Egypt. J. Aquat. Biol. & Fish., Vol 2, No. 3 : 65-80 (1998) *ISSN 1110-6131*

PHYTOPL ANKTON BIOMASS AND ENVIRONMENTAL FACTORS IN THE NOZHA HYDRODROME, ALEXANDRIA, EGYPT.

Samiha M.Gharib

National Institute of Oceanograph and Fisheries Kayet Bay, Alexandtia, Egypt.

Key words: Phytoplankton, Biomass,Environmental Factors Multple Regression analysis, Alexandsia

(Received may 9, 1998)

ABSTRACT

The seasonal development of phytoplankton biomass in the Nozha Hydrodrome during the period September, 1986- August, 1987 exhibited two annual peaks. The first in winter resulting from lack of nitrogen and availability of phosphorus, led to the development of N_2-fixing alga *Anabaenopsis circularis* which averaged 11.50 and 9.14 $mg.l^{-1}$ for the surface and near bottom layers respectively. The second peak in spring due to the diatom *Cyclotella meneghiniana* (10.9 and 11.0 $mg.l^{-1}$ for the surface and near bottom layers, respectively). The annual averages phytoplankton biomass were 6.26 and 5.78 $mg.l^{-1}$ for the two layers and lie within the range considered as characteristic of eutrophic waters. Small differences were found in the horizontal distribution and a slight increase was noticed from the western part of the hydrodrome to the east.

Results indicate that the biomass of the different classes was altered when compared with its numerical values. While Chlorophyceae was numerically the most important plankter, Cyanophyceae constituted 51.4% of the total algal biomass.

The multiple regression analysis between variations in phytoplankton biomass versus some physical and chemical parameters dealing with changes in its community illustrated excellent equations model which can be applied to predict the phytoplankton biomass in the hydrodrome.

INTRODUCTION

The Nozha Hydrodrome is an isolated part of Lake Mariut at latitude 31° 10 east and longitude 30° N with a total area of about 504 hectars (1200 feddans) and an average water depth 2.7m. The hydrodrome is constantly supplied with fresh Nile water through Mahmoudia Canal (Fig.1). The detailed morphometric features of the hydrodrome was previously given by Elster and Jensen (1960). Quantitative estimation of the phytoplankton community was carried out by Salah (1959). The distribution of hydrophytes was also given by Zaki (1960 a&b). Further contributions on the chemistry and hydrography of the hydrodrome wer carried out by Banoub and Wahby (1961) and Saad (1973). The physical and chemical characteristics of the bottom sediments were estimated by Saad (1972 & 1976). The periphyton community was also investigated by Samaan and Abdallah (1982). The phytoplankton community in the Nozha Hydrodrome was given by Gharib (1991), its chlorophyll *a* was studied by El-Sherif (1989a) and the nutrient salts were discussed by Samaan *et al* (1994a). Dynamics of nutrient salts between bottom sediments and adjacent water was discussed by Samaan *et al* (1994b). The Ecology of Chlorophyceae was discussed by El- Sherif *et al* (1994).

This paper describes the quantitative fluctations of the phytoplankton biomass in the hydrodrome in relation to the environmental factors. Reference is made to the influence of nutrients. Statistical analysis was performed to predict the phytoplankton biomass in the hydrodrome.

MATERIAL AND METHODS

Samples were collected monthly by Ruttner water sampler from surface and near bottom layers at seven selected stations from September, 1986 to August, 1987. The results were discussed seasonally.

The determination of the phytoplankton biomass was based on the calculation of the volume of each species from appropriate geometric formulae (Edler, 1979). The volume of algae was transformed into biomass (fresh weight) assuming that the specific gravity of the algae is one. In the present study, at least 30 individuals were measured for each species for every season and no standard cell volumes were used. The rare plankters with negligible volume were excluded in this estimation.

Statistical treatment of the phytoplankton biomass versus the prevailing physico-chemical parameters for both surface and near bottom layers was performed according to the stepwise multiple regression analysis at a confidence limit of 95% ($P<0.05$) using Number Crunched Statistical System (NCSS) proposed by Hintze (1993) on a computer.

Status of the hydrodrome prior to the present investigation

The hydrodrome water was previously considered as a mesotrophic basin due to its low nutrient content and subsequently its primary productivity was also low (Salah, 1959; Aleem and Samaan, 1969). For this reason, application of fertilizers (super phosphate and ammonium sulphate or ammonium nitrate) was proposed in April, 1982 till June, 1986. These fertilizers have raised the primary productivity as well as the annual fish yield by about 4 times (Wahby & Shraidach, 1985). In May, 1986, the concentration of nutrient salts in the water showed a sharp rise, coincided with a rapid increase of water temperature to 28°C caused a sudden development of undesirable bloom of blue-green algae. Accumulation of algal scums in the surface water created anoxic conditions in the subsurface layer and hydrogen sulphide was formed and causing complete oxygen consumption (Dowidar and Abdel Moati, 1989). This was followed by a mass mortality of fish in early June with a loss of about 4o tons of commercial fish. Rapid improvement of the water quality was performed through collection of all dead fish.

RESULTS AND DISCUSSION

Environmental Conditions (Fig.2)

The Nozha Hydrodrome lies in a warm temperate zone. Water temperature displays a minimum in winter (14.9°C) and a maximum in summer (28.3°C). The lowest transparency (45.7cm) in spring may be related to the high phytoplankton biomass and highest was measured in winter (76.5 cm). PH values remained aboue 8 throughout the year, reaching 9.2 in spring and decreased to 8.7 in autumn. The maximum value of the dissolved oxygen was recorded in winter (8.48 $mlO_2.l^{-1}$) and the minimum was in summer (4.07 $mlO_2.l^{-1}$).

Concentrations of dissolved inorganic nitrogen showed marked seasonal variation. In autumn, they averaged 130.4 and 156.3 $\leq gN.l^{-1}$ for the surface and near bottom layers respectively. Ammonium constituted 46.9% and 54.2% of the total values. The concentrations of dissolved nitrogen increased gradually to reach a maximum of 579 and 671 $\leq g\ N.l^{-1}$ for the two layers during spring, after a blooming of the N_2- fixing algae *Anabaenopsis circularis*. The concentrations decreased during summer.

Silica exhibited its lowest values in spring (6.27 and 6.20 mg $SiO_2.l^{-1}$ for the two layers respectively) probably due to the increase of diatoms and remained between 10.8 and 12.7 mg $SiO_2.l^{-1}$ during the rest of the year.

Concentrations of reactive phosphate showed abnormal high values during autumn (2061 and 1940 $\leq g\ PO_4.l^{-1}$ for the two layers respectivelty) and decreased gradually to reach 81.3 and 73.7 $\leq g\ PO_4.l^{-1}$ during summer.

Species composition and distribution

Atotal of 65 taxa haves been identified in the phytoplankton in the Nozha Hydrodro me, but cell volumes of 53 species were measured and the others excluded because they were rare and with negligible volume. They were including 14 species of Cyanophyceae, 7 species of Bacillariophyceae and 27species of Chlorophyceae. Beside 4 species of Euglenophyceae and one Dinophyceae.

Cyanophyceae were the dominant group, forming 54.0% and 48.5% of the total phytoplankton biomass in the surface and near bottom layers respectively while it ranked numerically the third group whera es it formed 18.1% and 16.1% of the total phytoplankton count (Table 1). Bacillariophyceae ranked the second group (27.3% and 32.0% of the total biomass for the surface and near bottom layers respectively). Chlorophyceae represented the third group (12.3% and

12.6% of the total biomass for the two layers) which was numerically the dominant group as it formed about 67.0% and 68.3% of the total phytoplankton count.

Although numerous species were measured, few of them formed the main bulk of the biomass, namely; *Anahaenopsis circularis* which formed 83.7% and 75.2% of the total Cyanophyceae biomass in the surface annear bottom layers respectively followed by *Gomphosphaeria aponina* (5.9% and 9.3%). *Cmeneghiniana* formed 77.6% and 79.1% of the total Bacillariophyceae biomass in the two layers respectively, while *Scenedesmus* spp., *Crucigenia* spp., *Tetraedron* spp. and *Chlorella vulgaris* formed collectively 76.5% and 76.4% of the total Chlorophyceae biomass in the two layers respectively. All the mentioned species formed about 82% of the total phytoplankton biomass.

Observation at seven stations indicated that the hydrodrome water sustained high phytoplankton biomass in both the surface and near bottom layers which were annually amounted to 6.26 and 5.78 $mg.l^{-1}$ respectively and are within the range considered as characteristic of eutrophic water (Vollenweider, 1968). This value is higher than that recorded in Lake Burollus (north of the Nile Delta) which amounted 2.35 $mg.l^{-1}$ (El-Sherif, 1989b). While in Lake Nasser, it amounted 22.91 $mg.l^{-1}$ in the surface and 4.09 $mg.l^{-1}$ in the near bottom layer (Zaghloul, 1985). Highest biomass at the surface water appeared at station II, while near bottom layer sustained more biomass at station III, both was due to *Anabaenopsis circularis* and *Cyclotella meneghiniana* (Fig.3). Phytoplankton biomass decreased westward of the hydrodrome i,e towards stations I and VII.

Seasonal fluctuations of the phytoplankton biomass

The seasonal variations of total phytoplankton biomass together with the contribution by algal groups (Fig.4) showed two biomass maxima, the first in winter amounted 11.5 $mg.l^{-1}$ in the surface and 9.14 $mg.l^{-1}$ in the near bottom layer corresponding to Chlorophyll *a* 17.4 and 17.3 $mg.m^{-3}$ for the two layers (El-Sherif, 1989b) as shown in Fig.(5). The most important species was *Anabaenopsis circularis* (6,828X10^3 and 4,701X10^3 $trichome.l^{-1}$) having an average volume of

1240 mm^3X10^{-9} per trichome. It contributed 94.0% and 87.2% to the blue-green biomass and 73.6% and 63.7% to the total phytoplankton biomass. At the same time the blue-green algae represented about 78.3% and 73.0% to the phytoplankton biomass. The lack of nitrogen and the availability of phosphorus led to the development of N_2-fixing algae which formed the higher phytoplankton biomass in winter (Fig.6).

Results indicated that low total N:P ratio (1:3.6) in winter is symptomatic of blue-green algal blooms in eutrophic lakes and N is considered a growth limiting nutrient as mentioned by Lund 1965; Claesson and Ryding 1977 and Canfield *et al* 1989. Also Smith (1983) proposed that the relative contribution of blue-green algae to total phytoplankton biomass is not dependent on absolute nutrient concentrations, but rather on the ratio (by weight) of total nitrogen (TN) to total phosphorus (TP) (TN/TP).

The second peak in spring resulting mainly of diatoms which amounted 5.35 $mg.l^{-1}$ in the surface and 5.63 $mg.l^{-1}$ in the near bottom layer corresponding to Chlorophyll *a* 15.3 $mg.m^{-3}$ in the surface and 15.8 $mg.m^{-3}$ in the near bottom layer (El-Sherif,1983a) as shown in Fig.(5). The most important species of diatoms were *Cyclotella meneghiniana* and *Nitzschia palea. Cyclotella meneghiniana* (1,853X10^3 and 1,954X10^3 $cell.l^{-1}$) having an average volume of 2435 mm^3X10^{-9} per cell. It contributed 84.3% and 84.5% to the diatoms biomass and 41.5% and 43.3% to the total biomass in the surface and near bottom layers respectively. *Nitzschia palea* (2298X10^3 and 2700X10^3 $cell.l^{-1}$) having an average volume of 287 mm^3X10^{-9} per cell. It contributed 12.3% and 13.8% to the diatoms biomass and 6.1% and 7.1% to the total biomass in the surface and near bottom layers respectively. At the same time the diatoms represnted 49.2% and 51.2% of the phytoplankton biomass. This vernal peak coincided with a drop in silica concentration (about 6.25 mg $SiO_2.l^{-1}$) as showen in Fig. (7) and availability of nitrogen (579 and 671 $\leq gN.l^{-1}$). Many studies (see. e.g. Lund,1955; Hutchinson, 1967; Bailey- Watis,1976) have indicated strong causal interactions between silica concentration and diatom abundance. At the same time, the blue-green algae represented about 34.7% and 32.5% of the vernal peak and *Anabaenopsis circularis* formed 72.4% and 67.1% to the blue-green biomass. Lowest phytoplankton biomass was observed during autumn and summer (Fig.4).

Statistical regression analysis were calculated according to Hintze (1993) dealing with phytoplankton biomass and the most effective physico-chemical parameters at both surface
(S) and near bottom layers (B) as follows:

Surface water (S):

Phytoplankton biomass ($mg.l^{-1}$)=56.07-1.52 tenp.-0.298 Secchi disc (r=0.81)

Near bottom water layer (B)

Phytoplankton biomass ($mg.l^{-1}$)=26.18-0.82 tevp. - 0.341 p04temp40.(r=0.68)

These models are adequate at a significant level 95% (P>0.05). Comparison of observed and calculated values for the two depths (Fig.8), showed a small average error due to the interference of other factors not incoporated in the model equation. The equation model reflect that the temperature was the most effective environmental factor controlling phytoplankton biomass at the two levels, beside transparency in the surface water. Reactive phosphate had also an effect at the near bottom water layer, indicating the random application of fertilizers stimulate the growth of phytoplankton as discussed before.

CONCLUSION AND RECOMMENDATION

Due to the different size of the algal species: nano and net plankton forms, high abundance does not always mean a high contribution to the algal biomass and so Chlorophyceae made up only 12.14% of the annual phytoplankton biomass in the Nozha Hydrodrome, while Cyanophyceae made up 51.4%, diatoms 29.55%, Euglenophyceae 4.58% and Dinophyceae 2.05%.

We can recommend that application of inorganic phosphorus and nitrogen fertilizers should proceed constantly in the hydrodrome but controling of eutrophication problems (undesirable algal blooms) should be carried out not only by reducing nutrient loading but also by management of fish habitat and fish community structure. We can recommen also to apply the statistical equations in the future to predict phytoplankton biomass in the hydrodrome.

REFERENCES

Aleem, A.A., and Samaan, A.A.,(1969). Productivity of Lake Mariut. Part1-Physical and Chemical aspects. Int. Revue ges. Hydrobiol. 54,3.313-355.Part II-Primary production. Int. Revue ges. Hydrobiol. *34*(4).491-527.

Bailey-Watis, A.E.,(1976). Planktonic diatoms and some diatom silica relations in a shallow eutrophic Scottish loch-Fresh Wat. Biol. *6*.68-80.

Banoub, M.W., and S.D. Wahby,(1961). Further contribution to the Chemistry and Hydrography of the Nozha Hydrodrome near Alexandria,1957-1958. Notes and Mem.,61. Alexandria Institute of Hydrobiology, U.A.R.,42 pp.

Canfield, D.E., Jr., E.Phlips, and C.M. Duarte,(1989). Factors influencing the abundance of blue-green algae in Florida lakes. Can. J. Fish. Aquat. Sci.*46*.1232-1237.

Claesson, A., and S.O. Ryding.(1977). Nitrogen-a growth limiting nutrient in eutrophic lakes. Prog. Water Technol. *8*.291-299.

Dowidar, N.M. and A.R. Abd El-Moati,(1989). Eutrophication as a cause of fish mortality in the Nozha Hydrodrome fish farm. Alex. Comm. in Science & Develop. Res. 25 Jan.-March.145-160.

Edler, L.,(1979). Recommendations for marine biological studies in the Baltic Sea. Phytoplankton and chlorophyll. The Baltic Marine Biologists Publication,(5).38pp.

El-Sherif, Z.M.,(1989.a). Chlorophyll *a* Biomass of Nozha Hydrodrome, Near Alexandria, Egypt. Bull. Inst. Public Health. Vol. XIX. *4*.(4).983-991.

El-Sherif, Z.M.,(1989b). Biomass of the standing crop of phytoplankton in Lake Burollus (Egypt). Bull.Nat. Inst. Oceanogr. & Fish., ARE,*15*(1).179-189.

El-Sherif, Z.M., S.A. Shabaan, A.A. Samaan and S.M. Gharib,1994. Ecology of Chlorophyceae in the Nozha Hydrodrome. The 4th Conf. of the Envir. Prot. is a must 10-12 May,1994.261-290.

Elster, H.J., and W.K. Jensen,(1960). Limnological and Fishery Investigations of the Nozha Hydrodrome near Alexandria, Egypt.1954-1956-Notes & Memories,43. Alex.Inst.Hydro. U.A.R.99pp.

Gharib, S.M.,(1991). Study of the biological productivity of the Nozha Hydrodrome as a model of artificially fertilized fish farm. Ph. D. Thesis, ElUniversity,Faculty of Science Botany Dept.453pp.

Hintze, J.L.,(1993). Number Cruncher Statistical System (NCSS). Version 5.035/93.

Hutchinson, G.E.,(1967). A treatise on Limnology. Vol.II, Introduction of lake Biology and the Limnoplankton. John Wielly Edit. New York,2.1115pp.

Lund, J.W.G.,(1955). Further observations on the seasonal cycle of *Melosira italica* (Ehr) Kutz. subsp. *subarctica* O.Mull. J.Ecol.*42*.151-179.

Lund, J.W.G.,(1965). The ecology of fresh water phytoplankton Biol. Rev.*40*.231-293.

Saad, M.A.H.,(1972). Investigations of the surface sediments of the Nozha Hydrodrome, near Alexandria, Egypt. Rapp. comm. Int. Mer. Medit., *20*(4).515-517.

Saad, M.A.H.,(1973). Some Limnological characteristics of the Nozha Hydrodrome, near Alexandria, Egypt, Hydrobiologia, *41*(4).477-499.

Saad, M.A.H.,(1976). Study of the core sediments of the Nozha Hydrodrome, near Alexandria, Bull. Inst. Ocean. and Fish. A.R.E *6*.19-34.

Salah, M.M.,(1959). Phytoplankton population in the Nozha Hydrodrome. Notes and Memoires, 40. Alexandria Institute. of Hydrobiology, U.A.R.,19pp.

Samaan,A.A. and R.R.Abdallah,(1982). Limnological Investigation of periphyton in the Nouzha Hydrodrome. Notes and Memoires, *.8*, (1), Alex. Inst. of Hydrobiology, A.R.E.,107-122.

Samaan, A.A., Z.M. El-Sherif, S.A.Shaaban Dessouki and S.M.Gharib,(1994a). Nutrient salts in the Nozha Hydrodrome (Egypt) as affected by previous application of inorganic fertilizers. J.Environ. Science, Mansoura Univ., Egypt. *8*.171-187.

Samaan,A.A., Z.M. El-Sherif, S.A.Shaaban Dessouki and S.M.Gharib,(1994b). Dynamics of nutrient salts between bottom sediments and adjacent water in the Nozha Hydrodrome (Egypt). Bull. Nat. Inst. Oceanogr. & Fish., A.R.E. *20*(2).85-97.

Smith,V.H.,(1983). Low nitrogen to phosphorus ratios favour dominance by blue-green algae in lake phytoplankton. Science (Wash.,DC) *221*.669-671.

Vollenweider,R.S.,(1968). Scientific Fundamentals of the Eutrophication of Lakes and Flowing Waters, with Particular Reference to Nitrogen and Phosphorus as Factors of Eutrophication .- Paris, Rep. Organization for Economic Cooperation and Development, DAS/CSI /68.27. 1- 192.

Wahby, S.D. and M.M.A. Shriadach, (1985). Fertilizing a large Fish pond-Nozha Hydrodrome. Rapp. Comm. Inst. Mer Medit, *29*(4). 191-194.

Zaghloul,F.A., (1985). Seasonal variations of plankton in lake Nasser, Ph.D. thesis, Seuz Canal.Unniv., Fac. Sci., Zoology Dept.

Zaki, S., (1960a). Density distribution of rooted hydrophytes in Nozha Hydrodrome.Notes and Memoires, *48*. Alexandria Institute of Hydrobiology, U.A.R., 28 pp.

Zaki, S., 1960 b. The effect of wind on the distribution and density of *Potamogeton pectinatus* in Nozha Hydrodrome. Notes & Memoires, *44*. Alexandria Institute of Hydrobiology, U.A.R., 33 pp.

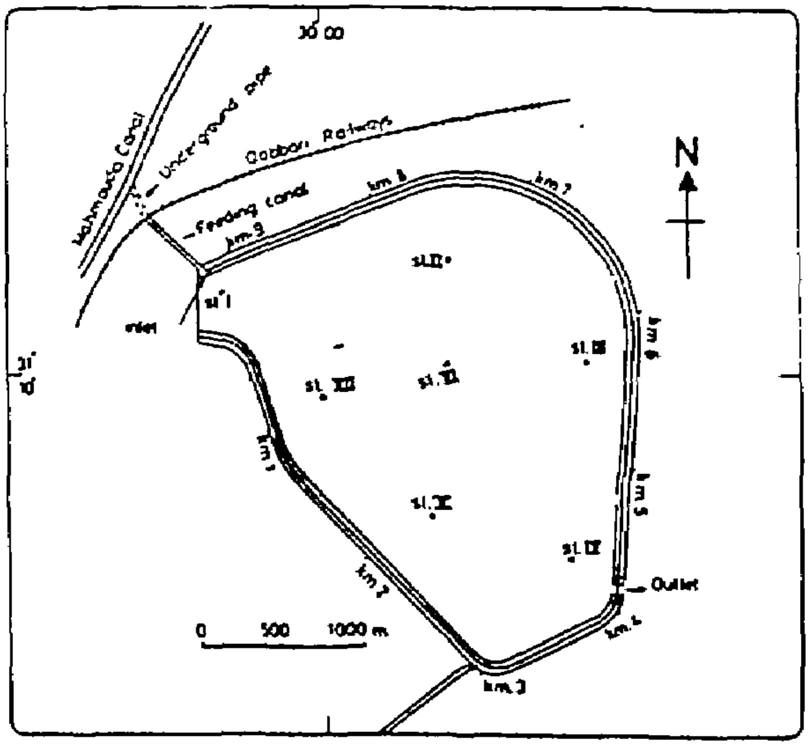

Figure 1: Position of stations in the Nozha Hydrodrome.

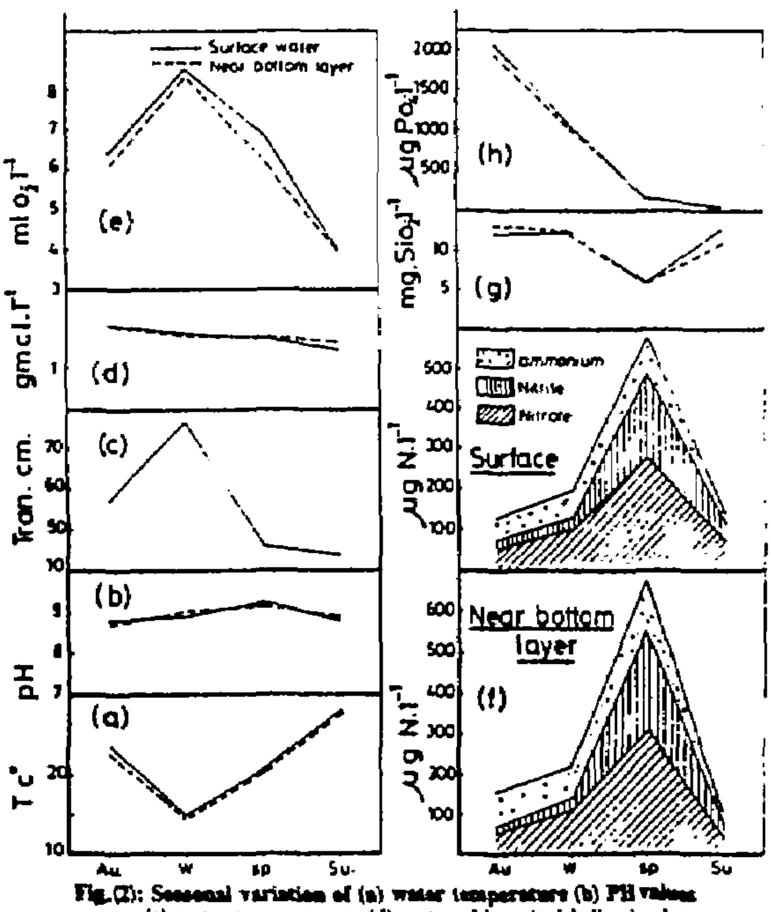

Fig.(2): Seasonal variation of (a) water temperature (b) PH values (c) water transparency (d) water chlorosity (e) dissolved oxygen (f) dissolved inorganic nitrogen (g) reactive silicate and (h) dissolved phosphate in the Nozha Hydrodrome.

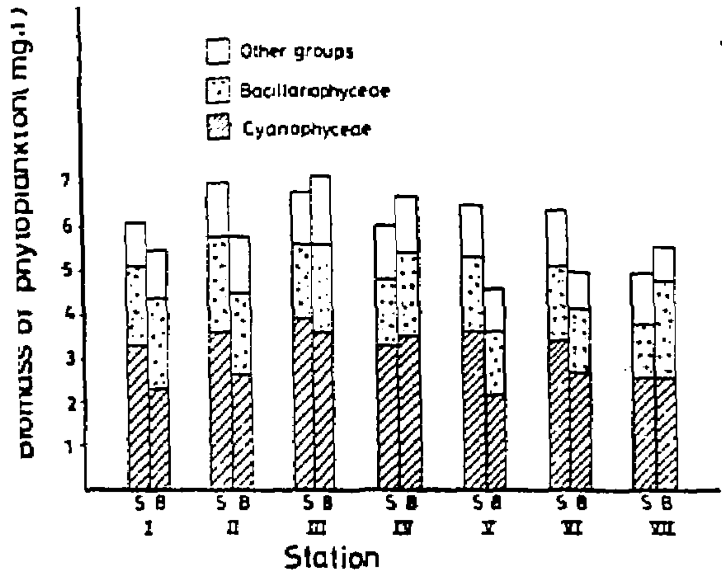

Fig.(3): Total average of phytoplankton biomass and main compoents (s:surface water,B: Near bottom layer.

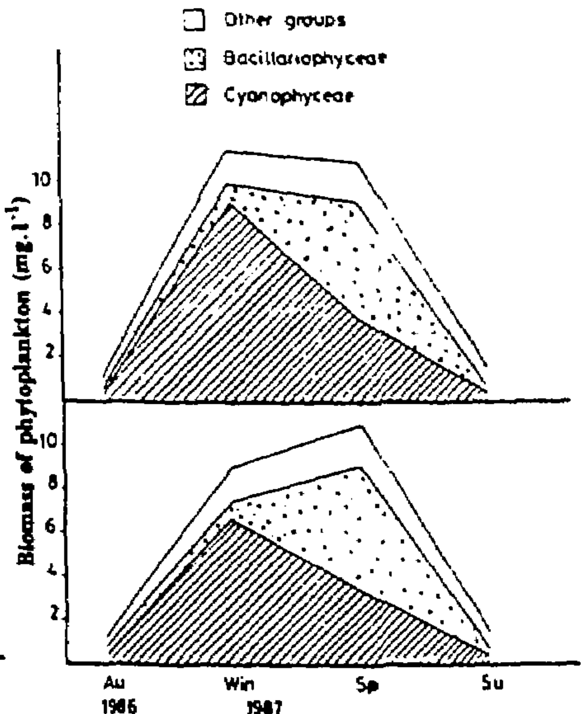

Fig.(4): Seasonal variation in total phytoplankton biomass together with the contribution by the main algal groups.

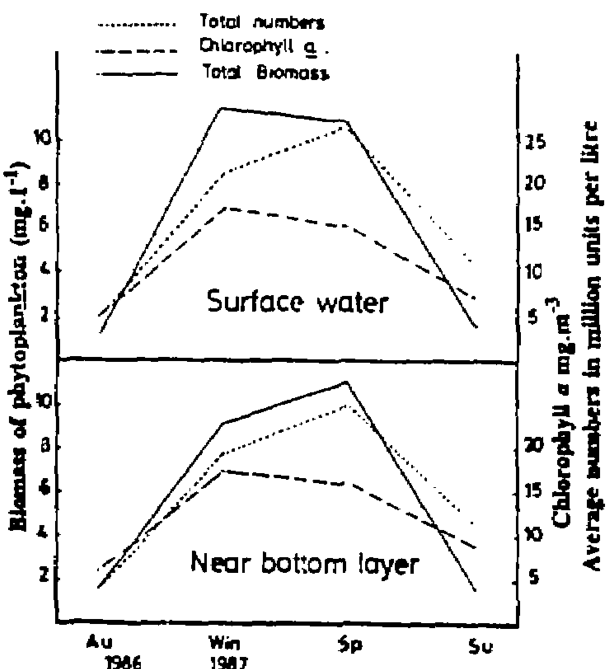

Fig.(5): Seasonal variation in total phytoplankton biomass in comparison with the total numbers and Chlorophyll a.

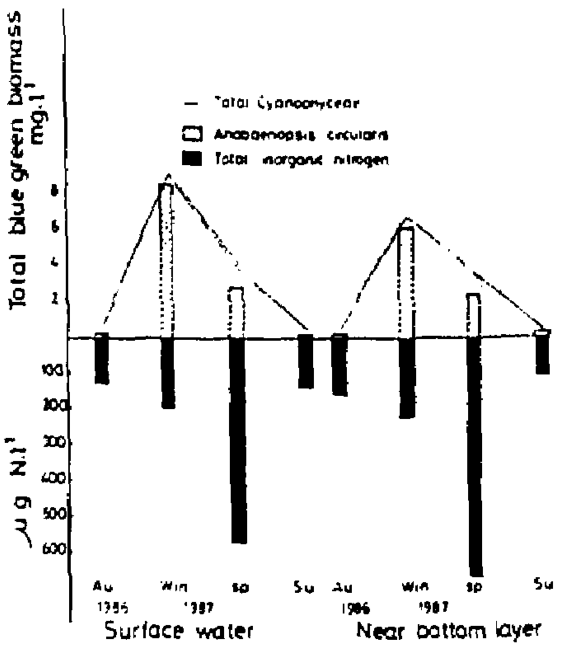

Fig.(6): Total Cyanophyceae biomass and the main genus component, over the autumn, 1986- summer1987 at the surface and near bottom layers. Also shown are total inorganic nitrogen over the same time period.

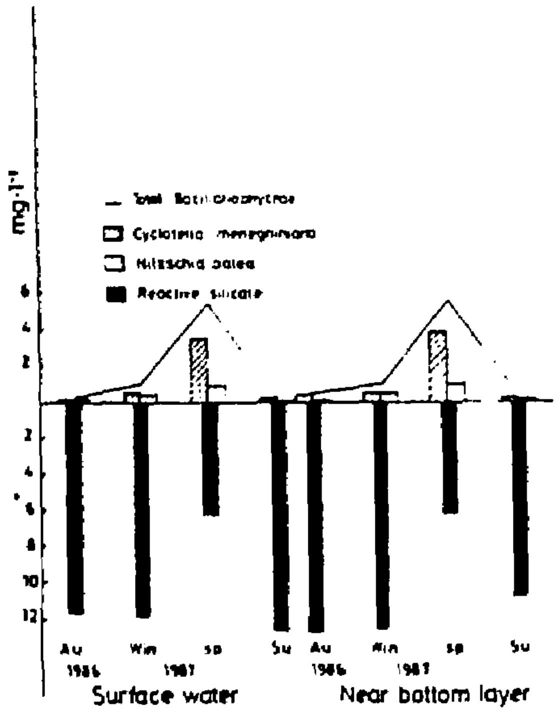

Fig.(7): Total Bacillariophyceae biomass and the two major generic components over the autumn 1986- summer, 1987 at the surface and near bottom layers. Also shown are average dissolved silicate levels over the same time period.

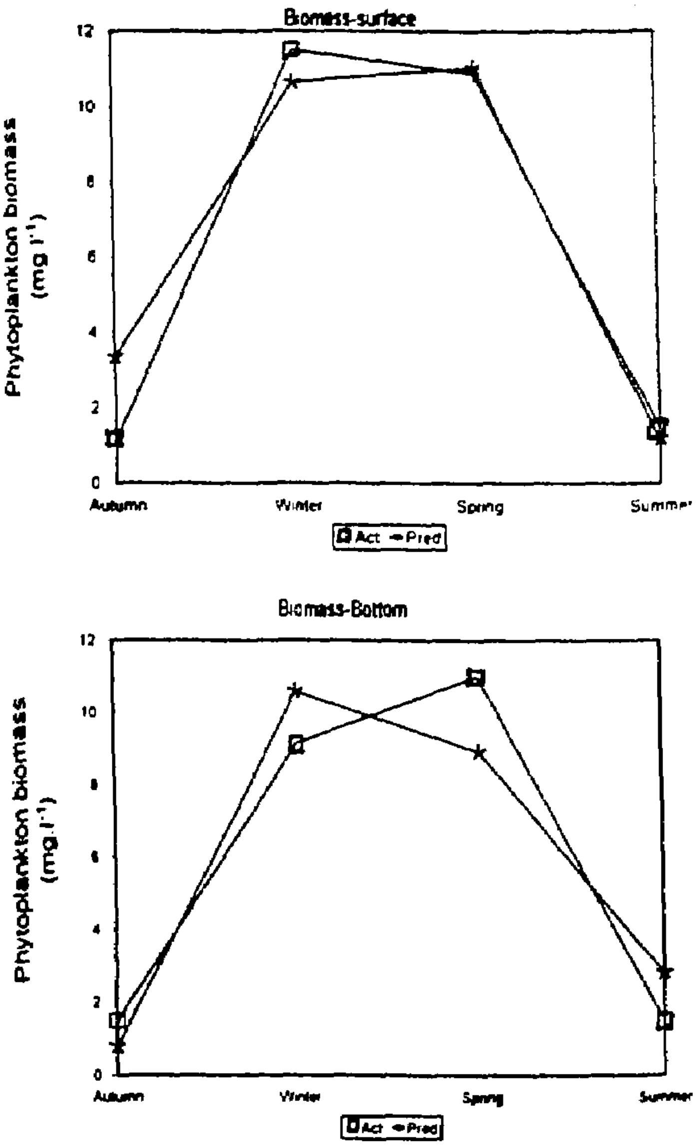

Fig. 8. Comparison of the actual phytoplankton biomass and predicted values according to the multiple regression model in the surface and near bottom water layers.

Table (1): Average biomass (mg. l^{-1}) and numbers (thousand unit.l^{-1}) of the different phytoplankton classes recorded in the surface water and near bottom layer and their percentage frequency to the total phytoplankton

Class	Surface water				Near bottom layer			
	biomass	%	numbers	%	biomass	%	numbers	%
Cyanoph-yceae	3.3858	54.0	2,859	18.1	2.8041	48.5	2,422	16.1
Bacillario-phyceae	1.7109	27.3	2,253	14.3	1.8492	32.0	2,282	15.1
Chloroph-yceae	0.7700	12.3	10,569	67.0	0.7256	12.6	10,284	68.3
Euglenop-hyceae	0.2967	4.7	82	0.5	0.2555	4.4	65	0.4
Dinophyceae	0.1019	1.7	10	0.1	0.1455	2.5	15	0.1
Total	6.2653	100	15,773	100	5.7799	100	15,068	100

الكتلة الحية للعوالق النباتية وعلاقتها بالعوامل البيئية فى مطار النزهة البحرى بالاسكندرية

سميحة محمود غريب

المعهد القومى لعلوم البحار والمصايد ــ الانفوشي ـــ الأسكندرية

درست التغييرات الموسمية للكتلة الحية للعوالق النباتية فى مطار النزهة البحرى فى الفترة من سبتمبر ١٩٨٦ حتى اغسطس ١٩٨٧ وقد جمعت العينات من سبع محطات شملت منطقة البحث حيث تم التعرف على ٦٥ نوع من العوالق النباتية تم قياس ٥٣ نوع منها واستبعد الباقى لندرة وجوده مع حجمه المتناهى فى الصغر.

اظهرت الدراسة زيادة مطردة فى الكتلة الحية للعوالق النباتية فى فصلى الشتاء والربيع وترجع الزيادة الاولى لوجود نوع من الطحالب الخضراء المزرقة المثبتة للنتروجين حيث وصلت الكتلة الى ١١.٥، ٩.١٤ مليجرام فى اللتر وذلك فى الطبقة السطحية للمياه والقريبة من القاع على التوالى. والزيادة الثانية كانت نتيجة لنمو نوع من الطحالب (الدياتومات) حيث بلغت الكتلة الحية على التوالى ١٠.٩ ، ١١.٠ مليجرام فى اللتر وذلك فى طبقتى المياه السطحية والقريبة من القاع.

وقد دلت النتائج على ان انخفاض نسبة النيتروجين الى الفوسفات فى الشتاء (١ : ٦.٣) ادى الى ظهور الطحالب الخضراء المرقة المثبتة للنيتروجين بكمية كبيرة قد تسبب الكثير من المشاكل. لذلك نوصى باستمرار تخصيب مياه الامطار بالمخصبات الصناعية مع التحكم فى النسبة بين ملحى النترات والفوسفات حتى نتلافى ظهور الانواع غير المرغوب فيها من الطحالب الخضراء المزرقة بكمية كبيرة والتى تسبب كثرتها مشاكل للثروة السمكية بالمزرعة.