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PHYTOPLAN COMMUNITY STRUCTURE IN Mex Bay, Alexandria, Egypt.

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ABSTRACT

Phytoplankton standing crop and diversity cycle in both Umum Drain and Mex Bay were studied and discussed in relation to the most effective environmental physico-chemical parameters. The bay is affected by huge amounts of brackish waste water discharged from Umum Drain rich in nutrient salts which create dense algal growth. A total number of 162 phytoplankton taxa were recorded and characterised by different ecological affinities. Few species were responsible of the main bulk of the community, namely; *Cyclotella meneghiniana, Nitzschia microcephala, Euglene caudate* and *Kirchneriella lunaris* in Umum Drain and *Skeletonema costatum, Cyclotella meneghiniana, Asterionella japonica* and *Prorocentrum micans* in Mex Bay.

The phytoplankton standing crop attained an average of 0.71 X 10^6 and 0.94 X 10^6 units. l^{-1}at the surface water of Umum Drain and Mex Bay respectively. The species diversity in Mex Bay showed irregular pattern ranging from 0.85 to 2.85 nats in the surface and from 0.68 to 3.10 nats in the near bottom layer.

The effect of the most ecological parameters on the standing crop and diversity index were stablished and discussed according to the regression models.

INTRODUCTION

Mex Bay is one of the main fishing grounds in the west of Alexandria. It extends parallel to the coast line for about 7Km, between El-Agamy head land and the western Harbour at longitude 29°50' E and latitude 31°10' N. It has averages: width 3Km, and total area about
20 Km^2. The depth of water in the bay fluctuates between 1.5 and 15 metres. The bay receives a heavy load of waste water from industrial outfalls and also from Lake Maryut via Umum Drain (6-11.8 X 10^6 m^3/day) (Said *et al*, 1991) through Mex pumping station. Umum canal drain is 45.8 Km long with a bottom width of 20m. and an average depth of 3-4 m.

The configuration of the bay, its major hydrography and chemical character have been studied by several authors; El-Wakeel and El-Sayed (1978); Mahmoud (1979 & 1985); Aboul-Dahab and Halim (1986 & 1988 a, 1988b) and El-Sarraf (1991). The distribution and ecology of the phytoplankton was studied by Dorgham *et al* (1987); El-Sherif (1989) and Samaan *et al* (1992), and the plankton of Umum Drain was studied also by Guerguess (1988). The characteristics of the water, phytoplankton and zooplankton population were also studied by Soliman and Gharib (1998).

The aim of the work is to study the spatial and temporal variations in the species composition of phytoplankton and the species diversity in order to evaluate the productivity of the bay water.

MATERIAL AND METHODS

Throughout the period from February to December, 1995, six trips were carried out in both Umum Drain and Mex Bay to collect phytoplankton samples from eight hydrographic stations (Fig.1). Sampling was made at surface water and near bottom layer using Ruttener sampler with a capacity of two litres.

The environmental conditions are studied by Soliman and Gharib (1998). Estimation of the phytoplankton standing crop was carried out by sedimentation method, counted and expressed as unit per litre. The following taxonomic references and publications were used for checking the species and for identification: Heurck (1896); Peragallo & Peragallo (1897-1908), Hustedt (1930); El-Nayal (1935 & 1936); Bachmann (1936); Allen (1937) Huber-pestalozzi (1938), Cupp (1943); Khunnah (1967), Diversity index was estimated according to Shannon Weaver (1963) as follows:

$$H_n^{i=1} = - S\, P_i \ln P_i$$

Where Pi= n /N is the proportion of the i^{th} (n_i) species to the total number of phytoplankton (N). Diversity index was expressed as nats.

The cluster analysis of Cormack (1971) is used to distinguish the groups of stations which behaved similarity on basis of the environmental conditions and abundance of phytoplankton groups. Correlation coefficient between biological (phytoplankton standing crop and diversity index) and physicochemical parameters were done of surface and near bottom layers (n = 48). Multiple regression equation at the confidence limit 95% (P = 0.05) were calculated at the two layers to quantify the standing crop and diversity index in relation to the most correlative environmental factors. The stepwise analysis was performed using Number Cruncher Statistical System (NCSS) proposed by Hintze (1993) using a computer.

RESULTS AND DISCUSSION

Phytoplankton Standing Crop

I- Species composition

A total of 162 species, comprising 85 Bacillariophyceae, 31 chlorophyceae, 8 Euglenophyceae, 21 Cyanophyceae and 17 Dinophyceae, were collected from both Umum Drain and Mex Bay during the course of present study. Out of these, 4 and 60 species were specific to Umum Drain and Mex Bay, respectively, where as 98 species (48 diatoms, 25 Chlorophyceae, 15 Cyanophyceae, 6 Euglenophyceae and 4 Dinophyceae) were common to both Umum Drain and Mex Bay. Few of them were perennial and the most were seasonal.

Diatoms contributed 50 and 83 species, Chlorophyceae 25 and 30 species, Cyanophyceae 16 and 20 species, Euglenophyceae 6 and 8 species and Dinophyceae 3 and 17 species, respectively, to a total species content of 100 in Umum Drain and 158 in Mex Bay. The fresh water forms distributed allover the bay and can be considered as "Hydrological indicators".

The number of species of the phytoplankton groups in Mex Bay in the different periods was summarized in Table (1); showed a gradual decrease, due to the increased amount of out falls discharged.

Tabel (2) it is obvious that, diatoms were more diversified in water salinity 30-38.5, while Dinophyceae were diversified in water salinity 20-30. Also. the diversity of Chlorophyceae, Cyanophyceae and Euglenophyceae in water salinity less than 10 may be attributed to the allochthonous fresh water forms.

II- Spatial and bimonthly variations of the total phytoplankton and stations similarity

(Fig. 2,3 and 4)

1- Umum Drain

Umum Drain represents the major source of waste water into the bay. It characterized by salinity < 10, and a steady increase in the concentration of oxidizable organic matter (O.O.M) and ammonia (Mahomoud, 1985, Anon, 1989, Soliman and Gharib (1998). The community comprised mainly of brackish and fresh water forms transferred from Lake Maryout. The total average numbers standing crop wre 0.71 X 10^6 and 0.87 X 10^6 units.l^{-1} in the surface and near bottom layers, respectively. These values were much higher than that recorded by Cuerguess (1988). Two peaks were recorded in the surface water; in February and June and other peaks were observed in the near bottom layer during February, April and June.

Bacillariophyceae were found to be the dominant group (average 0.46 X 10^6 units.l^{-1}) constituting from 13.4 to 89.5% to the total phytoplankton.

Allochthonous diatoms (fresh-water forms) constituted the main component. *Cyclotella meneghiniana* was the major dominant species (52.8% to the total diatoms), followed by *Nitzschia microcephala* (10.3%). The first species occurred throughout _the year, rising to two peaks in June and August and the second rising in June.

Euglenophyceae showed a very irregular production, constituting from 0.11 to 75.2% to the total algae with an average of 0.14×10^{6} $cell.l^{-1}$, mainly represented by *Euglene caudata* (88.4%). It appeared all the year round with a peak in February (67.8% to the total community). *Euglena acus* and *Phacus longicauda* showed different occurrence. Palmer (1969) noted that the genus *Euglena*, tops a list of sixty most tolerant genera to pollution. Munawar (1972) considered the genus as a biological indicator for organic pollution, high concentration of ammonia and organic matter, as agree with Nessim and Zaghloul (1991) and the present study.

Chlorophyceae constituted from 5.4 to 29.9% to the total phytoplankton, and represented mainly by *Kirchneriella lunaris* (18.2% to the total Chlorophyceae) and dominated in April. *Crucigenia quadrata* (12.2%) in December, *Scenedesmus quadricauda* (9.6%) in Sc. bijugatus (6.7%) in April and December.

Cyanophyceae never exceeded 8.7% to the total community. *Dactylococcopsis irregularis* was the most important, contributing 43.1% to the total cyanophytes with a high peak in April. *Spirulina platensis* (11.1%) restricted from June to October, *Oscillatoria limnetica* (13.0%) in February and December.

Dinoflagellates were observed in the near bottom layer during June and represented mainly by *Peridinium conicum.*

2- Mex Bay

Mex Bay showed a marked variability of phytoplankton standing crop in space andtime as well as in community structure. Generally, the high concentration of nutrients create dense algal growth in the surface water than in the near bottom layer, this phenomenon is well known for coastal water in various parts of the world (Vollenweider, 1981, Rao and Mohanchand, 1988, Zaghloul 1994 a,b and Zaghloul 1995). The increasing frequency of algal blooms is the best indication of eutrophication as mentioned by Cruzado (1988). Water column stability tended to increase in June and August which reflect as an important factor for phytoplankton growth as mentioned by Raymont (1980) and gree with the results of Zaghloul (1995) in the Eastern Harbour.

Mex Bay sustained high standing crop of phytoplankton with averages 0.94 X 10^6 and 0.48 X 10^6 units.1^{-1} in the surface and near bottom layers respectively. These values are much higher than that recorded by Samaan *et al* (1992) and El-Sherif (1989) and attributed to the increased drainage water which makes the bay as highly eutrophic region.

February

Water temperature reached 16°C, the diluted water mass was dominated and nutrient concentrations were high (Soliman and Gharib (1998). The phytoplankton counts showed a marked distinct between surface and near bottom layers with 93 species. Brackish and fresh-water forms were dominant in front of the drain. Euglenophyceae formed 46% to the surface community with 7 species and dominated by *Euglena caudata*. Diatoms formed 41.8% with 50 species and represented mainly by *Cyclotella meneghiniana, Skeletonema costatum* and *Asterionella japonica.* Chlorophyceae and Cyanophyceae formed respectively 6.3 and 5.5% to the surface community (16 and 12 species).

Stations 1 and 2 which were more affected by drainage water had the greatest similarity level of 96% due to their combination with the lowest salinity and highest concentrations of nutrient salts as well as similar phytoplankton counts. Station 3 affected also by the drainage water showed similar properties to the former stations with level of 92%.

April

Water temperature showed a slight increase accompanied by a rise in salinity. In consequence, the phytoplankton standing crop in the surface water showed its largest peak of the year, where the community included 97 species. Stations 4 and 6 were more fertile with density. The current extends westward along the coastline and transported the fertile water to the west (Gergis, 1979) as in station 4.

Diatoms were the main bulk of the community (85.7%) with 54 species. *Chaetoceros curvisetum* and *Skeletonema costatum* were the dominant forms. Chlorophyceae formed a high peak at station 2 in which *kirchneriella* spp., *Grucigenia quadrata and Scenedesmus dimorphus* formed the main bulk.

The dendrogram classification having a similarity level of 74% between stations 7 and 8 which were attained similar phytoplankton counts and a similarity of 67% between stations 4 and 5 in which salinity values and ammonia concentrations were nearly similar.

June

Water temperature increased remarkably with a distinct salinity stratification. A further progressive phytoplankton increase was observed in the near bottom layer. The community included 92 species and the bloom was seen to cover all the bay.

Diatoms (42 species) contributed 73.6% to the total community. As in April, *Skeletonema costatum* was leading. The species is indicator of eutrophication (Mihnea, 1985; Revellante and Gilmartin, 1985). Dinoflagellates comprised 14 species (19.5%) with apeak at station 5 mainly from Prorocentrum micans. The species is tolerance to domestic wastes (Zaghloul, 1994a). A good association was found between the occurrence of *S.costatum and Prorocentrum* spp. as mentioned by Iwasaki (1979).

In the linkage dendrogram, stations 1 and 4 were combined with similar phytoplankton counts and had a similarity level of 94%. Station 2 showed great similarity (84%) to the former stations due to its situation infront of the drain.

August

Water temperature raised up to 29.1°C associated with higher salinity (over 38.5) in the northeast of the bay. The phytoplankton standing crop (87 species) was high and outstanding peak was observed at station 8. Diatoms (42 species) contributed 86.1% to the total standing crop, represented mainly by *Cyclotella meneghiniana* and *Nitzschia longissima*. Dinoflagellates (9 species) contributing 10.0% with *Gessnerium mochimaensis* dominant and *Prorocentrum micans* frequent.

Stations 4 and 5 had a similarity level of 92% and were characterized by high salinity values (37‰), similar nutrient concentrations as well as equal numbers of phytoplankton. While stations 1 and 2 with similarity of 89% attained lowest salinity and similar counts of phytoplankton where *Cyclotella meneghiniana* was the dominant in each.

October

Despite of a sharp drop in phytoplankton standing crop, the greatest numbers of species were recorded allover the year (107 species). Vertically, a sharp drop in numbers were observed. The north eastern part of the bay was more fertile accompanied with high nutrient concentrations, nitrate reached its maximum (Soliman and Gharib in press). Diatoms contributed 81.3% to the total standing crop (53 species), represented mainly by *Cyclotella meneghiniana*. Chlorophytes (24 species) ranked the second (15.7%), mainly *Scenedesmus* spp.

Stations 1,2 and 7 which showed great similarity, were combined with the lowest value of salinity (6‰) and similar phytoplankton counts. The great similarity between stations 3 and 5 was due to the same salinity value (24‰) and the same phytoplankton counts.

December

A further temperature decrease was observed. Salinity was low inshore, increasing gradually offshore and the water column was stratified. The phytoplankton density was still low and the community was rich (100 species). Diatoms (54 species) contributed 58.4% to the total standing crop and dominated by *Asterionella japonica*. The species showed more susceptibility to the municipal wastes (Zaghloul, 1994a). Chlorophytes comprised 21 species (30.5%), mainly restricted near the drain and dominated by *Crucigenia* spp. and *scend. bijugatus*. Cyanophytes comprised 12 species (9.4%), mainly *Oscillatoria limnetica* and *Dactylococcopsis irregularis*, both restricted near the drain.

Station affinities delineated two groups, the first group showed great similarity between stations 5, 8 and 6, where they were characterized by equal salinity, concentrations of nutrient salts and phytoplankton counts. The leading species in this group was *Asterionella japonica*. The second group comprised stations 2 and 3 and showed highest phytoplankton counts. *Cyclotella meneghiniana* was the dominant species in the second group.

III- Phytoplankton and water quality relationships

Diatoms and Dinoflagellates were positively correlated with salinity, while the fresw hater groups showed negative correlations, this reflects the promoting effect of drainage water on algal growth. As a result of phytoplankton growth, standing crop was negatively correlated with water transparency (r= -0.2). Significant positive correlation was found between pH values and the numerical standing crop (r= 0.4). The positive correlation between oxidizable organic matter and each of ammonia and phosphate concentrations as a result of allochthonous and autochthonous sources and the negative one with salinity shows the drain water to be the major source of O.O.M in Mex Bay (allochtonous source). A positive correlation between O.O.M and phytoplankton (r= -0.23 & 0.63 in surface and bottom layers respectively)and also between dissolved oxygen and phytoplankton (r= .33 &0.26). The negative correlation between phytoplankton standing crop and nitrate (r= -0.32) means that phytoplankton prefere NO_3 rather than any other nitrogen form.

In the surface water, a strong positive correlations were existed between phosphate and each of Euglenophyceae (r= 0.37), Chlorophyceae (r= 0.61) and Cyanophyceae (r= 0.64), where it is negatively correlated with diatoms (r= -0.33) and Dinoflagellates (r= -0.36). Although phosphorus was unlimiting factor, yet it is essential element for the growth of the dominant groups. In the near bottom layer, it was also showed positive correlation with the fresh water forms. Due to the high consumption by diatoms silicate showed negative correlation (r= -0.29), but positive correlation with chlorophyceae and Cyanophyceae (r= 0.33, r= 0.32).

Concerning the relation between phytoplankton standing crop (St. crop) and the environmental parameters, a series of statistical regression models were estimated. These models describe the dependence of standing crop on the most effective measured abiotic factors at both surface water (S) and near bottom layer (B) as follows:

St. crop (S) units.l^{-1} = -31209 E^2 + 571753 pH-1654 Transparency - 56649 PO_4 (M.R= 0.48)

St. crop (B) units.l^{-1} = -375105 + 108388 O.O.M + 133618 Dissolved oxygen - 24470 NO_3 + 14057 SiO_4 - 148657 PO_4 (M.R = 0.79)

Phosphate was the most effective environmental factor controlling the phytoplankton standing crop at the two layers. PH values had a positive effect at the surface, while O.O.M, NO_3, dissolved oxygen and SiO_4 showed more effective in the near bottom layer comparison of observed and predicted values for the two layers (Fig 5) showed a small deviation which may be due to the interference of other, unmeasured physical and chemical variables not included in the model.

Diversity Index

1- Diversity Cycle

Generally, species diversity of phytoplankton in Umum Drain and Mex Bay showed irregular pattern. In Umum Drain, lowest values (1.08 nats in the surface and 0.93 nats in the near bottom layer) were recorded during April and June respectively. This accompanied with lowest numbers of species all over the year (16 and 14 species). The degree of dominance were 47 and 71% to the total community (203 x 10^3 & 1,361 x 10^3 units.l^{-1} respectively). The dominant species was *Skeletonema costatum* for the two layers of water. Highest values of diversity were 2.20 nats in the surface of December and 2.98 in the near bottom of April.

This was met with species richness of 24 and 37 species and phytoplankton standing crop of 316 X 10^3 and 1,549 X 10^3 units.l^{-1} respectively. Such increased diversity reflects the absence of distinct dominance of any particular species where the dominancy in December was shared by several species, particularly, *Cyclotella meneghiniana* (31%), *Crucigenia quadrata* (17%) and *Scenedesmus quadricauda* (4.6%), while in

April it shared by *C. meneghiniana* (19.5%), *Dactylococcopsis irregulais* (18.1%) and *Nitzschia microcephala* (8.0%).

In Mex Bay, species diversity was negatively correlated with phytoplankton standing crop (r= -0.25 and r= -0.39 in surface and near bottom layers respectively). The surface diversity index ranged between 0.85 nats (St.4, June) and 2.85 nats (St.7, December). This was met with species richness of 27 and 38 species and noticeable variations in the magnitude of phytoplankton numbers (1,693 X 10^3 & 263 X 10^3 units.l^{-1} respectively). The dominant species in June was *Skeletonema costatum* (79.%, while in December, the dominancy was shared by several species, as *Cyclotella meneghiniana* (18.2%), *Crucigenia quadrata* (10.7%) and *Kirchneriella lunaris* (9.1%).

In the near bottom layer, diversity index showed wider range from 0.68 nats (St.6, June) and 3.10 nats (St.8, October). This was met with species richness of 23 and 33 species and phytoplankton standing crop of 755 X 10^3 and 28 X 10^3 units.l^{-1} respectively. The low diversity was accompanied by higher frequency of only one species, *Skeletonema costatum* 88%), while the high diversity was corresponded to the dominancy of *Nitzschia sigma* (11%), *N.seriata* (10%) and *Cyclotella meneghiniana* (6%).

Simple equations confirmed negative correlation between species diversity (H) and the percentage frequency of the dominant species (D) at both surface (S) and near bottom layer (B) in Mex Bay as follows:

$$H(S) = 3.036 - 2.439\ D \qquad (r^2 = 0.867)$$

$$H(B) = 3.226 - 2.784\ D \qquad (r^2 = 0.911)$$

Figure (6) represents the relationship between diversity (H) and the degree of dominance (D).

2- Diversity and habitat structure relationship

Species composition of phytoplankton community and / or the dominance depend on the interaction between ecological, biological and evolutionary processes in the surrounding habitat (Margalef, (1978) and Hallegraeff & Reid, (1986). So, the availability of resources is one of the most important ecological factors affecting species diversity. This was emphasized by numerous workers as Cosser, 1988, Abdalla *et al*, (1992) and Zaghloul, (1995.)

According to Soliman and Gharib (in press), Mex Bay receives a huge amount of waste water rich in nutrient salts, this creates eutrophication at times particularly spring and summer. At the surface water, species diversity was negatively correlated with water temperature

(r= -0.51), O.O.M. (r= -0.32), salinity (r= -0.21), but appeared positively correlated with transparency (r=-0.26) and phosphate (r=0.23). At the near bottom layer, it was also negatively correlated with water temperature (r= -0.33), O.O.M. (r= -0.35) and positively correlated with nitrite (r=0.28).

The stepwise multiple regression equations describing the dependance of species diversity (H) and the most effective environmental factors are:

$$H(S) = 3.008657 - 0.058459 \text{ Temp.} + 0.001776 \text{ SiO}_4 - 0.017908 \text{ O.O.M.} \quad (M.R = 0.57)$$

$$H(B) = 2.119 - 0.022 \text{ O.O.M} + 0.136 \text{ NO}_2 - 0.003 \text{ SiO}_4 - 0.053 \text{ Terp.} + 0.022 \text{ S‰} \quad (M.R.= 0.57).$$

These models are adequate at a significant level of 95% (P= 0.05). From these equations, it appears that the effect of temperature, silicate and O.O.M. were pronounced in both two layers, while in the near bottom layer, the effect of nitrite and salinity was more clear. Comparison of the observed phytoplankton diversity to the models (Fig. 7) showed a small error to the interference of other factors.

In conclusion, the continuous land run off into the bay caused massive development of algal blooms and the coastal current allows such blooms to extend along the shore line and fresw hater forms were found as codominant with marine forms. A gradual deterioration of water quality creates on the long run nuisance and aesthetic problems in the recreational beaches. Accordingly, it is recommended that the waste water should be treated according to sanitary regulations before being discarded into the bay.

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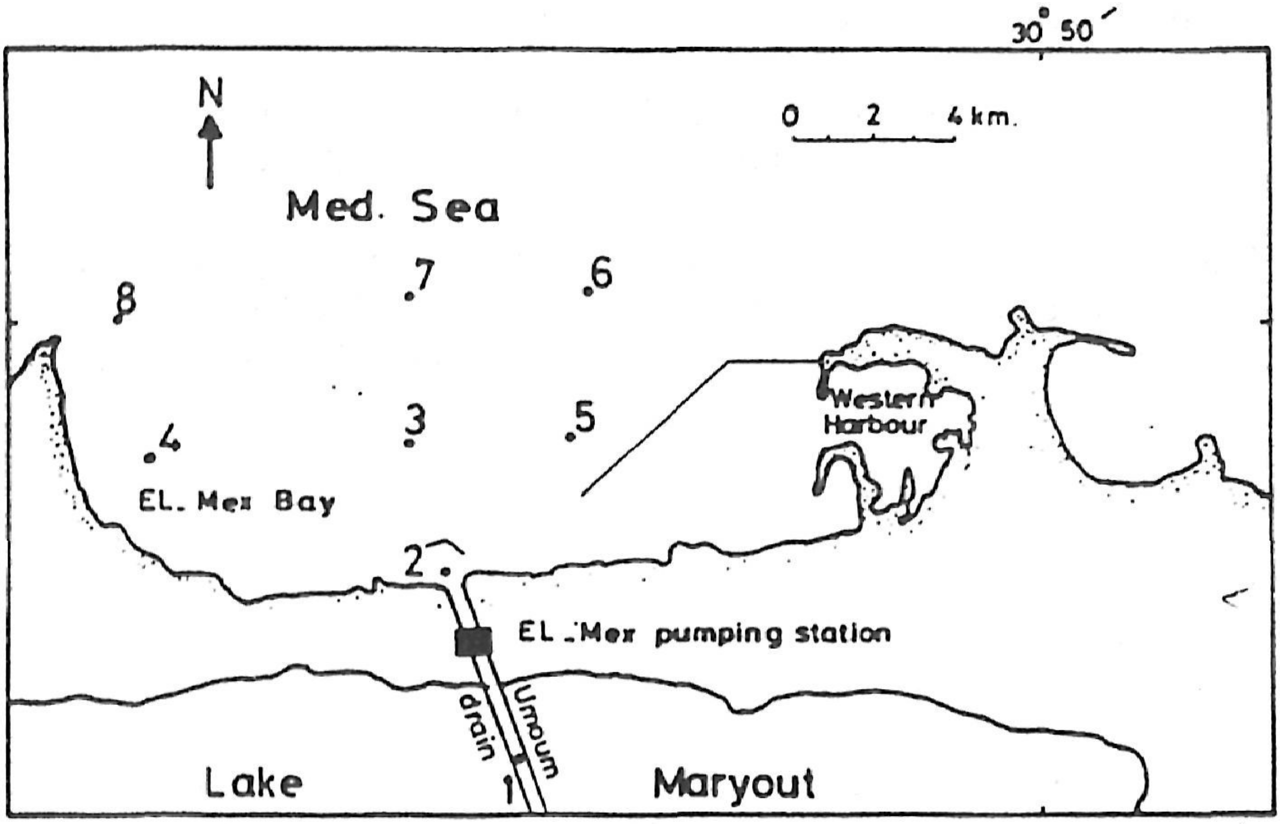

Fig. 1. Area of investigation and sampling sites.

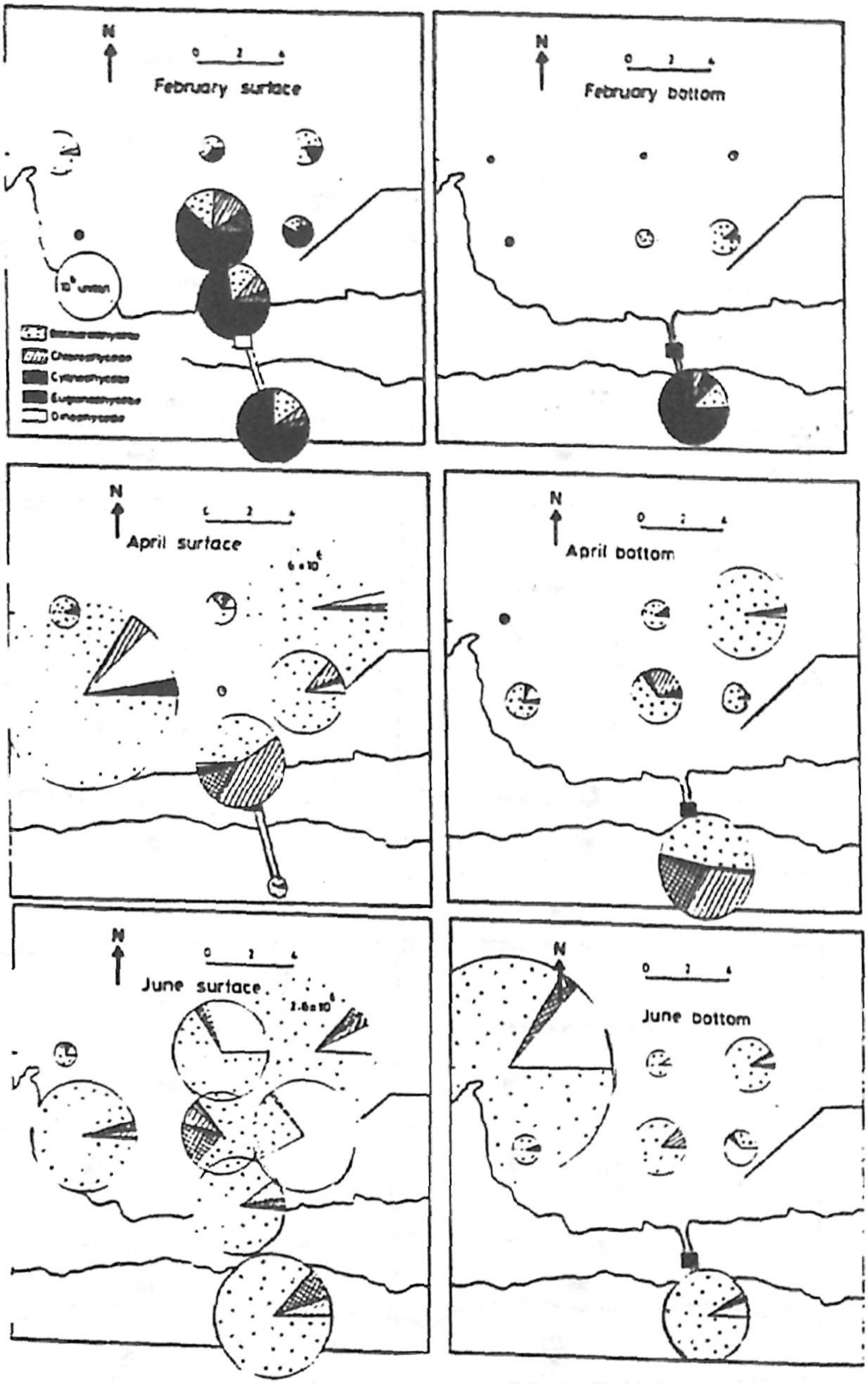

Fig. (2): Spatial and monthly abundance and percentage composition of phytoplankton in Mex Bay during February, April and June.

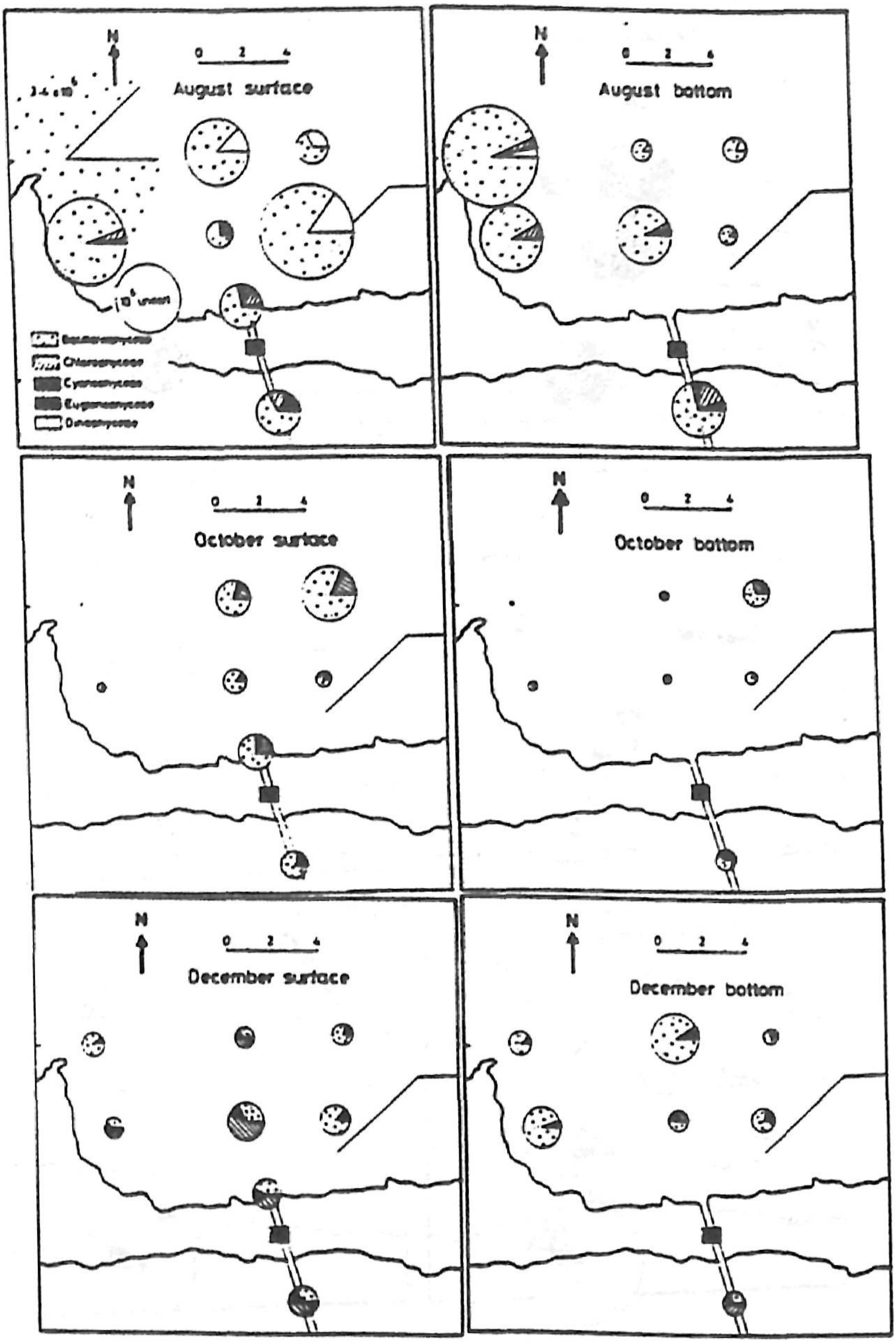

Fig. (3): Spatial and monthly abundance and percentage composition of phytoplankton in Mex Bay during August, October and December.

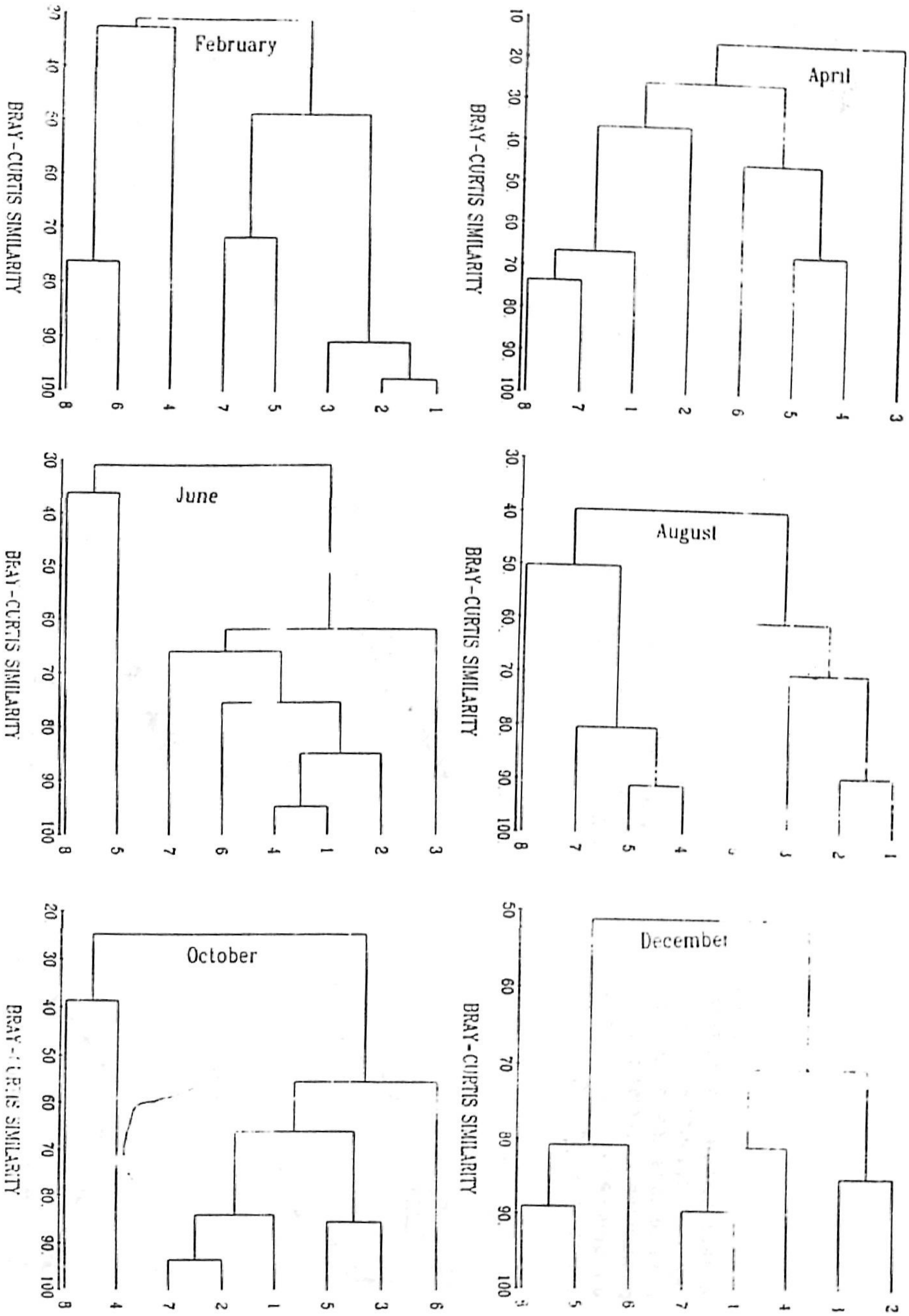

Fig. (4): Cluster dendrogram of stations in the surface water of Mex Bay based on the concentrations of environmental factors and abundance of phytoplar.kton groups.

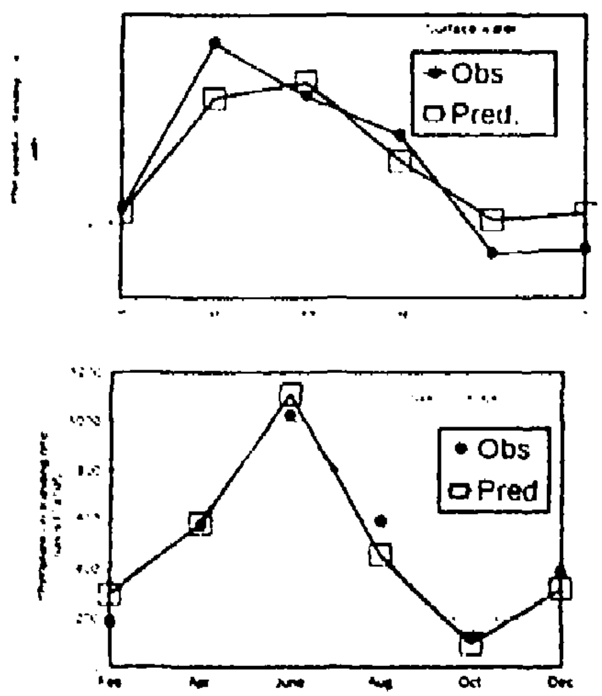

Fig (5): The actual phytoplankton standing crop compared with the predicted values as calculated by a multiple regression analysis of the relationship between phytoplankton and the most correlative environmental parameters.

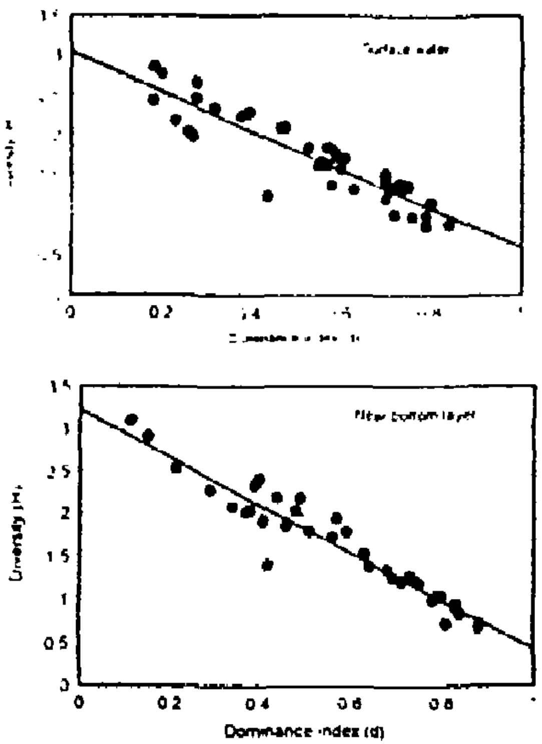

Fig. (6): Regression of diversity (H) on dominancy (D) in the surface and near bottom layers at Mex Bay

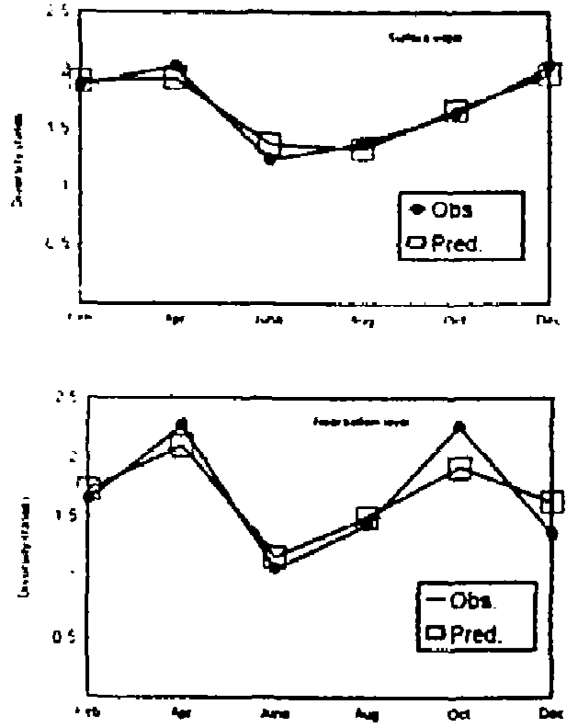

Fig. (7): Comparison of the actual diversity values with the predicted values as determined by a multiple regression analysis of the relationship between diversity and environmental factors.

Table (1): Numbers of species of the phytoplankton groups recorded in the different periods in Mex Bay.

Reference and period of study	Number of Species		
Phytoplankton groups	Dorgham *et al*(1987) 1982 - 1983	El-Sherif (1989) 1988	Present study 1995
Bacillariophyceae	119	83	83
Chlorophyceae	26	41	30
Cyanophyceae	11	26	20
Euglenophyceae	4	4	8
Dinophyceae	50	5	17
Total number of species	210	159	158

Table (2): Number of phytoplankton species recorded at different water types over the year.

Water Type	Umum Drain	Mex Bay Salinity			
Phytoplankton groups		< 10	10-20	20-30	30-38.5
Bacillariophyceae	50	43	49	62	67
Dinophyceae	3	3	7	15	14
Chlorophyceae	25	25	20	24	21
Cyanophyceae	16	17	15	16	12
Euglenophyceae	6	8	7	7	6
Total	100	96	98	124	120

تركيبة مجتمع العوالق النباتية في خليج المكس الأسكندرية

سميحة محمود غريب

المعهد القومي لعلوم البحار والمصايد - الأنفوشي - الأسكندرية

يتركز البحث في دراسة التوزيع الأفقي والرأسي للعوالق النباتية في منطقة خليج المكس ومصرف العموم في الفترة من فبراير حتى ديسمبر ١٩٩٥ وذلك في ضوء الظروف البيئية السائدة.

جمعت لذلك عينات من ٨ محطات حيث تم تعريف أنواع العوالق النباتية الموجودة بمصرف العموم وخليج المكس وكذلك تقدير المحصول القائم لها (عدد الخلايا في اللتر) وذلك في المياه السطحية والطبقة القريبة من القاع. واستعرضت الدراسة التغيرات الموسمية والمكانية في التركيب النوعي والكمي للعوالق النباتية.

بلغ عدد أنواع العوالق النباتية التي سجلت خلال فترة البحث ١٦٢ مصنفا غالبيتها العظمى من الطحالب المنشطرة (الدياتومات) وثنائيات السياط وذلك في خليج المكس. بينما شكلت الطحالب الخضراء والخضراء المزرقة واليوجلينات نسبة كبيرة في مصرف العموم والمنطقة التي تقع أمامه.

وقد أوضحت الدراسة أن الكميات الكبيرة من الملوثات التي تصرف في خليج المكس قد أثرت بصورة ملحوظة على هذه العوالق مما أدى الى ظهور الأنواع التي تعيش في المياه العذبة على امتداد الخليج كله وبخاصة أمام مصب المصرف.

وبمقارنة نتائج البحث مع الأبحاث السابقة على نفس المنطقة لوحظت زيادة مطردة في عدد العوالق النباتية وظهور بعض الأنواع التي تشير الى وجود تلوث في المنطقة ويمكن اعتبارها "دلائل تلوث".