STANDING CROP AND DISTRIBUTION OF ALGAL POPULATIONS OF ISMAILIA CANAL IN RELATION TO POLLUTANTS OF THE CHEMICALS AND FERTILIZERS FACTORY AT ABU-ZABAL

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Abstract:

The present study represents a comprehensive monthly investigation at the polluted sector in the Ismailia Canal facing chemicals and fertilizers factory at Abu-Zabal, compared with unpolluted sector at El-Mezallat region. The changes in algal standing crop and physico-chemical characteristics of Ismailia Canal water at the two sectors were studied from September, 1996 to August, 1997. The standing crop showed distinct seasonal variations. The dominance of algal groups was arranged in the following descending classes:
Chlorophyceae > Bacillariophyceae > Cyanophyceae > Dinophyceae. The number of species recovered in the polluted sector was lower but always higher in the total algal count than in the control sector. At polutted site, the values of pollution index ranged between 0.016 and 0.056. On the other hand levels of eutrophication index ranged from 0.70 to 2.07. These data indicate that Ismailia Canal water facing chemicals and fertilizers factory at Abu-Zabal is oligotrophic to mesotrophic with heavy inorganic pollution.

Key words: Abu-Zabal, chemicals and fertilizers, Ismailia Canal, phytoplankton, pollution.

Introduction

The wastewater effluents discharged into the Ismailia Canal by the chemicals and fertilizers factory in the region of Abu-Zabal caused many complicated problems to the Ismailia Canal water at this area.

Little works were carried out on Ismailia Canal. Nassar (1980) studied the algal flora of three water habitats in the vicinity of Cairo. These habitats were, River Nile, Ismailia Canal and Tawfikia Canal. She concluded that these habitats are slightly polluted. Ismail (1984) investigated the association aspects between algae and macrophytes in different water ecosystems including one site of Ismailia Canal at Cairo.

The aim of this study was to follow up monthly sampling the changes in the physico-chemial characteristics and consequently in phytoplankton composition and concentration in the Ismailia Canal water near the chemicals and fertilizers factory of Abu- Zabal. Sampling was carried out monthly from September 1996 to August 1997.

(ISSN: 1110-8649)

Materials and Methods:

Sampling sites:

Site (1): The polluted site was located in front of the chemicals and fertilizers factory of Abu-Zabal along the main course of the Ismailia Canal about 20 km north of El- Mazallat region.

Site (2): The control site was situated at El- Mazallat region (the beginning of Ismailia Canal in Cairo).

Sampling:

Subsurface water samples were collected monthly from each site. Four replicates were collected from around each sampling site at different distances. These replicates were mixed together and again divided into four or more portions.

Water temperature and dissolved oxygen were measured in Situ using DO_2 Meter (JENWAY, Model 9071). PH value was recorded using a field pH meter (pH PEN JENCO 610).

Transparency (visibility) was measured by using Scecki disc (25 Cm in diameter) according to Allen *et al.* (1974).

Water analysis:

Analysis of water including chloride, sulphate, carbonate, bicarbonate, phosphate-P, nitrate-N, Silicate-Si, total alkalinity, total soluble salts and major cations were determined according to the methods recommended by the American public Health Association (1985). Aliquots of water samples were preserved for subsequent counting and identification of algae using Lugol's solution with acetic acid.

Identification and counting:

Living and preserved cells were identified according to the systems proposed by Nygaard (1976); Palmer (1980); Bourrelly (1981) and Prescott (1982). Diatoms were cleaned and identified according to Riley (1967). Centrifugation was carried out to concentrate algal cells and counting was conducted by means of Sedgwick-Rafter cell (American Public Health, Association, 1985). Any filamentous or massed colonial forms were counted as one cell. The results were, expressed as counts per one litre.

Statistical analysis:

Species diversity index (H):

The appropriate statistic in Brillouin's index (Pielou, 1966) was used for quantitative analysis of species diversity of phytoplankton

$$H = \frac{1}{N} \log 10 \frac{N^!}{N^!1\,N^!2\,N^!3\,N^!s}$$

Where, H is Brillouin's diversity index, N is the total number of individuals and $N^!s$ is the number of individuals of the S^{th} species.

Pollution index (d):

The degree of pollution was analysed according to Shannon and Weaver (1963).

$$d = -\sum_{i}^{S} ni/n \log 2\,(ni/n)$$

where, (ni) is the number of individual sp. in the i^{th} species (S) and (n) is the total number of individuals collected.

Eutrophication index (E.I):

It is determined according to (Nygaard, 1949 and Round, 1981).

$$E.I. = \frac{\text{cyanophyceae} + \text{chlorococcales} + \text{centric diatoms} + \text{Euglenophyceae}}{\text{Desmids}}$$

Results and Discussion

The changes in water chemistry at the two sections selected were followed at regular months during a period of one year, extending from September 1996 up to August 1997. Details of temperature, visibility, pH value and levels of dissolved oxygen were also considered (Table 1). Regular monthly measurements of water temperature showed always a slight increase in either average maxima or average minima in the polluted site (chemicals and fertilizers factory) as compared with those recorded for unpolluted site.

The pH values of the unpolluted site during this study was on the alkaline side. On the other hand most of the pH values of the unpolluted site were on the acidic or neutral side and fluctuated from 3.55 to 7.65 (Table 1). The low pH figures recorded for water of Ismailia Canal at site 1 could be mainly attributed to the influence of wastewater effluents discharged into Ismailia Canal water from the chemicals and fertilizers factory of Abu-Zabal at this area.

The acidic levels of waters seemed to affect considerably the growth and distribution pattern of some phytoplankton groups (Erondu and Chindah 1991). For instance Chlorophyta members profoundly flourished under these situations. The percentage distribution of such group ranged between 38.71% to 86.60% of total populations (Table 2). Flourishment of Chlorophycean members were mainly due to intensive accumulation and high densities of species such as *Chlorella vulgaris* Beyerinck; *Ankistrodesmus falcatus* (Corda) Ralfs; *Botryococcus braunii* kutz.; *Dictyosphaerium pulchellum* Wood; *Monoraphidium contortum* Komarkova; *Pedistrum simplex* (Meyen) Lemm.; *Scenedesmus quadricauda* (Turp) Breb and *Staurastrum paradoxum* Meyen. (Kuang *et al.*, 1994)

The acidic conditions at this area seemed to favour the growth and multiplication of Bacillariophyta. The assemblage of this group fluctuated from 10.26% to 52.89 % of the total crop allover the period of investigation (Table 2). In this connection Erondu and Chindah (1991) reported that the phytoplankton community in acidic water (PH ranged from 5.5 to 6.5) of the New Calabar River (Nigeria) was dominated by Bacillarioophyta.

Table 1: Average values of some physico – chemical characteristics of Ismailia Canal water at Site 1 (Chemicals and fertilizers factory of Abu-Zabal) and Site 2 (El-Mazallat region) during the period September 1996 to August 1997.

Characters	Seasons	Autumn			Winter			Spring			Summer		
	Months	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July	Aug.
Temperature, C°	Site 1	29.5	27.0	23.5	19.5	18.5	21.5	20.0	24.0	28.5	29.5	30.5	32.0
	Site 2	26.0	23.5	20.0	17.5	17.0	17.0	19.0	20.0	26.0	26.0	27.0	27.0
Visibility, Cm	Site 1	10	15	10	10	15	10	10	15	10	15	10	5
	Site 2	25	25	20	10	15	20	20	20	20	20	30	20
pH	Site 1	7.10	6.25	5.40	6.85	7.30	4.20	3.55	7.65	7.20	5.70	6.90	3.80
	Site 2	8.10	8.25	8.30	8.50	8.35	8.30	8.10	8.20	8.20	7.95	8.10	7.95
Dissolved oxygen, mgl^{-1}	Site 1	2.46	3.36	4.65	4.79	5.21	5.12	4.54	5.42	4.55	3.54	3.99	3.45
	Site 2	2.55	3.19	4.71	5.51	5.45	5.56	4.69	5.29	4.30	3.74	4.10	4.16
Chloride, mgl^{-1}	Site 1	34.44	35.50	90.17	55.03	55.74	42.60	37.28	26.63	49.70	26.63	39.05	39.05
	Site 2	30.18	30.18	30.18	47.93	53.25	33.73	31.95	31.24	31.95	21.30	24.85	28.40
Sulphate, mgl^{-1}	Site 1	69.08	118.00	33.38	125.23	42.31	16.15	139.23	21.69	16.00	110.62	124.62	53.08
	Site 2	22.77	18.31	16.15	24.00	23.69	10.15	13.23	7.83	10.46	10.00	4.15	8.92
Carbonate, mgl^{-1}	Site 1	2.40	0.00	0.00	0.00	0.00	0.00	0.00	3.60	0.00	0.00	0.00	0.00
	Site 2	4.80	6.00	14.40	8.40	0.00	0.00	0.00	0.00	4.80	9.60	16.80	7.20
Bicarbonate, mgl^{-1}	Site 1	111.02	24.00	21.35	109.80	158.60	0.00	0.00	154.33	122.00	36.00	0.00	0.00
	Site 2	170.19	164.70	159.82	208.62	213.50	183.00	167.75	186.05	154.94	139.08	130.54	150.06
Total alkalinity, mgl^{-1}	Site 1	113.42	24.00	21.35	109.80	158.60	0.00	0.00	157.33	122.00	36.00	0.00	0.00
	Site 2	174.99	170.70	174.22	217.02	213.50	183.00	167.75	186.05	159.74	148.68	147.34	157.25
Nitrate – N, mgl^{-1}	Site 1	1.29	1.06	1.70	10.95	0.72	0.41	0.05	0.63	0.22	0.14	0.21	0.26
	Site 2	0.68	0.54	0.60	0.86	0.69	0.30	0.48	0.47	0.13	0.21	0.39	0.42

Table 1: Continued

Characters	Seasons	Autumn			Winter			Spring			Summer		
	Months	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July	Aug.
Phosphate – P, mgl^{-1}	Site 1	2.04	1.21	6.93	6.30	4.19	3.93	2.85	1.95	2.68	6.07	3.35	5.02
	Site 2	0.52	0.36	0.20	0.39	0.24	0.29	0.53	0.35	0.41	0.53	0.41	0.37
Silicate – Si, mgl^{-1}	Site 1	9.76	3.78	19.98	7.60	5.14	29.46	15.00	3.24	7.22	20.27	26.97	39.40
	Site 2	2.98	0.74	0.51	4.57	0.69	1.77	1.34	1.44	1.54	3.62	2.49	3.54
Total soluble salts, mgl^{-1}	Site 1	312	224	332	454	310	272	276	242	200	348	322	382
	Site 2	182	148	200	202	326	194	192	294	178	228	180	124
Sodium, mgl^{-1}	Site 1	25.3	36.8	6.9	11.5	29.9	6.9	20.7	11.5	11.5	18.4	27.6	29.9
	Site 2	6.9	27.6	11.5	11.5	11.5	11.5	6.9	6.9	16.1	6.9	16.1	11.5
Potassium, mgl^{-1}	Site 1	7.43	10.56	1.96	2.74	6.65	2.72	7.04	2.74	3.52	6.26	10.16	11.34
	Site 2	3.13	5.08	2.74	1.95	1.95	3.13	1.95	1.56	3.91	1.56	4.69	3.52
Calcium, mgl^{-1}	Site 1	40.08	80.16	40.08	84.16	40.08	28.05	52.10	28.05	32.06	92.18	92.18	20.04
	Site 2	16.03	24.05	20.04	16.03	20.04	40.08	28.05	24.05	22.06	32.06	20.04	16.03
Magnesium, mgl^{-1}	Site 1	17.01	58.33	7.29	14.58	12.15	12.15	43.75	17.01	14.58	36.46	29.17	21.87
	Site 2	11.87	18.33	12.15	9.72	14.58	14.58	7.29	26.74	14.58	29.17	17.01	9.72

Table 2: Percentage distribution of the phytoplanktonic groups of Ismailia Canal water at Site 1 (Chemicals and fertilizers factory of Abu-Zabal) and Site 2

Algal groups	Seasons	Autumn			Winter			Spring			Summer		
	Months	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July	Aug.
Cyanophyta													
Species	Site 1	9	8	8	9	9	8	5	4	9	7	11	7
number	Site 2	10	8	12	10	8	9	6	8	8	9	11	15
% of total	Site 1	12.86	17.39	23.53	23.68	22.50	28.57	21.74	11.11	16.67	20.00	22.92	19.44
	Site 2	14.08	19.05	22.22	18.18	17.39	16.67	14.29	17.39	16.00	13.64	16.67	21.43
Individual	Site 1	44	76	136	183	47	59	141	62	94	70	62	52
number	Site 2	77	79	158	85	45	38	94	92	56	89	76	81
% of total	Site 1	3.89	3.90	7.04	5.67	1.98	5.09	14.51	4.59	5.47	3.78	6.70	1.37
	Site 2	7.27	7.06	7.28	4.08	2.63	3.14	7.11	7.30	4.40	8.61	10.41	7.34
Chlorophyta													
Species	Site 1	32	20	17	18	20	10	9	14	27	17	22	15
number	Site 2	35	20	22	31	23	22	15	18	21	29	28	29
% of total	Site 1	45.71	43.48	50.00	47.37	50.00	35.71	39.13	38.89	50.00	48.57	45.83	41.67
	Site 2	49.30	47.62	40.74	56.36	50.00	40.74	35.71	39.13	42.00	43.94	42.42	41.43
Individual	Site 1	667	1509	1096	2648	1235	603	408	572	990	1552	767	3290
number	Site 2	503	641	881	1555	800	429	432	390	290	553	438	701
% of total	Site 1	58.97	77.42	56.73	82.11	52.02	51.98	41.98	42.37	56.57	38.71	82.83	86.60
	Site 2	47.50	57.28	40.60	74.58	46.84	35.43	32.68	30.93	22.78	53.48	60.00	63.50
Bacillariophyta													
Species	Site 1	24	14	8	9	10	10	8	17	17	9	13	12
number	Site 2	25	13	13	13	14	22	19	18	21	25	25	25
% of total	Site 1	38.47	30.43	23.53	23.68	25.00	35.71	34.78	47.22	31.48	25.71	27.08	33.33
	Site 2	35.21	30.95	24.07	23.64	30.43	40.74	45.24	39.13	42.00	37.88	37.88	35.71
Individual	Site 1	416	359	697	386	1089	498	420	714	664	226	95	449
number	Site 2	475	397	1103	436	862	743	790	775	927	387	214	321
% of total	Site 1	36.78	18.42	36.08	11.97	45.87	42.93	43.21	52.89	37.94	12.19	10.26	11.82
	Site 2	44.85	55.48	50.83	20.91	50.47	61.35	59.76	61.46	72.82	37.43	29.32	29.08

Table 2: Continued

Algal groups	Seasons / Months	Autumn Sep.	Oct.	Nov.	Winter Dec.	Jan.	Feb.	Spring March	Apr.	May	Summer June	July	Aug.
Euglenophyta													
Species number	Site 1	1	2					1				1	
	Site 2			4							1		
% of total	Site 1	1.43	4.35					4.35				2.08	
	Site 2			7.41							1.52		
Individual number	Site 1	1	3					3				1	
	Site 2			19							1		
% of total	Site 1	0.09	0.15					0.31				0.11	
	Site 2			0.88							0.10		
Dinophyceae													
Species number	Site 1	1	2	1	2	1			1	1	2	1	2
	Site 2	1	1	3	1	1	1	2	2		2	2	1
% of total	Site 1	1.43	4.35	2.94	5.26	2.50			2.78	1.85	5.71	2.08	5.56
	Site 2	1.41	2.38	5.56	1.82	2.17	1.85	4.76	4.35		3.03	.3.03	1.43
Individual number	Site 1	3	2	3	8	3			2	2	6	1	8
	Site 2	4	2	9	9	1	1	6	4		4	2	1
% of total	Site 1	0.27	0.10	0.16	0.25	0.13			0.15	0.11	0.32	0.11	0.21
	Site 2	0.38	0.18	0.41	0.43	0.06	0.08	0.45	0.32		0.39	0.27	0.09
Total No. of species	Site 1	70	46	34	38	40	28	23	36	54	35	48	36
	Site 2	71	42	54	55	46	54	42	46	50	66	66	70
Total No. of organisms	Site 1	1131	1949	1932	3225	2374	1160	969	1350	1750	1854	926	3799
	Site 2	1059	1119	2170	2085	1708	1211	1322	1261	1273	1034	730	1104

N.B: Individual number x 10 = organisms / ml^{-1}.

The most dominant species of Bacillariophyta were excelled by *Cyclotella ocellata* pant, *Synedra ulna* (Nitz.) Ehrenb and *Melosira granulata* Ralfs. Opposing to the afore mentioned groups, Cyanophyta, Euglenophyta and Dinophyceae sustained low figures of percentage composition at this area which ranged between 1.37% to 14.5%; 0.09% to 0.31% and 0.10% to 0.32% of total yield respectively (Table 2). The high diversities in Chlorophyta and Bacillariophyta exhibited at low pH (polluted site) and high pH values (control site) during the present investigation indicate their tolerance to change in pH values. Generally it can be concluded that the heterogenic nature of the Ismailia Canal phytoplankton communities may be responsible for such discrepancies. The present data are in good agreement with previous finding by (Saad and Antoine, 1983 and Kobbia *et al.*, 1993).

The results of the present investigation (Table 1) revealed that the lowest visibility levels were displayed at polluted area in front of chemicals and fertilizers factory of Abu- Zabal since the average monthly measures ranged from 5 to 15 cm. Whereas the highest visibility levels recorded in control area at El-Mazallat region fluctuated from 10 to 30 cm. It seemed probable that the low water visibility of the site located in the vicinity of industrial area could mainly be attributed to flourishing of phytoplankton. These observations seemed to be in harmony with the finding of Kobbia *et al.* (1993) and El-Attar (2000), who reported that the increase in phytoplankton density in some polluted waters of some freshwater ecosystems may lead to noticeable drop in transparency measurements.

As revealed from the results herein obtained (Table 1), the dissolved oxygen content of water of site located in the neighborhood of industrial area (site 1) was slightly less than that recorded for control water (site 2). Dissolved oxygen content ranged between 2.46 to 5.42 mgl^{-1} in the former site in contrast to 2.55 to 5.56 mgl^{-1} in the latter one. Talling (1976) stated that oxygen super saturation due to photosynthetic activity is often encountered in regions with abundant phytoplankton populations. Accordingly, it was expected that the relatively high dissolved oxygen in control water of the present investigation would correlate with a concomitant increase in standing crop, a phenomenon that was not observed. On the contrary relatively low oxygen content in polluted water was associated allover seasons with remarkable elevation in standing crop. An understanding of such phenomenon could be explained in the light of consumption of great portion of oxygen evolved in photosynthetic activity of dense population in polluted sector in oxidizing the waste organic industrial effluents. Also Saad and Antoine (1983) found that the sewage disposal into the Ashar Canal (Iraq) increased the algal populations while its dissolved oxygen contents decreased.

The date of the present investigation (Table 1) further indicate that nitrate-N contents at polluted area was more than that recorded for control site. This could be principally due to the industrial wasted discharged to the Ismailia Canal at the polluted area. Similar results were obtained by Casey (1975) and Kobbia *et al.* (1993).

The amount of phosphate-P in Ismailia Canal water in the vicinity of the industrial area always exceeded those of the control (Table 1). The levels of such nutrient element ranged between 1.21- 6.93 mgL^{-1} in the former site as compared with 0.20 – 0.53 mgL^{-1} in the latter one. Such increases may probably be connected with disposal of industrial wastes at Abu- Zabal district and/or to organic and inorganic phosphate salts precipitated in the sediments from decayed cells. Cole (1983) reported that in a non-stratified Danish lake the annual release of phosphorus from sediments was greater than the amount received from external source. It is also probable that the organic phosphorus released from decaying organic matter in polluted area further modifies the actual amount of phosphorus present in the water. This deduction seemed to be in harmony with those obtained by Goldman and Horne (1983). Again, it emphasizes the significance of deposits in the polluted transect of Ismailia Canal as a reservoir for supplying the Ismailia Canal water with excess nutrients. The results of the present investigation show that the rise in yields of the standing crop exhibited during most seasons at the polluted site accompanied with concomitant increase in the phosphorus levels. On the other hand, the lowest values of the standing crop that were almost recorded at the control site were correlated with the lowest values of the phosphorus in this site. In this connection Gemza (1995) found that the increased discharges of the total phosphorus in the waters of the Severn Sound Georgian Bay (Canada) led to an increase in the phytoplankton densities of the nearshore waters.

The present data (Table 1) reveal that the silicate silicon content in the water of Ismailia Canal exhibited different seasonal variations among the studied sites. The levels of silicate content at the polluted site ranged between 3.24 and 39.40 mgL^{-1}, whereas at the control one it ranged between 0.51 and 4.57 mg L^{-1}. The highest values of silicate content were recorded at the polluted site. It could be attributed to the influx of industrial waste effluent in the water at this site. The individual number of Bacillariophycean members at polluted site (chemicals and fertilizers factory) ranged between (95 x 10 cells ml^{-1}) to (1089 x 10 cells ml^{-1}) with percentage composition ranged between 10.26% to 45.87% of total populations (Table 2), this is due to the available values of silicate at this area. However, Strickland and Parson (1965) reported that the limiting concentration of silicates affecting phytoplankton growth appears to vary between 700 µg L^{-1} and 1400 µg L^{-1}. Therefore, it is worthy to conclude that the silicate – silicon contents of the Ismailia Canal waters at the investigated sites during the present study are exceeding the demand of Bacillariophyta.

It is perhaps relevant to mention that the levels of sulphate contents in Ismailia Canal water at control area lay within the range of those recorded for other control sectors of the Nile River by Kobbia *et al.* (1990). The high sulphate parts of polluted site could be due to numerous pollutants discharged to the Ismailia Canal at this industrial area. This deduction is consistent with those obtained by El Ghandour *et al* (1983) and Kobbia *et al* (1993) who reported that the high sulphate contents of some polluted sites of the Nile could be due to numerous pollutants including the oxidized sulphur gases and other compounds dumped to the Nile waters from the factories located at these polluted sites.

The Chlorosity value of Ismailia Canal water at control investigated area (Table 1) fluctuated between 21.30 and 53.25 mg L^{-1} whereas in polluted area, it varied between 26.63 and 90.17 mg L^{-1}. These levels led to an increase of chlorophyceae specially at polluted site (Kobbia *et al.,* 1990).

Referring to the total soluble salts of Ismailia Canal water at the studied area the highest levels were recorded in the water lying in the vicinity of the industrial region, it fluctuated between 200 and 454 mgL^{-1}. On the other hand, the lowest level was manifested in the water located faraway from industrial activities, where it did not exceed 326 mg L^{-1}. It is quite apparent that the increased contents of the total soluble salts and chloride ions in the Ismailia Canal water in the vicinity of the industrial area are due mainly to inflow of the waste water effluents discharged from chemical and fertilizers factory located at this site. The heavy loads of nutrient salts contained in such effluents led subsequently to marked increase in the standing crop of algal populations at this polluted site. Such results are in harmony with the finding of Kobbia *et al* (1993) who studied some polluted and control sites of the River Nile.

The data presented in table 1 show that with the exception of two months carbonate was completely depleted all over the period of study at polluted site. In the same time bicarbonate and total alkalinity were represented in low amounts at polluted site comparable to that of corresponding control.

The relatively low bicarbonate contents of the Ismailia Canal water at polluted site are closely connected with low pH values. In this connection Baudo *et al* (1978) pointed out that the increase of CO_2 evolved through metabolic activities of aquatic biota and decay of organic matter in polluted regions lower the pH values of the water.

It is worthy to notice that Ismailia Canal water showed relatively higher contents of monovalent cations (Na^+ and K^+) and divalent cations (Ca^{++} and Mg^{++}) in polluted site as compared of those of the control water (Table 1). Such variation may be connected with effects of the discharged pollutants of chemicals and fertilizers factory to the Ismailia Canal water at the polluted area. Similar observations were recorded by Kobbia *et al.*, 1993 and El-Attar (2000) who investigated some polluted and unpolluted freshwater bodies.

Generally calcium, magnesium and sodium were predominant and exceeded always the levels of potassium at the two sites. Talling and Talling (1965) suggested that the amounts of sodium and calcium determine the species present rather than quantitative development of phytoplankton. In some cases the cation contents in relation to each other give an indication of the type and intensity of standing crop of phytoplankton populations (Lewis and Weibezahn, 1981). However the cation concentrations in the Ismailia Canal waters of the investigated area had the following decreasing order calcium > magnesium > sodium > potassium.

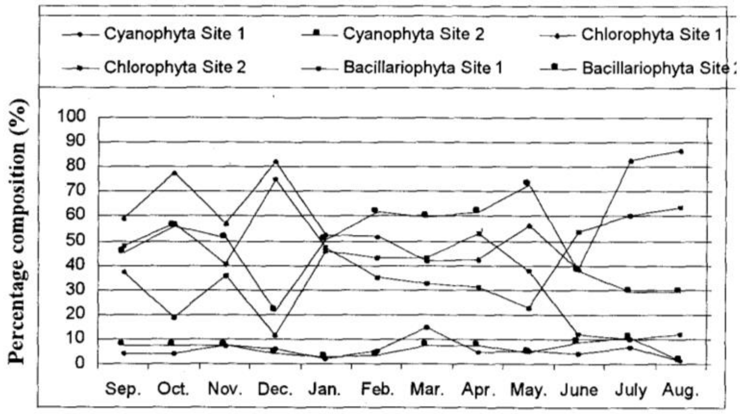
The data of the present investigation (Fig. 1) further indicate that the standing crop of total algal populations at polluted area was more than that recorded for control site. The total algal counts ranged from 9.26×10^3 to 37.99×10^3 cells ml^{-1} in the former site and from 7.30×10^3 to 21.70×10^3 cells m L^{-1} in the latter one. The pronounced increase in standing crop of the algal populations recorded at polluted site may be due to high nutrients especially nitrate, phosphate and other soluble salts contained in the industrial wastes which have been discharged in Ismailia Canal water. These observations seemed to be in harmony with those recorded by (Kobbia *et al.*, 1993; Paerl and Tucker, 1995 and Smoot *et al.*, 1998). They pointed out that high algal standing crop almost accompanied by low species diversity were recorded in waters characterized by high concentrations of inorganic nutrients attributed to industrial waste discharges or nutrient enrichment. The results of this investigation (Table 2) revealed that the control area (site 2) comprised a total of 135 species, out of these 23 belong to Cyanophyta, 53 to Chlorophyta, 49 to Bacillariophyta and 5 to each of Euglenophyta and Dinophyceae. Further reduction in species number was noticed in the Ismailia Canal water facing chemicals and fertilizers factory of Abu – Zabal (site1). Where a total of 117 spices were isolated. Twenty one species of these belong to Cyanophyta 50 to Chlorophyta, 37 to Bacillariophyta, 5 to Euglenophyta, and 4 to Dinophyceae. It is of particular interest to notice that although Chlorophyta was represented by less species number at site 1, yet the percentage composition of such group was maximum and ranged from about 39% to 87% of total yield (Table 2 and Fig. 1). In this connection, it should be recalled that Shah and Patel (1994) reported that assemblages of Chlorophyta and Cyanophyta were presumably favoured in inorganic polluted water bodies in most cases, since they have the ability to grow under wide range of chemical variability. It was observed that the most highly dominant Cyanophycean species recovered at the two sites during this study were *Phormidium autumnale* (C.A Ag.) Gomont; *Cylindrospermum stagnale* (Kutz.) Bornet; *Merismopedia tenuissima* Lemm. *Gloeocapsa rupestris* Kutz. and *Microcystis aeruginosa* Kutz. However *Phormidium autumnale* (C.A Ag.) Gomont occupied the first rank in the dominance contributing to 40.55 % and 30 82% of total Cyanophycean crops at the polluted site and control site respectively. Also this species occupied an important place among all recorded species in the two investigated sites.

It is obvious that the number of Bacillariophyta members inhabiting the Ismailia Canal waters occupied the second rank in the order of species dominance of phytoplankton populations at the two sites, the highest numbers of Bacillariophyta members were recovered at site 2 (unpolluted), while the lowest numbers were sampled from site 1 where the pH was acidic (Table 2).

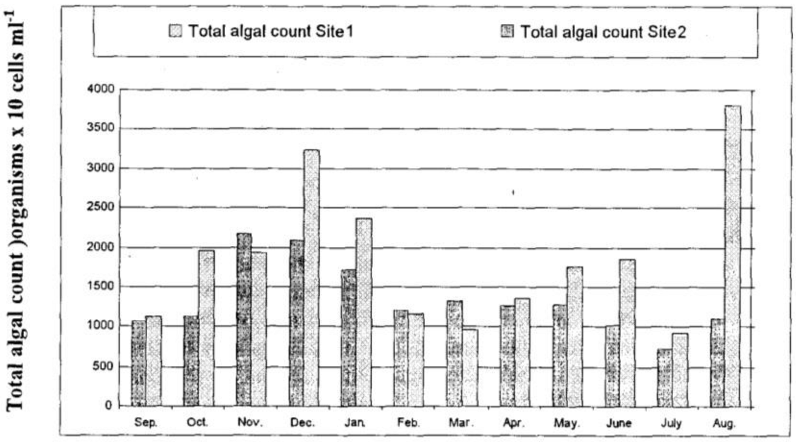
It is worthy to notice that the Bacillariophyta species recorded during this investigation at the two sites are almost typically oligotrophic forms, i.e. the pinnate types were almost dominant, while most of centric species were subdominant. These observations lend a support to the idea that the Ismailia Canal waters at the two sites even in the industrial area may be oligotrophic or mesotrophic. In this connection Swayer (1966) and Kobbia *et al* (1990) reported that pennales generally exhibits strong oligotrophic tendency.

The data presented here clearly indicate that Euglenophyta members were rarely recovered and Dinophyceae were less frequent in the two sites. These observations seem to be in harmony with the findings of Kobbia *et al* (1990).

The results of this investigation (Fig. 2) further show that the diversity index, as one of the measures for degree of pollution ranged between 0.63 and 1.09 at site 2 (control). On the other hand it ranged between 0.43 and 0.49 at site 1 (polluted water). These observations indicate the presence of some changes in species composition and number of species between the polluted and control sectors. In this connection Kobbia *et al* (1993) noticed some relations between certain algal species to polluted or unpolluted waters, which indicate that phytoplankton inhabiting polluted waters differed from that in unpolluted water. Levels of eutrophication index at control site ranged from zero to 3.51. On the other hand, at polluted site it fluctuated between 0.70 and 2.07 (Fig. 2). The values of pollution index (Fig. 2) being recorded at site 1 ranged between 0.016 and 0.056, whereas at station 2 it ranged between 0.032 and 0.067. These data indicate that Ismailia Canal water facing chemicals and fertilizers factory is oligotrophic to mesotrophic with heavy inorganic pollution. Similar results were recorded by Kobbia *et al* (1990).



Sampling Time



Sampling Time

Fig. 1: Monthly variations in Standing crop and Percentage distribution of main algal groups of Ismailiya Canal water at Site 1 (Fertilizers and Chemicals Factory of (Abou - Zaabal) and Sit 2 (El-Mazallat region) during the period September, 1996-August, 1997.

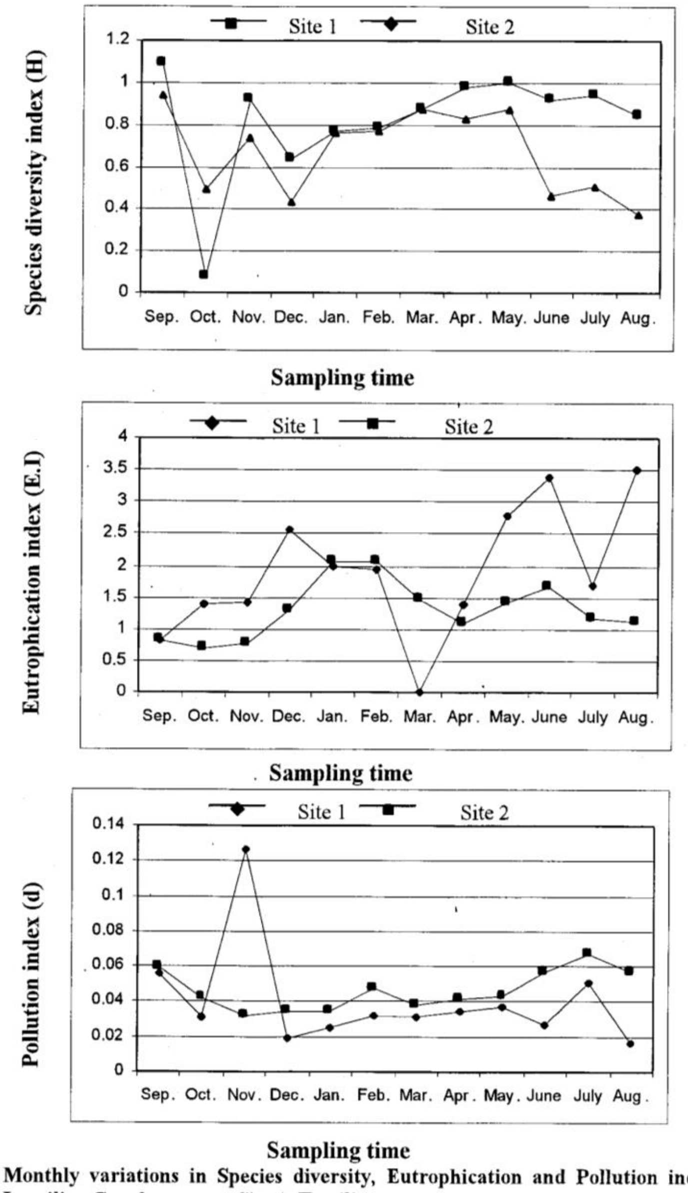


Fig. 2: Monthly variations in Species diversity, Eutrophication and Pollution indices of Ismailiya Canal water at Site 1 (Fertilizers and Chemicals Factory of Abou-Zaabal) and Site 2 (El-Mazallat region) during the period September, 1996 - August, 1997.

It is perhaps relevant to mention that the reduction in number of species at polluted site if coupled with low species diversity index, one can reach to a conclusion that the water of this site is most highly polluted. Such deduction could be accepted as a diagnostic feature of polluted water. In accordance with this, Lizotte and Simmons (1985) have pointed out that increased diversity values of phytoplankton indicated water quality improvement of Kanawha river at west Virginia. Wu and Suen (1985,) studying the change of algal communities in response to increase of water pollution in Hsin – Dien River (Taiwan), concluded that the change in relative abundance of Bacillariophyta, Chlorophyta and Dinophyceae could be taken as a criterion for water pollution. Moreover, changes might take place in community structure and phytoplankton size may be used for the evaluation of the state and magnitude of pollution.

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الملخص العربى

المحصول القائم وتوزيع المجتمعات الطحلبية لمياه ترعة الاسماعيلية وعلاقة ذلك بملوثات مصنع أبو زعبل للأسمدة والكيماويات.

أمين عرفان دويدار ، سعيد عبد القادر العطار ، ربيع عبد التواب شهاب
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تمثل هذه الدراسة متابعة شهرية لمنطقة التلوث بترعة الاسماعيلية المواجهة لمصنع أبو زعبل للأسمدة والكيماويات بالمقارنة بمنطقة المظلات البعيدة عن منطقة التلوث.

تم دراسة التغيرات فى الصفات الفيزيائية والكيميائية لمياه ترعة الاسماعيلية وكذلك المحصول القائم وحجم الفلورا الطحلبية وتركيبها النوعى فى الفترة من سبتمبر ١٩٩٦ إلى أغسطس ١٩٩٧ .

أظهرت الدراسة اختلافات موسمية واضحة فى التركيب النوعى والمحصول الكلى للفلورة الطحلبية ورتبت السيادة للمجموعات الطحلبية كالآتى:
الطحالب الخضر > الطحالب العصوية > الطحالب الخضراء المزرقة > الطحالب السوطية

سجلت أعداد الأنواع الطحلبية فى منطقة التلوث أمام مصنع أبو زعبل للأسمدة والكيماويات معدلات أقل منها فى المنطقة المقارنة على الرغم من الزيادة الملحوظة فى التعداد الكلى الطحلبى.

تم تقدير كل من دليل التباين النوعى ودليل التلوث ودليل الإثراء الغذائى وقد أوضحت هذه الأدلة تباين الأنواع الطحلبية فى منطقة التلوث والمنطقة المقارنة كما أوضحت أيضا أن مياه ترعة الاسماعيلية فى المنطقة المواجهة لمصنع أبو زعبل للأسمدة والكيماويات مياه شديدة التلوث (غير العضوى) فقيرة أو متوسطة فى المغذيات.