1st Int. Symp. Phycol. (ISP).
(21-22) Oct. 2000.

Egypt. J. Phycol. Vol. 1, 2000

DIATOM COMMUNITIES ASSOCIATED WITH SOME AQUATIC PLANTS IN POLLUTED WATER COURSES , NILE DELTA.

Mona M. Gaballah[*], **Hussain E. Touliabah**[**] **and Mamdouh S. Serage**[***]

[*] *Botany Department, Faculty of Science (Ismailia), Suez Canal University.*

[**] *Botany Department, Faculty of Girls, Ain Shams University*

[***] *Botany Department, Faculty of Science (Damietta), Mansoura University.*

Abstract

The communities of diatoms associated with some aquatic plants in two polluted water courses in the Nile Delta were identified. Three types of hydrophytes, *Eichhornia crassipes* (Mart.) Sloms, & *Pistia stratiotes* L. as floating hydrophytes; *Ceratophyllum demersum* L., and *Chara* sp. as submerged and *Persicaria salicifolia* (Willd) (Assenov) as emergent species have been distingushed. Relationship between the microalgae and the present hydrophytes were studied.

Forty-six diatom taxa were identified and most of them can be used as indicator of freshwater pollution. *Bacillaria paxillifer, Gomphonema spp., Nitzschia palea, N. lorenziana, Synedra ulna, Navicula viridula, Cyclotella meneghiniana* were the predominant species. Results indicated that pennate forms dominated the centric one. The taxonomic composition of epiphytic diatoms was more or less similar on the different plants during the investigation period. *Eichhornia crassipes, Ceratophyllum demersum* and *Chara sp.* hosted higher number of individuals of associated diatoms. However, lower numbers of individuals were recorded on the emergent species *P. salicifolia.*

The physical and chemical characteristics of the water samples were also analysed and correlations between the occurrence of diatoms and the selected plants in relation to the prevailing environmental parameters were performed. Some heavy metals like Cu and Pb exhibit highly positive correlation with the dominant diatom species as well as diversity index. Nevertheless, water temperature and NH_4–N showed high negatively correlation with the total number of diatoms.

Introduction

Epiphytes are the assemblage of organisms, which develops on submerged plants (Moss, 1980). Some epiphytes are attached to some aquatic plants in particular on their submersed parts, while others are only loosely associated (Round and Hickman, 1971). For many years the attached microalgae to the surface of aquatic plants in wetlands have been ignored as quantitatively studies. Evidence is now that these algae not only productive but can often serve as regulators of nutrient cycling in many fresh waters in particular wetlands (Wetzel, 1993). Not only does the recycling of resources allow very high efficiencies of use of imported resources, but the uptake, assimilation and retention of nutrients are high within the aquatic ecosystem. Hence, an accumulation of nutrients occurs in the attached communities, which results in rapid and maximum retention of loads entering the ecosystem. (Grimshaw *et al.*, 1997).

Diatoms are the most abundant and species rich primary producers in rivers, occurring in all habitats (Round, 1991). They are particular potential for assessments of aquatic bio-diversity and water quality (Cox, 1991). Furthermore, diatoms have been used to provide as measure of the effects of organic and inorganic compounds (e.g. pesticides and metals) effluents in aquatic ecosystem (Stevenson & Lowe, 1986). Diatoms dominate

(ISSN: 1110-8649)

the epipyte community (Ayyad,1980;; El-Khatib, 1991; Nawanko & Akinsoji, 1992; Cox, 1991).It is favoured over algae by their size and form.

In Egypt, unfortunately studies on the diatoms associated with aquatic plants are few e. g. (Ayyad, 1980 and El-Khatib, 1991). The major objective of the present study was to survey and identify various diatoms associated with some different aquatic plants and to relate their diversity to possible environmental factors. In addition to these about, there are good fundamental reasons to examine diatom community on aquatic plants. There remains a long-standing controversy about whether plant surface and architectures significantly affect epiphytic community structure. Some authors note similarities in epiphytic communities among macrophytes (Cattaneo & Kalff, 1979; Fontaine & Nigh, 1983 and El-Khatib, 1991). By contrast, others have recorded variation in epiphytic flora among plant hosts, speculating that macrophyte tissue might provide a specific chemical environment with effects on nutrients (Blindo,1987).

Materials and Methods

Study Area

Two polluted water courses in the north-eastern section of the Nile Delta (Damietta district) were selected for the present study (Fig. 1). These water courses receive sewage effluent and large loads of nutrients especially N and P from agricultural activities and domestic sewage. Large amounts are also leached from the decomposed aquatic plants on the sides of the water courses.

The study area lies in the Nile Delta of Egypt, with warm weather (20-35°C) and mild winter (10-20°C). Rainfall varies from 102 mm/yr, the mean evaporation varies between 2.6 mm/day and 8.1 mm/day. Relation humidity varies from 69% during summer to 89% during winter.

Plant Material

Five macrophytes formed distinct largely mono specific stand in the irrigation and drainage in the Nile Delta (Damietta district) were selected for this study. The submerged *Ceratophyllum demersum* L., *Chara* sp., the free floating *Eichhornia crassipes* (Mart.) Sloms and *Pistia stratiotes* L., the emergent species *Persicaria salicifolia* (Willd). Asseno v.

Samples were collected during winter, spring and summer. 100 gm of each fresh plant part were taken. Each fresh weight washed well with constant volume of distilled water. The attached diatoms were removed mechanically by shaking vigorously in water according to Foester and Schliching, (1965) and preserved in Lugol's (I_2 KI_2). The diatomaceous material was cleaned by sedimentation and centrifugation at 3000 RPM. The residue was washed several times with distilled water until it become free from Lugol's. The carbonaceous matter was then removed by boiling in a mixture of sulphuric acid and potassium dichromate (3:1). The mixture was repeatedly washed with dist. water till it become acid free. Each sample was settled in a one ml chamber and counted with an inverted microscope. Identification of diatoms was according to Prescott, (1961), Hendey, (1964) and Hustedt, (1937). The counted epiphytic diatoms are expressed as a number of species X 10^3/gm.

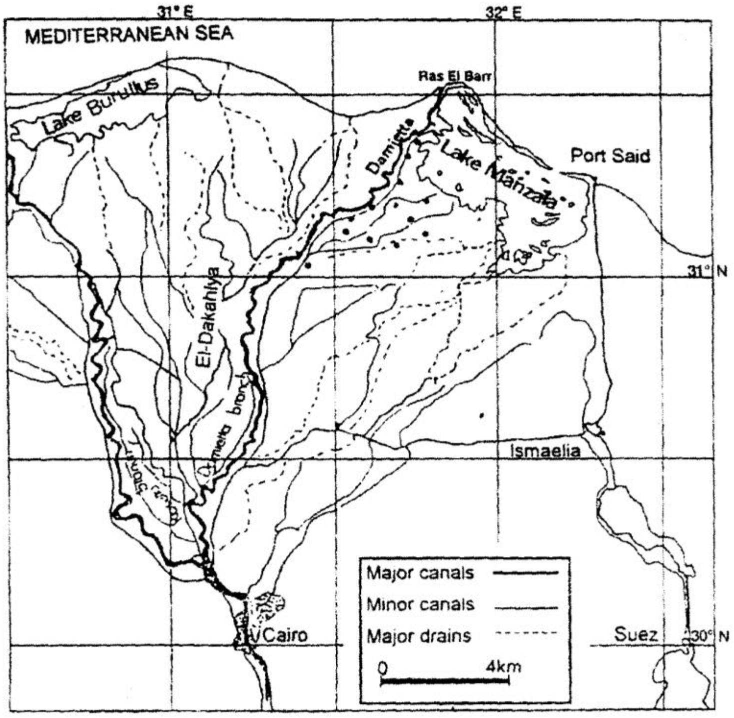


Fig. (1): Location of the investigated area

Water Analysis

Water samples for physico-chemical data were collected at the same time as plants. Water pH was determined using a combined pH meter digital Model 5986. Chemical analyses were carried out according to APHA, (1992). Temperature was measured *in situ* with a mercury thermometer.

Data Analysis

The diversity index components based on Shannon-Winner (1949) information was calculated. Correlation matrix was also applied between the physico-chemical parameters and using Statistic program ver. 5 used epiphytic diatoms on each plant.

Results

Water Quality

The physico-chemical parameters of the two selected sites are presented in Table(1). The highest water temperature 36 °C was recorded in summer and the lowest one was observed in winter 17.6 °C. pH values shifted toward alkaline situations in both canals (6.5 -

7.8). Chemical Oxygen Demand ranged between 5.5 mg O_2 L^{-1} and 18 mg O_2 L^{-1} giving its maximum during summer at site 2. NO_3-N concentrations varied between 298 μg L^{-1} at site 1 in winter and 2500 μg L^{-1} in summer at site 2. NH_4-N levels varied between 1.09 mg L^{-1} at site 1 in winter and 25.30 mg L^{-1} in summer and spring at site 2. PO4-P concentration ranged between 1.30 mg L^{-1} in summer and 3.50 mg L^{-1} in winter. Fe values varied between 1.04 in site 1 in spring and 2.40 mg L^{-1} in summer. Manganese content varied between a minimum of 69.30 μg L^{-1} at site 1 and 710 mg L^{-1} in summer at site 2. Zinc levels fluctuated between 74 μg L^{-1} in winter at site 1 and 330 μg L^{-1} in spring at site 2. Pb concentration showed its maximum occurrence of 123 μg L^{-1} in summer and spring at site 2. Cu ranged between 23 μgL^{-1} in winter at site 1 and 140 μg L^{-1} in site 2 at summer. Cd levels varied between a minimum of 2.26 μg L^{-1} at site 1 and 15.30 μg L^{-1} in spring at site 2. Generally the average values of chemical parameters at site 2 were much higher than those recorded at site 1.

Associated Diatoms

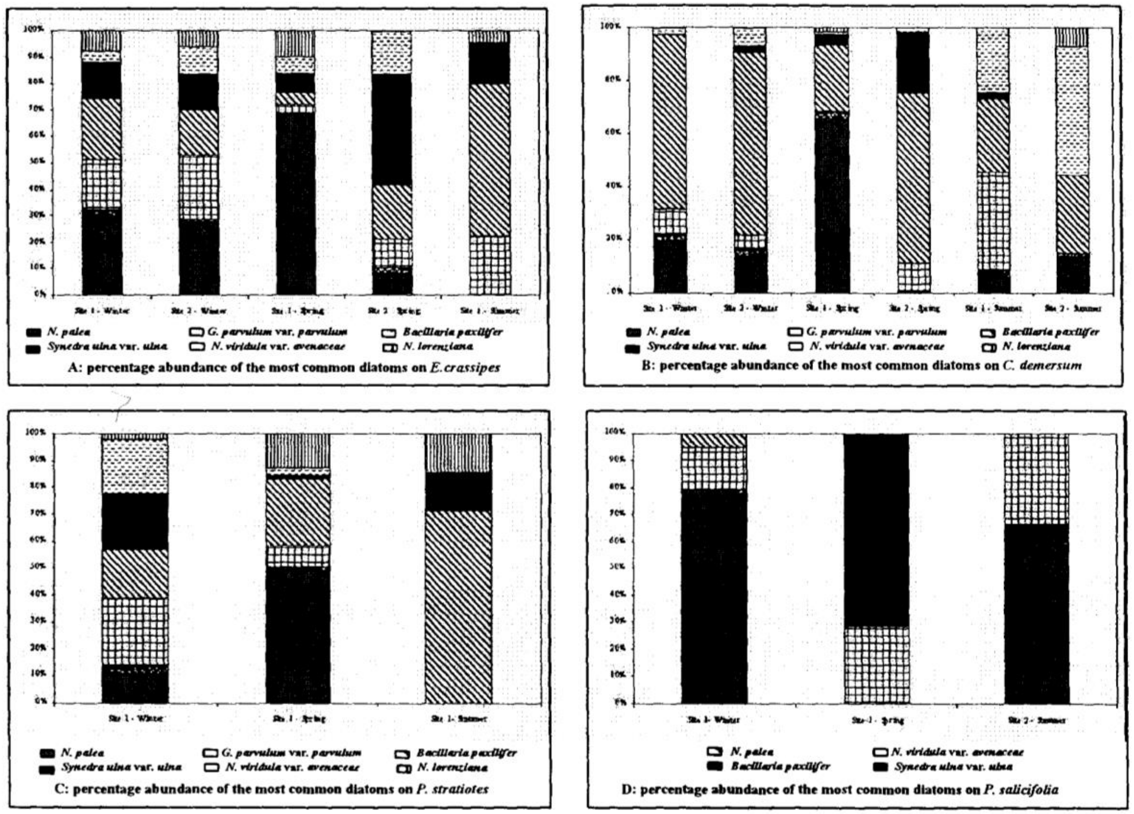
Occurrence of the identified diatoms on the selected parts are presented in Table 2, and their percentage abundance are presented in Fig. 2. A total of 46 diatom species comprising three centric and fourty-three pennate forms were recorded. The most common epiphytic diatom species on the selected aquatic plants were *Bacillaria paxillifer* (O.F. Mull) Hendey. *Gomphonema* were represented by *G. gracile, G. olivaceoum* Kütz, and *G. paravulum* (Kütz). The latter species was the commonest one. *Navicula viridula var. avenaceae* (Breb.) Grun., *Synedra ulna* var. *ulna* (Nitzsh.) Ehr. and *Nitzschia palea* which was not recorded on *Chara* sp during the investigated period. The percentage abundance of these diatoms is represented in Fig. 2. *Bacillaria paxilifer* occurred on all the selected plants with maximum value of 300 X 10^3 cells/gm on *C. demersum* and forming of 53% of the total diatoms abundance in winter at site 2 (Fig. 2,b). *Navicula viridula* var. *avenaceae* also was recorded on all studied plants reaching its highest value (80 X 10^3 cells gm^{-1}) occurred on *Chara* sp in winter at site 1 (Fig. 2,e). It formed 8.6% of the total diatom. *Nitzschia palea* was observed on all the selected plants except *Chara* sp.

Other diatom species appeared with an abrupt increrase on some selected aquatic plants and contributed high percentage abundance. On *E. crassipies*, *Aulocosira granulata* var. *granulata* and *Stauronies anceps* Ehr. formed about 38% and 15.2% of the total diatoms respectively. Also on *Chara* spp, *Calonies permagna, Navicula dicephala, Navicula pygmaea* and *Nitzschia obtusa var. scalapelliformis* contributed about 29.38%, 10.75%, 12.37% and 21.51% of the total diatoms respectively. *Gyrosigma spencrii* was more dominant on *P. stratios* which formed 15.87% of the total diatoms.

The highest values of species diversity (2.9 bits ind^{-1}) were recorded on *E. ceassipes* and *P. stratiotes* while the minimum (1.0) recorded on *P. salicifolia*.

Table (1): Some physico-chemical characteristics of the irrigation (site1) and drainage (site 2) canals during the study period.

Parameters		Winter		Spring		Summer		Mean		Absolute value			
										Max.	Min.	Max.	Min.
		Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 1	Site 2	Site 2
Water temperature	°C	17.60	19.00	32.00	35.00	36.00	36.00	28.53	30.00	36.00	17.60	36.00	19.00
PH		7.40	6.50	7.80	7.40	7.10	7.00	7.43	6.97	7.80	7.10	7.40	6.50
COD	mg O_2 L^{-1}	5.50	10.30	14.90	17.00	12.60	18.50	11.00	15.27	14.90	5.50	18.50	10.30
HCO3	mg L^{-1}	76.00	192.60	242.50	325.00	220.00	227.00	179.50	248.20	242.50	76.00	325.00	192.60
CO3	mg L^{-1}	5.30	6.58	1.80	7.50	10.50	12.30	5.87	8.79	10.50	1.80	12.30	6.58
Na	mg L^{-1}	75.00	89.60	74.00	89.50	93.00	118.00	80.67	99.03	93.00	74.00	118.00	89.50
K	mg L^{-1}	6.90	8.80	3.70	5.60	1.30	1.50	3.97	5.30	6.90	1.30	8.80	1.50
Ca	mg L^{-1}	34.70	44.60	31.60	50.30	45.10	69.00	37.13	54.63	45.10	31.60	69.00	44.60
Mg	mg L^{-1}	400.00	710.60	864.00	951.00	771.00	758.00	678.33	806.53	864.00	400.00	951.00	710.60
NO2-N	µg L^{-1}	66.10	140.80	46.60	120.00	73.00	188.00	61.90	149.60	73.00	46.60	188.00	120.00
NO3-N	µg L^{-1}	298.00	740.60	409.50	1900.00	581.00	2500.00	429.50	1713.53	581.00	298.00	2500.00	740.60
NH4-N	mg L^{-1}	1.09	1.30	8.20	25.30	4.10	25.30	4.46	17.30	8.20	1.09	25.30	1.30
PO4-P	mg L^{-1}	1.90	3.50	1.68	2.74	1.30	2.80	1.63	3.01	1.90	1.30	3.50	2.74
Si	mg L^{-1}	5.69	5.40	5.05	5.40	5.60	6.50	5.45	5.77	5.69	5.05	6.50	5.40
Fe	mg L^{-1}	2.40	3.27	1.04	1.39	1.40	1.88	1.61	2.18	2.40	1.04	3.27	1.39
Mn	µg L^{-1}	69.30	120.00	122.50	710.00	133.20	187.00	108.33	339.00	133.20	69.30	710.00	120.00
Zn	µg L^{-1}	99.80	150.00	74.00	330.00	220.00	145.30	131.27	208.43	220.00	74.00	330.00	145.30
Pb	µg L^{-1}	29.90	123.00	35.60	120.50	35.00	45.50	33.50	96.33	35.60	29.90	123.00	45.50
Cu	µg L^{-1}	23.60	140.60	35.60	50.60	45.90	51.80	35.03	81.00	45.90	23.60	140.60	50.60
Cd	µg L^{-1}	2.26	13.20	5.10	15.30	7.50	8.30	4.95	12.27	7.50	2.26	15.30	8.30



A: percentage abundance of the most common diatoms on *E. crassipes*

B: percentage abundance of the most common diatoms on *C. demersum*

C: percentage abundance of the most common diatoms on *P. stratiotes*

D: percentage abundance of the most common diatoms on *P. salicifolia*

Fig. (2): The percentage abundance of the most dominant diatoms on selected aquatic plant.

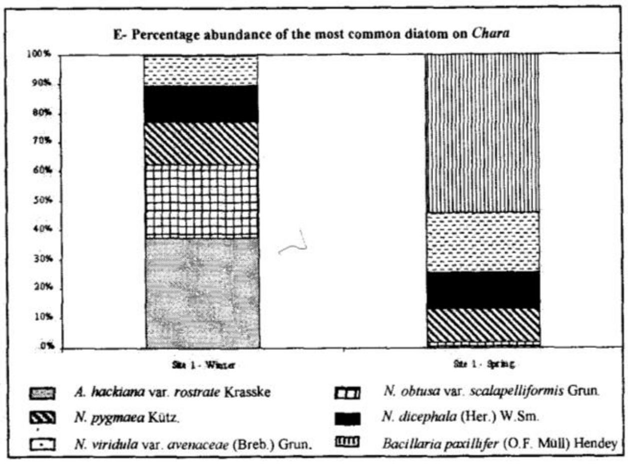


Fig. 2. Continued: The percentage abundance of the most dominant diatoms on selected aquatic plant

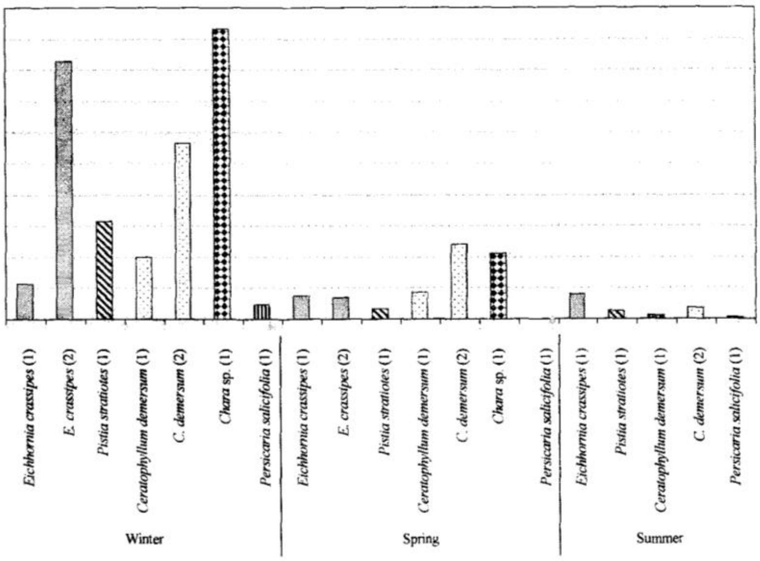


Fig. (3): Distribution of the total numbers of Diatoms at the selected plants.

Table 2. Occurrence of epiphytic diatoms (No. of Individuals X 10^3/gm) recorded over the study period on the five aquatic plants in some polluted courses in the Nile delta. I=Site 1, II= Site 2.

Season	Winter							Spring							Summer				
	E. crassipes	*E. crassipes*	*P. stratiotes*	*C. demersum*	*C. demersum*	*Chara sp*	*P. salicifolia*	*E. crassipes*	*E. crassipes*	*P. stratiotes*	*C. demersum*	*C. demersum*	*Chara sp*	*P. salicifolia*	*E. crassipes*	*P. stratiotes*	*C. demersum* I	*C. demersum* II	*P. salicifolia* I
Diatoms	I	II	I	I	II	I	I	I	II	I	I	II	I	I	I	II	I	I	II
	Centrales							Centrales							Centrales				
Aulacosira granulata (Eher.) Sim.	0	6	120	0	0	0	0	1.1	18	1.4	0	0	0	0	0	1	0	0	0
A. varians Ag.	0	15.6	0	0	0	0.1	0.8	0.1	0	0	1.4	0	0	0	0	0	0	0	0
Cyclotella meneghiniana kütz.	0	32.3	0	10	50	0	0	0	0	0	2	4	0	0	34	0	0	0	0
	Pennales							Pennales							Pennales				
Achnanthes brevipes Ag.	0	80	0.1	0	0	0	0	0.1	0.1	0.2	1	1.4	0.7	0	0	0	0.1	0	0
A. minutissisma kütz	0	0.2	0	10	0	0	0.1	0	0	0.5	1.4	0	0.1	0	0	0	0.1	0	0
A. hackiana var. rostrata Krasske	18	0.1	0.1	9	0.2	300	0	1	0.2	0.8	0.1	0	0.1	0	0	0	2.2	0	0
Amphora coffeaeformis Ag.	0	27	20	0.1	0	0	0	0.4	0.2	0.2	0	0	0.1	0	6.8	2	0.1	0	0
A. ovalis var. pediculus kütz.	0	30	0	0.2	0.1	0	0	0.2	4	0.1	0	0	0.2	0	0.4	0	0.2	0	0
Bacillaria paxillifer (O.F. Müll) Hendey	14.6	50	18	90	300	3	30	3	4	6	11	141	62	0	10.2	4	2.2	8	2
Caloneis permagna (Bail.) Cleve.	0	0	0	0	0	1	0	0	0	0	0	0	0.3	0	0.8	0	0	0	0
C. bacillum Grün.	0	0	0	0	0	128	0	0.2	0	0	0.1	0	0	0	0.4	0	0	0	0
Cocconeis calcare Cl. A. Cl.	0	0.3	10	0	9	0	0	0.1	0.2	0.8	0	0	0.2	0	0.1	0	0	0	0
C. placentula Eher.	0	1	1	0	0.3	2	0.1	0.2	0.3	0.1	2	0	1	0.1	0	0	0	0	0
Cymbella cesatii (Roben) Grün.	0	0.4	0.5	0	0.9	0	0	0	0	0	0	0	0.1	0	4	0	0	0	0
C. affinis kütz.	0.2	0.1	0	0	0.1	0.1	0	0	0	0	0	0	0.2	0	0	0	0	0	0
Cymatopleura solea (Breb.) W.sm.	2	0.1	0	0	0	0	0	0	0.1	0	0	0	15	0	0.8	0	0	0	0
Diploneis-ovalis kütz.	0	0.1	0	0	20	0	0	0	0	0	0	11.7	6	0	3	0	0	0	0
Eunotia sp.	0	0.1	0.1	0	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
Gomphonema gracilis var. lanceolatum Kütz.	3	60	0	5	2	0.2	0.3	0.1	2	0.1	0	0	0	0	3	13	0	0	0
G. parvulum var. parvulum Kütz.	12	70	25	13	25	0.1	0.2	1.8	2	1.8	0	23	13	0	4	0	3	0	0
G. olivaceoum (Lyngb) Kütz.	0	10	2	10	22	0	0	1	4	0.8	0	0.2	12	0	4.5	0	0	0	0
Gyrosigma spencrii Kütz.	2	0	50	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G. macrum (W.Sm) Cl.	0	0	0	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hantzschia amphioxys (Eher.) Grun.	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. continued.

Diatoms	I	II	I	I	II	I	I	I	II	I	I	II	I	I	I	II	I	I	II
Navicula radiosa kütz.	0	0.3	0.1	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	2	0
N. hungrica Grün.	4	2	0.1	0	2	0	0	0.1	0.1	2	0	0	0	0	0	0	0	0	0
N. viridula var. viridula kütz.	0.2	21	11	0.1	0.1	0	4	2	4	0.4	0.7	2	0.2	0.1	4	4	1	3	2
N. viridula var. avenaceae (Breb.) *Grun.*	2.6	30	20	3	30	80	6	4	3	0.6	0.3	4	24	0.2	0	0	2	13	1
Navicula dicephala (Her.) W. Sm.	0	0.3	0.1	3	0	100	0	0.2	0.1	0.2	0.1	0.2	14	0.2	0	0	0	0	0
N. pygmaea kütz.	1	4	0	0	8	115	0	0	0	0	0	0	13	0	0	0	0	0	0
N.pupula kütz.	0	0.2	0	0	0.1	0	0	0.1	2	0	0	0	0.1	0	0	0	0	0	0
Nitzschia amphibia Grun.	0.1	6	0.1	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0.1	0
N. dissipata (Kütz) Grun.	16	30	0.2	15	0	0	0	0.8	0	0.4	0	0	0.1	0	0	0	0	0.1	0
N. filiformis (kütz.) Grun.	0	10	0	0.1	0	0	0	0.1	0	0.6	6	0	14	0	0	0	0	0	0
N. hungarica Grun.	0	5	0	0.1	0.2	0	0	0.1	0	0.4	0.1	0	14	0	0	0	0	0	0
N. linearis (Agardh) W. Sm.	0	2	0.1	0	0	0	0	0	0.1	0	13	0	2	0	0	0	0	0	0
N. obtusa var. scalpelliformis Grun.	0	15	0	0	10	200	3	0	0	0	1	0	2	0	0	0	0	2	0
N. palea (kütz.) W. Sm.	21	84	13	30	70	0	2	45	2	12	30	1.8	0	0	0	0	0.7	4	0
N. parvula W. Sm.	0	26	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0.1	0	0
N. sigma Kütz.	2	0.5	0	0.1	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0
N. lorenziana Kütz.	5	18	2	0.7	2	0.7	0	6.3	0.1	3	0.7	0	0	0	0.8	0.8	0	2	0
N. scalaris Grun.	0	0	2	0	2	0	0	0	0	0	13	0	0	0	0	0	0	0	0
Pleurosigma angulatum (Queck) W.Sim.	0	20	0	0	0	0	0	0	12	0	0	0	0.8	0	0	0	0	2	0
Surirella ovata Kütz	0	4	0	0	0	0	0	0	0.8	0	0	0	0.8	0	0	0	0	0.1	0
Synedra ulna var. ulna (Nitzsch) Ehr.	9	40	20	0	10	0	0	5	8	0.3	2	51	0.2	0.5	2.7	0.8	0.2	0	0
Stauroneis anceps Ehr.	0	126	0	0	0	0	0	0.8	0	0	0	0	0	0	1.7	0	0	0	0
Total	112.7	827.7	315.5	199.9	564.2	930.2	46.5	74.1	67.4	32.9	85.9	240.3	211.4	1.1	81.2	25.6	11.9	36.3	5
No. of Species	17	41	24	21	25	14	1 0	26	24	23	19	11	30	5	17	7	12	11	3
Diversity Index	2.314	2.906	2.056	1.887	1.727	1.727	1.222	1.632	2.335	2.222	2.018	1.268	2.374	1.414	2.073	1.467	1.944	1.838	1.055

Discussion

In the Nile Delta, the problem of water pollution and the change in water quality in particular water transparency is one of many interrelated environmental factors e.g. high load of nutrients especially N and P (Serage,1991), industrial pollution and human activities (Khedr & El-Demerdash, 1995).

The two water courses are irrigation and drainage canals were characterized by its high organic matter. COD values ranged between 5.5 and 18 mg O_2 L^{-1}, concentrations of dissolved nutrients in particular NO_3-N, NH_4-N and PO_4-P were above limits demonstrating the polluted nature of both canals due to they receive sewage effluent and, large agricultural activities. Large amounts of these nutrients are leached from the decomposed aquatic plants on the sides of the water courses (Serage, 1991). Heavy metals concentrations were comparatively high and its order was Fe > Mn > Pb > Cu > Cd. On the average of the chemical parameters, drainage canal exhibit high nutrient than irrigation canal.

A total of 46 diatom species were identified, comprising 3 centric and 43 pennate forms. The majority of the attached diatoms mostly pennate that are attached to plants by mucus pads, stipes or by direct adherence of frustules. Some diatoms which are common members of the plankton were often trapped by the roots or held in the tangle of attached forms. These include *Aulacosira granulata* (Eher) Sim., *A. varians* (Ag.) and *Cyclotella meneghiniana* (Kütz). The same result was found by (El-Khatib, 1991).

The chemical characteristics of the two polluted water courses reflecting impression about the species composition of diatom communities associated with the selected plants. Most of them are indicators of eutrophic and organically polluted waters (Kazmierz, 1984) and tolerant to some of heavy metals. They showed a positive significant correlation with both PO_4-P($r = 0.5$ to 0.79, at $p < 0.05$) and Cu & Pb ($r = 0.63$ to 0.88, $p < 0.05$). In general, phosphorus tend to be the element controlling the rate of plant growth and is responsible for eutrophication (Vymazal, 1995). Whitton, (1970) indicated that, *Nitzschia palea, Gomphonema parvulum* and *Navicula viridula* could tolerate Cu concentrations exceeding 1 mgl^{-1} also the occurrence of *Syndra ulna* and its resistance to municipal sewage and chemical plant waste was reported by (Turboyski, 1979 & El-Khatib 1991). *Bacillaria paxillifer* was recorded on *E. crassipes* in organically polluted water in Nigeria (Nwankwo & Akinsoji, 1992).

Contradictory results have been reported on the selectivity of epiphytic algal species with respect to substrate, thus, while some authors found clear difference in species composition as a function of substrate (Antonie *et al*, 1986 and Gough and Gough, 1986) Others concluded that most algae are non selective and note similarities in epiphytic communities among macrophytes in eutrophic waters (Cattaneo & Kallf,1979 and Fontaine & Nigh, 1983).

The results of the present investigation are in a good agreement with the latter standpoint, since the species composition of associated diatoms (Fig. 2) was more or less similar on the selected plants and they are more correlated to characteristics of the two polluted water courses. In this respect, Ayyad,1980; El-Khatib, 1991 and Tesoin & Tell, (1996) reported that, different macrophytes from the same location host very similar algal assemblage. Confirming to the previous results, Cattaeno et al., (1998) indicated that, the species composition of the epiphytic algae was more closely correlated to water characteristics rather than the plant type. On the other hand, the abrupt increase of *Achnanthus hauckiana* var. *rostrata, Navicula pygmyeae, N. dicephala* and *Nitzschia obtusa* var. *scalapelliformis* than the classical dominant species on *Chara* sp in addition to the absence of a *Nitzschia palea* may be related to inhibitors formed by basiphyte (Round,1981). Two sulpher compounds were extracted from Charales inhibiting a *Nitzschia palea* (Antonie *et al.*, 1980) and this may support the first standpoint.

With regard to the total species and diatom individual's *E. crassipes*, *C. demersum*, *Chara* and *P. stratios* hosted higher numbers as compared with *P. salicifolia* (Table 2). This is may be explained by the physical nature of the host plant (Round, 1981) and architecture (Cattaeno *et al.*, 1998). The morphology of the root net of the floating plants e.g. *E. crassipes and P. striotes* also the dissected leaves of the *Chara* and leaves of *C. demersum* form bowl-shaped whorls net tightly together particularly near the tip of the stem all together representing a more efficient epiphyton retaining trap. While the emergent *P. salicifolia* had a smooth surface tended to it having a few number of associated diatoms, in connection with this information, the smooth stips of *Laminaria digitata* has few epiphyte relative to the rough stipe of *L. hyperborea* (Round, 1981).

Shading of macrophytes may blay an important role in distribution of epiphytic diatoms distribution (Grimshow *et al.*, 1997). *P. salicifolia* occurred beside the bank of the water courser, while floating as well as submerged occurred in the middle of the water bodes where irradiance was higher (Serag, 1991) with promote the proliferation of these microorganisms. The less number of diatoms individuals may be explained by some inhibitory substance from the host plant to epiphyte (Anthoni *et al.*, 1980).

From the quantitative point of view, the total number of diatoms individuals and species were summer (Fig. 3.) as compared with that of winter. This is may be explained by the seasonal variables especially water temperature, NH_4-N level and grazing. Our results demonstrate that the maximum value of water temperature and NH_4-N occurred in summer (Table 1), also the total number of diatoms was highly negatively correlated with water temperature and NH_4-N ($r = -0.8$ and -0.54, $p < 0.05$ respectively). Confirming our result Patrick *et al.* (1968) found that an average temperature of 34 °C to 38 °C resulted in a shift of the dominance in the algal flora from diatoms to blue-green algae or may be due to a rapid rise of zooplankton Vymazal (1995).

Conclusion

- The majority of associated diatoms on the selected plants include those species that have been associated with eutrophytic and organically polluted sewage water.
- The watercourses of Nile Delta were rich in nutrients which support growth on many aquatic macrophytes and epiphytic diatoms.
- The decrease and increase of the number of diatoms on selected macrophyte plants depend on; the physical nature of the plant, and architecture. The more varied morphology resulted in a higher diversity and individuals of associated diatoms. The absence of some diatom species may be due to inhibitory substances excreted from the host plant.
- The seasonality variables especially temperature and ammonia control the distribution of epiphytic diatoms.
- This study demonstrates a strong effect of aquatic plant species and architecture on the development of epiphytic diatoms and could be used in fish culture and water management.
- The obtained results based on macrophytes and associated diatoms will be useful for the general guideline for monitoring the organic pollution in the irrigation and drainage Canal in the Nile Delta.

References

American Public Health Association, APHA. 1992. Standard methods for the examination of waste water. 18th Edition. 1015 Fifteenth Street. NW. Washington, DC, **pp. 20005**.

Antoine, R., Cairms, J., Jr., and Schmeyer, A. 1986. Use relative sensitivity of diatoms and fish to twenty common constituents of industrial waters progress. *Fish culture*, **30: 137**.

Anthoni, U., Christophersen, C., Madsen, J., Wium-Anderson, S. and Jacobsen, N. 1980. Biologically active sulphur compounds from the green alga *Chara globularis*. *Phyto. Chem.*, **19: 12278-1229**

Ayyad, S. M. 1980. Ecological studies on the epiphytic algae inhabiting some hydro-macrophytes on Mansoura-Damietta Area. M.Sc.Thesis, Botany Department. Fac. of Science, Mansoura University, **pp.148**.

Blindo, I. 1987. The composition and density of epiphyton on several species of submerged macrophytes – The neutral substrate hypothesis tested. *Aquat. Bot.* **26: 157-168**.

Cattaneo A. and Kalfe, J. 1979. Primary production of algae on natural and artificial aquatic plants: a study of interactions between epiphytes and their substrate. *Limnol. Oceanogr*, **24:1031-1037**.

Cattaneo, A., Galanti, G., Gentinetta, S. and Romo, S. 1998. Epiphyitic algae and macroinvertebrates on submerged and floating – leaved macrophytes in an Italian lake. Fresh water biology **39:725-740.**

Cox, E.J. 1991. What is the basis for using diatoms as monitors of river quality ?. In. WHITTON, B.A., Rott, and FRIEDRICH, G. (eds.). Use of algae for monitoring rivers Proceedings of an International Symposium. Land esamt Für Wasser und Abfall Nord and heir Wesr falen, Düsseldorf, Germany, **pp. 33-40**.

El-Khatib, A. A. A. A. 1991. Ecological studies on the hydrophytes and their epiphytic algae in relation to water pollution at Sohag area, Egypt. Msc. Thesis. Assuit Univ. **pp.126.**

Foester, J. and Schliching. H. 1965. Phyco-periphyton in an oligotrophic lake. *Trans. Am. Micros. Sos.*, **84:485-502**.

Fontaine, T.D. III and Nigh, D. G. 1983. Characteristics of epiphyte communities on natural and artificial submersed lotic plants: substrate effects. *Arch Hydrobiol.*, **96:293-301**.

Gough, S. and L. Gough. 1986. Comment on primary production of algae growing on neutral and artificial aquatic plants. A study of interactions between epiphytes and their substrate. *Limnol. Oceanog.*, **26: 978-988**.

Grimshaw, J.H., Wetzel, R.G., Brandenburg, M., Segerblom, K., Wenkarl, J.L., Marsh, A.G., Charnetzky, W., Haky, E.J. and Carracher, C. 1997. Shading of periphyton communities by wetland emergent macrophytes: Decoupling of algal phytosynthesis from microbial nutrient retention. *Arch. Hydrobiol.*, **139(1):17-27**

Hendey, N.I. 1964. An Introductory account of the smaller algae of British Coastal water. Pt. V. Bacillariophyceae (Diatoms) Ministry of Agriculture and Food. Fishery investigation. Serial Iv. Xxi.+ 317 pp. HM .

Hustedt, F. 1937. Die Kieslagenᵛ. In: RABENHORST (ed.): Kryrtogamen. Flora von Deut Schland, Osterreich und der Schweiz. Akademische Verlags gesell-Schalf M.L.H. Leipzig.

Kazimierz, W. 1984. Diatom communities in pure and polluted waters in Biala przemsza river basin (Southern Poland). *Acta Hydrobiol.* **25/26.**

Khedr, A.A. and El-Demerdash, M.A. 1995. Distribution and environmental relation of the aquatic macrophytes in the north-east Nile Delta, Egypt. Proceedings of the Fifth International Conference (environmental protection is a must), **pp.197-216** .

Moss, B. 1980. Ecology of Fresh water. Blackwell Nakai, S.; Inove, Y.; Hosomi, M. and Murakami, A. 1999. Growth inhibition of Blue-green algae by Allelophytic effects of macrophytes. *Wat. Sci. Tech.* **39(8):47-53** .

Nawanko, D.I. and Akinsoji, A. 1992. Epiphyte community on water hyacinth *Eichhornia crassipes* (MART.) SOLMS in coastal waters of south-western Nigeria. *Arch. Hydrobiol.*, **124(4):501-511** .

Patrick, R., Cairms, J. and schmeyer, A. 1968. The relative sensitivity of diatoms and fish to twenty common constituent of industrial waters progress. *Fish cultures*, **30:137.**

Prescott, G.W. 1961. Algae of the Western Great Lake Area. *Wm. C. Brown Co. Iowa*: **pp. 977.**

Round, F.E. 1981. The ecology of Algae. Cambridge, University press, Cambridge. **pp. 77.**

Round, F.E. 1991. Use of diatoms for monitoring rivers. In WHITION, B.A., ROTT, E. FRIEDRICH, G. (eds.). Use of algae for monitoring rivers. Proceedings of an International Symposium. Landesamt für wasser und Abfall Nordrhein. Westfalen, Düsseldorf, Germany, **pp.25-32** .

Round, F. E. and Hickman, M. 1971. Phytobenthos sampling and estimation of primary production. In: IBP Handbook no. 16, Holme, N.A. and McIntire (eds.). BlackwellScientificPublications, Oxford **pp 169.**

Serage, M. 1991. Studies on the ecology and control of aquatic and canal bank weeds of the Nile Delta, Egypt. Ph.D. Thesis, Mansoura University.

Shannon, C. E. & weaver, W. 1949. The mathematical theory of communication – the University of Iiionis. Press, III ionis

Stevenson, R.J. and Lowe, R.L. 1986. Sampling and interpretation of algal patterns for water quality assessment. In Rationale for sampling and Interpretation of ecological Data in the assessment of freshwater ecosystems (B. Isom, ed.), ASTMSTP 894. *Am. Soc. Test., Mater.*, Phildelphia.

Tesolin, G. and Tell, G. 1996. The epiphytic algae on floating macrophytes of a parama river floodplain lake. *Hydrobiologia* **333:111-120** .

Turoboyski, L. 1979. *Hydrobiologia techniczna*, PWN, *Warszawa* **pp. 444.**

Vymazal, Jan. 1995. Algae and element cycling in wetlands. Lewis publishers.

Wetzel, R. G. 1993. Constructed Wetlands: Scientific foundations are critical. In : Moshiri, G. A. (ed.): Constructed Wetlands for Water Quality Improvement. Lewis Publishers, Inc., Chelsea, MI. **pp.3-7.**

Whitton, B. A. 1970. Toxicity of heavy metals to fresh water algae : a review, *Phykos*, a, **9:116.**

مجتمعات الدياتومات المصاحبة للنباتات المائية فى بعض القنوات المائية الملوثة – دلتا النيل

منى محمد جاب الله * - حسين السيد طليبة ** - ممدوح سالم سراج الدين***
* جامعة قناة السويس – كلية العلوم – قسم النبات
** جامعة عين شمس – كلية البنات – قسم النبات و الميكروبيولوجيا
*** جامعة المنصورة – كلية علوم دمياط – قسم علوم البيئة النباتية

تم التعرف على بعض الدياتومات المصاحبة لبعض النباتات المائية فى بعض القنوات الملوثة فى دلتا النيل و دراسة مدى العلاقة بين هذه الدياتومات و النباتات المختارة هى : ورد النيل و الزقيم (من النباتات الطافية) و نخشوش الحوت و الكارا من النباتات شبة المغمورة و ضرس العجوز من النباتات المغمورة .

تم التعرف على ٤٦ نوع من الدياتومات التى يمكن إستخدام معظمها كمؤشر لتلوث البيئة المائية . كما نجد أن الأجناس السائدة لمجموعة الدياتومات هى البسيلاريا بازليفر و الجمفونيما و النتشيا باليا و النتشيا لورانزيا و السينيدرا اولنا و النافيكيلا فريدولا و السيكلوتيا منجهنيانا . كما نجد أن الدياتومات الريشية أكثر شيوعا من الطحالب الشعاعية القرصية و لقد و جد أن هناك تقارب ال حد كبير فى تشابه محتوى النباتات المائية من الدياتومات وقت الدراسة . كما لوحظ أن أعداد الدياتومات التجمعه على كل من ورد النيل ونخشوش الحوت كانت أكثر من تلك الأعداد المتجمعة على النباتات المغمورة (ضرس العجوز).

تم أيضا دراسة العوامل الفيزيائية و الكميائية و مدى العلاقة بينهم و النباتات المائية و الدياتومات المصاحبة لهما. كما تم تقدير كمية بعض العناصر الثقيلة مثل الحديد و النحاس و الزنك و الرصاص و الكادميوم حيث وجد أن هناك علاقة موجبة بين النحاس والرصاص مع الدياتومات و معامل التنوع بينما كانت درجات الحرارة والأمونيا لها تأثير عكسى مع الكثافة الكلية للدياتومات.