to short peridos, mainly between December and February Just to keep the water in the Rosetta at a more or less constant level not exceeding 2.9 m above mean sea level. In addition, continuous infiltration of fresh water takes place through the gates of barrage in an estimated rate of about half a million cubic meter per day. The total amount of Nile water flowing into the sea varies greatly from one year to the other, with an average of about 4×10^9 cubic meter per day. It increased during 1977, which represents the period of the present investigation to 7.5×10^9 cubic meter. Such discharged water is mostly silt free.

Several investigations have been done before and after the construction of the High Dam to follow up the biological and nonbiological changes that might occur along the continental shelf of the Egyptian Mediterranean Coast. Thus Halim (1960) estimated the effect of the Nile flood on the fertiltiy of Mediterranean waters infront of Damietta mouth. The cruise

of Ichthyolog in October, 1964 surveyed the hydrographyic conditions as well as the distribution of phytoplankton and zooplankton (Halim et al 1967). A second survey was peraormed in the same area covering the four seasons of 1966. It comprised the physical and chemical conditions (Rzhonsintsky, 1970 and Ledovesky, 1970), phytoplankton (Savich, 1970) and zooplankton (Drobisheva, 1970). Dowidar (1965) studied the standing crop and community composition of plankton around Alexandria. In 1977 the Instutite of Oceanography and Fisheries carried out a research project for investigating the Fisheries of Sardine and other pelagic fishes along the Mediterranean Coast from Rosetta to El-Sallum between longitudes 27° and 31° E. The present work is part of this project dealing with the distribution of phytoplankton at Rashid section lying infront of Rosetta Nile Branch.

MATERIAL AND METHODS

Four stations extending perpendicular to the shore line infront of Rosetta Nile Branch were selected as sampling stations (Fig. 1). They were located at a distance of about 8, 14, 24 and 35 km away from the coast. The first two stations I and II are considered as inshore stations with average depths of 12 and 24 meter respectively. Stations III and IV are regarded as offshore ones with average depths of about 55 and 100 meter. Sampling of phytoplankton was performed by collecting one liter of sea water from

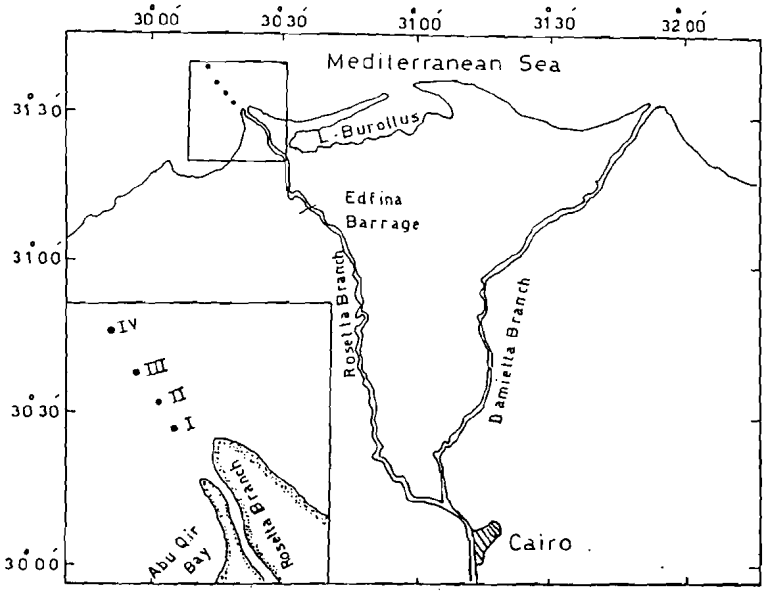

Fig. (1)
Position of stations.

the standard depths (surface, 10, 20, 50 and 100 meters), depending on the water depth at each station, by means of Nansen Reversing bottle and then preseved with neutral formaline solution. In the laboratory the samples were allowed to sediment for 48 hours in graduated cylinders. The supernatant water was then siphoned slowly until the volume of water containing the plankton sediments is reduced to 50 ccs. Subsamples of 2 ccs were examined and the different phytoplankton species were counted under a research binoucular microscope. The phytoplankton standing crop was then calculated as their total number per liter, Vertical hauls of phytoplankton were also taken by a fine net number 25 (pore size 50 μ) and these were examined in order to estimate the rare plankters that may escape from sedimentation techinque.

The diversity index was calculated according to the equation of Shannon and Weaver (1963).

$$H = -\sum P_i \log P_i$$

Where $P_i = n/N$ is the proportion of the i th. (n_i) species to the total number of phytoplankton (N).

THE PHYTOPLANKTON COMMUNITY

The phytoplankton community infront of Rosetta Branch comprised 105 species. Diatoms contributed numerically about 99.7% of the total population (average 26, 968 cell/1) and they comprised 75 species. However, about 8 diatom species appeared as dominant while the rest were infrequently or scarcely recorded.

Dinoflagellates included 21 species, within 7 genera, they constituted collectively 0.12% of the total phytoplankton with an average of 33 cell/l. They appeared as scattered cells all the year round but were more frequent in the summer.

Members of cyanophytes, chlorophytes and sillicoflagellates were also scarcely observed. They comprised collectively about 0.18% of the total phytoplankton (average 53 cell/l). Table 1 represents the distribution of the more frequent diatoms and their percentage frequency of the total phytoplankton.

DISTRIBUTION AND DIVERSITY OF PHYTOPLANKTON

a. Winter Season (January):

The winter was characterized by vertical mixing of water produced by winter convection. The coastal stations, however, showed partial stratification due to the relatively large amount of fresh water discharged from Rosetta Branch (2.1×10^9 m^3). Thus the surface water temperature in this region reached 15.5°C and salinity 35.49‰ while these values increased to 16.9°C and 38.68‰ at 10 meters depth. The water salinity

TABLE 1

Distribution of the more frequent diatoms in cell/l and their percentage frequency to the total phytoplankton during the different seasons.

	Species	Season				
		Winter	Spring	Summer	Autumn	% to total phytoplankton
1	Chaetoceros affinis var. Willei (Cran.) . Hustedt.	535	560	--	181	1.18%
2	Chaetoceros curvisetus Cleve	69	16	--	42	0.12
3	Chaetoceros decipiens Cleve	51	385	--	57	0.46
4	Chaetoceros didmum Ehr.	--	86	--	17	0.095
5	Cyclotella kutzingiana Thwaites	65212	144	3	34	60.43
6	Cyclotella meneghiniana Kutz	293	127	20	5	0.41
7	Hemiaulus spp.	26	7	20	51	0.10
8	Leptocylindrus danicus Cleve	--	28	--	91	0.11
9	Lithodesmus undulatum Ehr.	172	53	--	--	0.21
10	Melosira crucipunctata Bachn	2073	--	65	32	2.00
11	Melosira granulata angustissima Muller	1720	--	52	7	15.95
12	Rhizosolinea spp.	161	20	28	97	0.28
13	Skeletonema costatum (Greve)	2691	9592	1	97	11.44
14	Asterionella Japonica Cleve	132	--	--	617	0.69
15	Navicula crucifere Grunow	128	9	1	--	0.13
16	Nitzchia spp.	568	36	7	7	0.56
17	Pleurosigma decorum.	85	--	8	83	0.16
18	Striatella delicatula (Kutz)	8	--	--	48	0.05
19	Synedra spp.	660	--	6	2	0.62
20	Thalassionema nitzchoides Grunow.	9	48	--	42	0.09
21	Thalassiothrix frauenfeldii (Grum) Cleve	4378	86	7	8	4.14

increased also gradually away from the shore to reach an average of 38.8 ‰ at station IV. Consequently, the highest density of phytoplankton was observed at the inshores as affected by the inflow of the Nile water, attaining respectivily 293.006 and 63.378 cell/l. for station I and II. This was associated by the increased numbers of **Cyclotella kutzingiana, Melosira granulata, M. crucipunctata** and **Skeletonema costatum.** The density of phytoplankton decreased gradually towards the open sea to 21022 cell/l at station III and 2553 cell/l at station IV. The surface coastal water rich in phytoplankton occupied the upper 20 meter layer, whereas an open sea flow with lower density of phytoplankton appeared as a subsurface layer below 25 meter depth and extended over the continental slope till station III as shown in figure (2).

The number of species recorded in January reached 65. The average diversity amounted to 0.52 at both stations II and III, and 0.46, 0.48 for stations I and IV respectively. Such low diversity index was associated with the dominance of **Cyclotella kutzingiana** which represented numerically about 73 % , 77 % and 72 % of the total phytoplankton at station II, III and IV rospectively. The relatively lower diversity recorded at station I was associated with the increased numbers of both **Cyclotella kutzingiana** (67 %) and **Thalassiothrix frauenfeldii** (21 %).

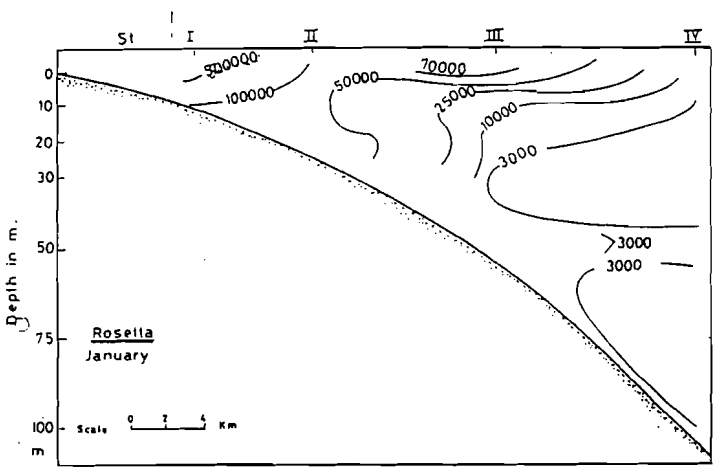

Fig. (2)
Vertical distribution of the total phytoplankton (cell/l) at Rosetta section during the winter.

b. Spring Season (May):

The surface water temperature increased in the spring by about 5°C. A weak thermal stratification started to develop showing a gradual vertical gradient of water temperature in the upper 25 meters, followed by a homothermal water layer which persisted till the bottom. Parallel to this, the numbers of phytoplankton decreased but still showing relatively high values in the surface water of station I due to the flourishing of **Skeletonema costatum** (Figure 3). The average standing crop at the inshore station I reached 39,589 cell/l. This value decreased rapidly away from the shore to 3,330; 1,918; 322 cell/l at station II, III and IV respectively. A relatively high density of phytoplankton was noticed near to the bottom between station II and III, and this was attributed to **Chaetoceros affinis** and **Ch. decipiens.** The drop of phytoplankton standing crop in the spring was also accompanied with a reduction in the number of species to 42 and a slight increase in diversity for stations II, III and IV to an average of 0.60 . On the other hand, the diversity at station I dropped to a minimum value of 0.1 . This was associated with the dominance of **Skeletonema costatum** which represented 97% of the total standing crop.

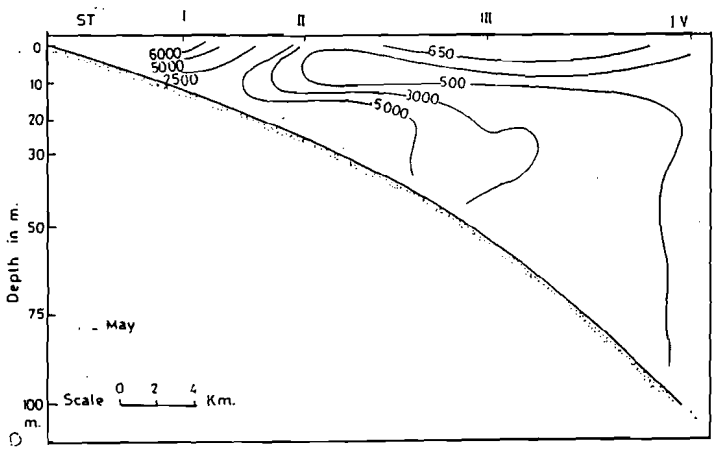

Fig. (3)
Vertical distribution of the total phytoplankton (cell/l) at Rosetta section during the spring.

c. Summer Season (July) :

The surface water temperature increased in the summer to an average of about 26°C. Consequently, a strong thermocline developed, which occupied a layer between 50 and 80 meters below the surface. As a result of water stratification and expected nutrient depletion from the photic zone, the standing crop of phytoplankton remained low at all depths and fluctuated between 80 and 500 cell/l. Their number tended to decrease gradually with both increasing depth and away from the shore (figure 4). The reduction of phytoplankton counts in the summer was accompanied by an increased diversity index at the inshore stations to 0.87. This value decreased to 0.7 and 0.61 at station III and IV respectively, while the community composition remained nearly the same (43 species). Such increased diversity reflects the absence of any distinct dominance for a particular species.

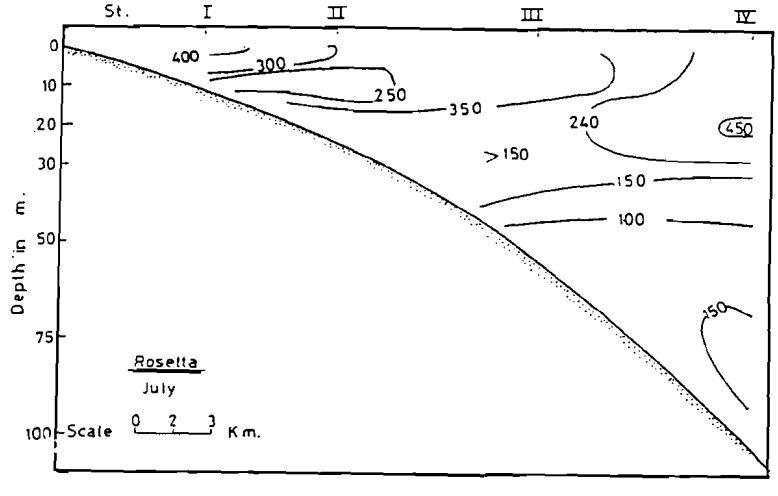

Fig. (4)
Vertical distribution of the total phytoplankton (cell/l)
at Rosetta section during the summer.

d. Autumn Season (November):

The water temperature in the upper layer decreased in November by about 3°C, the thermocline deepened to occupy a depth between 50 and 100 meter below the surface. The counts of phytoplankton remained low at both the inshore and off-shore stations, but showing a pronounced increase when compared with the summer records. Thus, the average counts for the successive stations I-IV were 1,652; 3,208; 1,550; 269 cell/l, respectively. The highest frequency of 5,625 cell/l was noticed at 20 meter depth of stn. II adjacent to the bottom of the continental slope (Figure 5). Such increase was traced for about 6.5 km away from the shore as a subsurface layer between 10 and 40 meter. The lowest densities appeared at all depths of the offshore station IV.

Further increase in the diversity index to values ranging between 0.69 (stn. IV) and 1.01 (stn. I) were recorded during the autumn. This was accompanied by increased numbers of the phytoplankton components to 58 species.

The more frequent diatoms comprised **Chaetoceros decipiens, Ch. affinis, Pleurosigma decorm, Skeletonema costatum** and **Leptocylindrus danicus.**

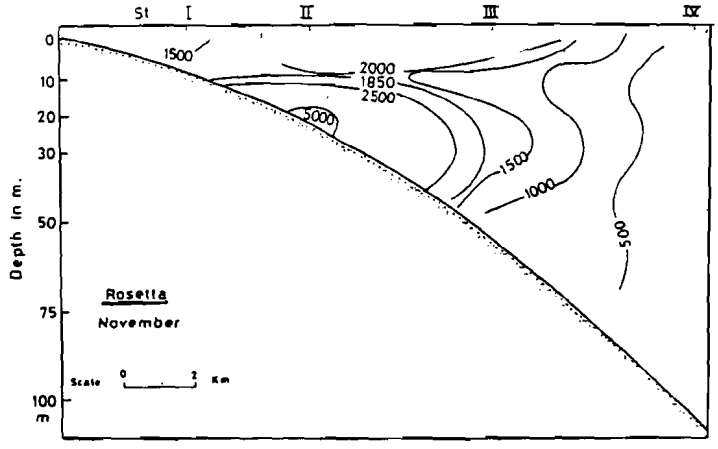

Fig. (5)
Vertical distribution of the total phytoplankton (cell/l) at Rosetta section during the autumn.

DISCUSSION

The phytoplankton community infront of Rosetta Branch was characterized by the presence of a large number of species although few of them were responsible for the bulk of the population. Diatoms contributed numerically about 99.7% of the total community with an annual average of 26,968 cell/l. Such percentage is much higher than the records of the other Mediterranean localities which amounted to 37% in the Bay of Baka (Dobrosavlyevic, 1971), 70.7% in Kastela Bay near Split (Pucher-Petkovic and Marasevic, 1979) and 75% in Lebanese Coastal waters (Lakkis and Novel-Lakkis, 1971).

The majority of diatoms recorded in the present investigation are cosmopolitan and belong to the neritic warm zones. Most of them are littoral while about 20 species are pelagic, being mostly infrequent or rare. The distribution of the dominant diatoms was confined to the winter and to a much less extent in the spring. The summer sustained the lowest standing crop with no piculiar dominant species.

Cyclotella kutzingiana (Thwaites) represented the main component of phytoplankton (60% of the total community), with an average annual of 16,350 cell/l for the whole sector. Its distribution was confined to the winter, particularly in the upper 20 m layer of the inshore stations which were affected by the outflow of fresh water from Rosetta Branch. Their values within this layer amounted to 196,410 and 46,403 cell/l at stations I and II respectively. The species is considered as a netritic tropical and subtropical diatom.

Melosira granulata var. angustissima Mull and **M. crucipunctata** Bachm, contributed respectively 15.95% and 2.0% of the total phytoplankton (annual averages 4,316 and 542 cell/l). They appeared mainly in the winter with a density of 17,204 and 2,073 cell/l. These two species are charactaristic plankters of the Nile water and this may explain their dominance at the inshore stations coinciding with the introduction of the Nile water. The two species are considered as indifferent forms (Foged, 1948), previously recorded along the Egyptian Mediterranean coast during the flood season (Dowidar, 1965).

Thalassiothrix frauenfeldii (Grun) Cleve contributed about 4.14% of the total phytoplankton with an annual average of 1,120 cell/l. Its distribution was also confined to the winter. The species is a cosmopolitan oceanic form, favouring temperate water (Sournia, 1968). It is widely distributed in the Mediterranean (Tregouboff and Rose, 1957).

Skeletonema costatum (Grev.) Cleve represented about 11.44% of the total community (annual average, 3,095 cell/l). It appeared as the most dominant diatom in the spring with an average of 9,592 cell/l, while it ranked as third in winter (average 2,691 cell/l). The species is regarded as a cosmopolitan neretic and meroplanktonic diatom (Cupp, 1943). It

is widely distributed in the Mediterranean all the year round, attaining its maximum frequency in spring (Pavillard, 1925 and Wawsik, 1961). It is also widespread in the Egyptian Mediterranean waters (Dowidar, 1965).

The diatoms **Chaetoceros affinis** var. willei (Gran) Hustedt. and **Ch. decipiens** Celve, inspite of being recorded in low counts yet, they shared by a good fraction in the spring population. **Ch. affinis** is a cosmopolitan neretic, temperate species (Cupp, 1943), widespread in the Mediterranean (Pavillard, 1925, 1937), previously recorded in cosiderable numbers along the Egyptian Mediterranean Coast (El-Maghraby and Halim, 1965).

Ch. decipiens is an oceanic, arctic and boreal species, often found near shore and is widespread in the Mediterranean. Its absence from the summer collection in the present investigation confirms its tendency for cold water.

Comparing the winter peak recorded for Rashid sector during the present investigation (94, 990 cell/l) with the other Mediterranean localities, it appears to be higher than the maximum density in Ville Franche (16,800 cell/l) as given by Minas et al (1968). On the other hand, it was comparable with that of Lebanese Coastal water (100,000 cell/l) as shown by Lakkis & Novel Lakkis (1979) and to the observations of Bernard (1958) at Monaco (109,000 cell/l) but much lower than the following records : 200,000 cell/l at Gulf of Naples (Carroda et al, 1979); 759,000 cell/l at Algeria (Bernard, 1958); 461,000 cell/l around Crete (Bernard, 1958); 463,000 cell/l at Split (Ercegevic, 1936) and 36,7 X 10^6 cell/l at Karry La Rout (Ki-Taikim, 1980).

The numbers of phytoplankton decreased rapidly throughout spring to reach its minimum value of 265 cell/l in summer. This is attributed to the development of thermocline in summer season and the expected nutrient depletion in the photic zone.

The average annual value of the standing crop of phytoplankton at the Rosetta section amounted to 27,054 cell/l. This value lies among the more productive regions of the Egyptian Mediterranean Coasts which are constantly subjected to inland discharge such as El-Mex (average 38,530 cell/l) and Abu Qir Bay (10,950 cell/l) as estimated by Samaan (1983). However, it is less than the records of the other Mediterranean localities. Thus the average numbers of phytoplankton reached 35,000 cell/ in the Gulf of Marseille (Travers, 1975) 409,730 cell/l in kastella near Split (pucherPetkvic and Marasovic, 1979) and 322,000 cell/l in the North west Mediterranean (Ki-Tackim, 1980).

Results of the present investigation indicate that the magnitude of the standing crop of phytoplankton at the inshore stations of of Rosetta section is controlled by the amount of fresh water discharged from Rosetta Branch. The main components of the community consisted of marine or brakish water forms which can tolerate a wide range of salinity. The density of phytoplankton at the offshore regions were more or less similar to the records of the other offshore sectors. The phytoplankton blooms,

previously recorded at the mouthes of Damitta and Rosetta Branches during the flood season which reached an average of 2,400,000 cell/l (Halim, 1960) at the former branch is not recognized nowadays.

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