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IMPACT OF TRACE METALS ON THE DISTRIBUTION OF PHYTOPLANKTON AND THEIR CONTENT IN *OREOCHROMIS NILOTICUS* AT ROSETTA BRANCH (EGYPT).

Adel H. Konsowa
National Institute of Oceanography and Fisheries

Key words : Trace metals , phytoplankton, *Oreachromis*, Rosetta Branch .

ABSTRACT

The data indicated that El-Rahawy, Sobel, Kafr El-Ziat and Edfina sectors represent the highly polluted area along Rosetta Stream. Phytoplankton crops recorded downstream the discharging point of El-Rahawy and Kafr El-Ziat Drains were higher than the corresponding values occurred at the upstream areas. At Edfina sector, the numerical density of phytoplankton was high upstream the barrage compared to its downstream sector (Estuarine) and this phenomenon can be related to the negative impact of high salinity. Bacillariophyceae occupied the first predominant position followed by Chlorophyceae and Cyanophyceae. Diatoms, Green and Blue-green algae constituted about 99% of the total phytoplankton crop. Trace metal contents of Rosetta Branch can be arranged in descending order as follows: Fe > Mn > Ni > Pb > Co > Zn > Cd > Cu > Hg. The levels of Fe, Mn and Ni in *Oreochromis niloticus* flesh collected from El-Rahawy, Sobel, Kafr el-Ziat and Edfina were high compared to the samples caught from El-Kanater Sector.

INTRODUCTION

Rosetta Branch serves as a fishing ground for commercial fisheries. It is considered also the main source of freshwater for the western side of Nile Delta. Rosetta Stream receives domestic, industrial and agricultural wastes from several sources that discharge directly or indirectly in the branch. The major sources of pollution to this branch are El-Rahawy (raw sewage) and Sobel (agriculture wastes) Drains, . In the meantime, Soda & Lime and El-Malya Companies at Kafr El-Ziat City are the main source of industrial pollution to the branch. Trace metals play a significant role in phytoplankton ecology (Barber and Ryther, 1969). Bruland (1980) studied the effect of Zinc, Manganese and Iron on the reproductive rate of 21 species of marine phytoplankton. Sunda *et al.* (1981) investigated the concentration of copper on the oceanic phytoplankton uptake and regeneration cycles. Hickel and Pollingher (1988) studied the structure of the Blue-Green *Cyanodictyon imperfectum*, showing external Iron deposition between the cells. Kobbia *et al.* (1993) studied the phytoplankton biomass in the Nile Water near the Starch and Glucose Factory at Giza (Egypt). Massoud *et al.* (1994) investigated the role of phytoplankton cells on the control of heavy metal concentrations in seawater. Hassan (1996) studied the effect of industrial waste of Iron and Steel Factories on growth, chlorophyll and photosynthetic activity of *Scenedesmus quadricauda*. Sobhy (1999) investigated the effect of the same waste on natural phytoplankton communities. Hornuny and Krom (1989) determined trace metals in offshore and inshore fish farm from the Mediterranean Sea. Lasheen (1981) determined trace metals of River Nile Water such as Cd, Co, Cu, Cr, Pb, Zn and Mn. Awad (1993) found that the metallic ion concentrations in River Nile water were arranged as follows: Fe > Mn > Zn > Cu

The present investigation was carried out in order to provide information about the effect of pollution on phytoplankton communities in Rosetta Branch and to determine the level of some trace metals in *Oreochromis niloticus* flesh inhabiting this branch.

MATERIALS AND METHODS

Four quarterly cruises along Rosetta Branch were carried out in July & October 1999 and January & April 2000. The studied area extended from El-Kanater El-Khairya to Edfina Barrage with a total length of 200 km. Eight different sectors were chosen to represent different habitat of this branch. The selected sectors (Fig. 1) were as follows:.

- Sector 1 (El-Kanater): situated at about 500 m downstream El-Kanater El-Khairya Barrage.
- Sector 2 (El-Rahawy): located at about 250 m downstream the discharging area of the raw sewage.
- Sector 3 (Tamelay): located at about 60 km from El-Kanater El-Khairya Barrage.
- Sector 4 (Sobel): located at about 250 m downstream of Sobel Drain.

- Sector 5 (Kom-Hamada): situated at about 100 km from El-Kanater El-Khairya Barrage.
- Sector 6 (Kafr El-Ziat): located at about 250 m downstream the industrial waste of Soda & Lime and Malya Companies.
- Sector 7(Edfina 1): located at about 250 m upstream Edfina Barrage.
- Sector8(Edfina2):located at about250m downstream Edfina Barrage.

Composite water samples were collected by Ruttner Bottle to represent the middle and the two banks of each sector. Sedimentation method was used to concentrate of phytoplankton cells. Drop method technique was applied for counting the phytoplankton community (APHA, 1992).

For trace metal analyses, subsamples were fixed with concentrated HNO_3 to pH < 2. Mercury was determined in the water by preservation in situ with 5% $KMnO_4$ to violet color and measured by cold vapor technique, using Hydride Unit Model (MAS-10). *O. niloticus* were collected from various sections of the branch. A known weight from its dried flesh was digested in concentrated HNO_3 according to APHA (1992). Determinations of trace metal concentrations in water and flesh were carried out by Atomic Absorption Perkin Elmer Model (3110) according to APHA, (1992).

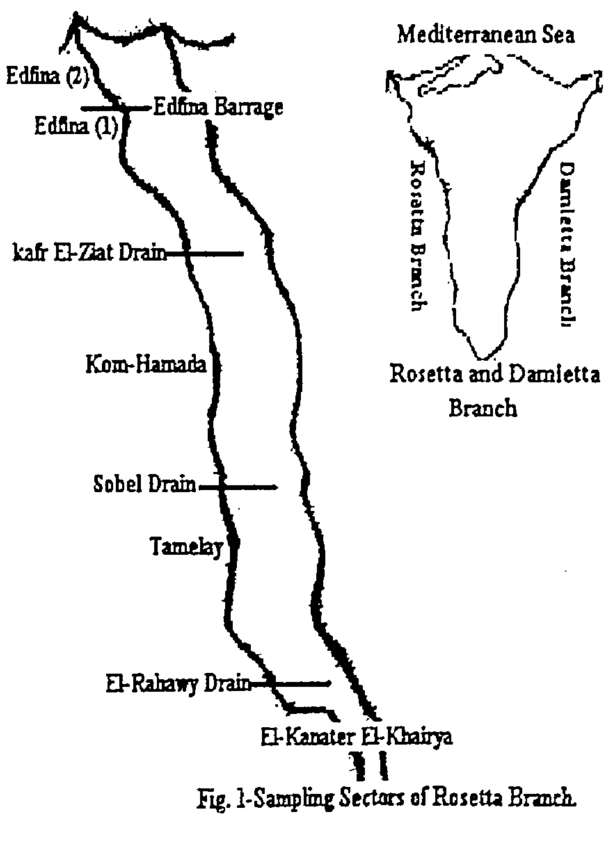

Fig. 1-Sampling Sectors of Rosetta Branch.

Results

The present results (Table 1) indicated that the downstream of El-Rahawy, Sobel and Kafr El-Ziat Sectors harbored high phytoplankton crops compared to their upstream areas. Phytoplankton community at Edfina (2) showed a sharp decline downstream Edfina Barage (Rosetta Estuarine) compared with Edfina(1) The phytoplankton inhabiting Rosetta Branch were represented by five classes namely, Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae and Dinophyceae as shown in Table (2). Diatoms occupied the first predominant position, constituting 63.27% of the total phytoplankton crop. Their maximum count was recorded at El-Rahawy, while the minimum number was found at Edfina (2). The leading species of diatoms, green and blue-green algae are given in Table (3) and can be summerized as follows: Diatoms were dominated by *Melosira granulata, Synedra ulna, Cyclotella chaetoceras and Cyclotella ocellata.*

Melosira granulata was the most abundant species. *Synedra ulna* and *Cyclotella ocellata* were observed at all sections except Edfina (2). *Cyclotella chaetoceras* decreased gradually from El-Kanater to Sobel and completely disappeared at Kom-Hamada, Kafr El-Ziat and Edfina Sectors. Chlorophyceae were less found compared with diatoms. They occupied the second predominant position, contributing 27% of the total phytoplankton crop. Their numerical density showed an obvious increase at Sobel and Kafr-El-Ziat and were dominated by *Oocystis parva, Ankistrdesmus falcatus, Scenedesmus quadricauda* and *Pediastrum simplex*. Cyanophyceae occupied the third predominant position and constituted 8.8% of the total phytoplankton crop. Blue-greens were dominated by *Microcystis aeruginosa* and *Cylindrospermopsis raciborskii, Lyngbya limmnetica* and *Merismopedia tenuissima.* Euglenophyceae and Dinophyceae were scarce and represented only by *Euglena varibilis, Phacus pleuronectes* and *Peridinium cinctum.*

Trace metal concentrations in the water can be arranged as follows:Fe>Mn>Ni>Pb>Co> Zn>Cd> Cu > Hg. Their concentrations are shown in Table (4&5) and can be summerized as follows:

Iron concentrations ranged from 2.2 ppm at Edfina (1) in summer to 238.7 ppm at Edfina (2) in spring. Manganese levels fluctuated between 0.8 ppm at El-Kanater in autumn and 33.6 ppm at Edfina (2) in summer. Nickel minimum value of 0.2 ppm was recorded at Tamelay in summer, while its maximum concentration of 29.2 ppm occurred at El-Rahawy in autumn. Lead concentrations varied from 0.2 ppm at El-Kanater in summer to 28.2 ppm at Edfina (2) in spring; Cobalt minimum value of 0.2 ppm was determined at El-Kanater in summer, while its maximum concentration of 9.6 ppm occurred at Edfina (2) in autumn. Zinc concentration increased from 0.2 ppm at El-Kanater in winter to 21.2 ppm at Kafr El-Ziat in autumn. Cadmium values ranged from 0.1 ppm at El-Kanater in winter to 4.8 ppm at Edfina (2) in summer. Copper content was below the detection limits at El-Rahawy, Tamelay, Sobel and Edfina (1) & (2) while its maximum level of 3.41 ppm was detected at Kafr El-Ziat in autumn. Mercury concentrations were substantially low compared to the other trace metals determined in Rosetta Branch. Its concentrations ranged from 0.003 ppm at Kom-Hamada in summer to 0.17 ppm at El-Kanater in winter.

Trace metal concentrations measured in flesh of *O. niloticus* (Table 6) showed that iron content was much higher than manganese and nickel concentrations measured at the selected fish. In the same time, Iron levels at El-Rahawy Sector had a substantial increase in comparison with the other polluted sectors at Sobel, Kafr El-Ziat and Edfina (2).

DISCUSSION

It is evident from the data that the population density of *Cyclotella chaetoceras, Melosira granulata, Cyclotella ocellata* and *Synedra ulna* at El-Rahawy and Kafr-El-Ziat were abnormally higher than the other sectors. This can be realized to stimulatory effect of wastes that are discharged at these areas. This agrees with Sobhy (1999) who recorded high densities of diatoms at the highly polluted area at Helwan. He reported that this area is polluted by Fe (120 ppm), Zn (25.4 ppm) and Mn (20 ppm).

In spite of the high concentrations of Fe (63.45 ppm) and Mn (12 ppm) at Sobel, green algae were flourished and dominated by *Oocystis parva, Ankistrodesmus falcatus, Scenedesmus quadricuda, Pediastrum simplex* and *Golenkinia radiata.* This finding can be related to the high nutrient levels (N&P) in the agricultural drainage waters that are discharged via Sobel Drain. In this respect, Flores & Barone (2000) stated that different algal species can exploit nutrient sources, both organic and inorganic, with varying capabilities. They also found that different nitrogen sources may selectively stimulate the development of dominant algal species. In general, Chlorophyta was represented by less species number at polluted area of River Nile (Starch and Glucose Factory), yet its percentage composition was maximum and ranged from 67 to 93% of the total yield (Kobbia *et al.* (1993).

The blue-green algal species *Micrcystis aeruginosa, Merisopedia tenuissima* and *Cylindrospermopsis raciborskii* had increased at the downstream of the industrial waste at Kafr El-Ziat City. This revealed the tolerance of these species to the industrial waste pollution. In this respect, Cranodictyon & Weibull (1981) reported that the blue-green *Cyanodictyon imperfectum* is characterized by the ability to precipitate iron oxide, which is deposited externally in the mucilage between two adjoining cells in the form of dense rings. Davila (1995) found that numerous species of algae bind metal ions with protein or polysaccharides in the interior of the cell, which may deactivate the metal ion's toxicity.

Dinoflagellates were rarely found along Rosetta Branch except Sobel Sector, where *Euglena varibilis, Phacus pleuronectes* and *Peridinium cinctum* occurred. This observation may be attributed to drainage water that was loaded with agricultural wastes, especially nitrogen and phosphorous compounds. This agrees with Abd El-Karim (1999) who pointed out that dinoflagellates flourished at Damietta Branch towards the downstream of Faraskour Sector due to the high nutrient concentrations.

Phytoplankton standing crop and species composition at Edfina (2) showed a sharp decline compared to Edffina (1). Most of phytoplankton species recorded at this branch are completely freshwater. Therefore, the abnormal increase of salinity (9 ppt) recorded at the beginning of Rosetta Estuarine has adverse effect on phytoplankton crop. Generally, the toxic effect of salinity on phytoplankton might be due, at least in part, to its interference with the uptake of magnesium by the growing organisms (Tempest & Meers, 1968).

The high trace element concentrations in *O. niloticus* flesh is mainly related to their high levels in the water, especially in the polluted sectors. The accumulation of metallic ions in its flesh is mainly through their natural food (phyto & zooplankton). These data agree with the findings of Mathis and Cummings (1993) who reported that the concentration of trace metals in the omnivorous fish muscles in the Illinois River was appreciably greater than that in the muscles of carnivorous fish. The trace metal concentrations in the surface water of Rosetta Branch are exceeding the permissible levels that recommended by Egypt Environmental Affairs Agency (EEAA, 1994) except Zinc. The permissible level of trace metals in surface water reported by EEAA, 1994 are as follows: Fe, 1.5 ppm; Mn, 1.0 ppm; Ni, 0.1 ppm; Pb, 0.5 ppm; Co, 2 ppm; Zn, 5 ppm; Cd, 0.05 ppm; Cu, 0.5 ppm and Hg, 0.005 ppm

The metallic ion levels in *O. niloticus* flesh caught from Rosetta Branch have adverse effects on human health. So it is recommended to solve the pollution problems in Rosetta Branch by treating all the wastes (sewage, industrial and agriculture effluents) before their discharge to the natural water.

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Table (1) Total phytoplankton crop (No of cells x 10^5 L^{-1})

Seasons	El-Kanater	El-Rahawy	Tamelay	Sobel	Kom-Hamada	Kafr-El-Ziat	Edfina (1)	Edfina (2)
Winter	229	263	225	237	83	103	15	0
Spring	116	349	90	101	34	120	70	29
Summer	93	98	67	109	74	161	53	23
Autumn	26	34	78	33	9	240	63	10
Average	116	186	115	120	50	156	50	17

Table (2): Class composition (No. of cells x 10^5 L^{-1}) and its percentage abundance to total phytoplankton crop

	El-Kanater		El-Rahawy		Tamelay		Sobel		Kom-Hamada		Kafr-El-Ziat		Edfina (1)		Edfina (2)	
Class composition	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Bacillariophyceae	410	88.38	686	92.2	364	78.13	292	60.83	78	40	328	48	92	48	32	47.1
Chlorophyceae	18	3.88	20	2.69	32	6.96	142	29.58	110	55	164	47	94	47	32	47.1
Cyanophyceae	34	7.33	38	5.11	62	5.11	34	7.08	10	5	130	6	14	6	4	5.8
Euglenophyceae	0	0	0	0	2	0	10	2.08	0	0	2	0	0	0	0	0
Dinophyceae	2	0.43	0	0	0	0	2	0.43	0	0	0	0	2	0	0	0

Table (3): The leading diatoms (No. of cells x 10^5 L^{-1}) and its percentage abundance to total Bacillariophyceae

	El-Kanater		El-Rahawy		Tamelay		Sobel		Kom-Hamada		Kafr-El-Ziat		Edfina (1)		Edfina (2)	
Dominant species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Melosiera granulata	120	29	160	23	94	25	88	30	33	42	104	31.7	78	85	32	100
Synedra ulna	10	2.4	16	2.3	14	3.8	20	6.8	12	15	36	11	2	2.2	0	0
Cyclotella chaetoceras	230	56	420	61	196	54	148	50	0	0	0	0	0	0	0	0
Cyclotella ocellata	16	3.9	28	4	18	5	8	2.7	25	32	156	47.5	8	8.7	0	0

The leading green algae (No. of cells x 10^5 L^{-1}) and its percentage abundance to total Chlorophyceae

	El-Kanater		El-Rahawy		Tamelay		Sobel		Kom-Hamada		Kafr-El-Ziat		Edfina (1)		Edfina (2)	
Dominant species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Oocystis parva	6	33	6	30	6	18.7	30	21.1	6	5.5	10	6.1	10	10.6	0	0
Golenkinia radiata	4	22	0	0	0	0	22	15.5	0	0	0	0	0	0	0	0
Scenedesmus quadricauda	0	0	0	0	8	25	24	16.9	16	14.5	24	14.6	16	17	8	25
Scenedesmus dimorphus	0	0	0	0	0	0	8	5.6	8	7.3	0	0	8	8.5	0	0
Pediastrum simplex	0	0	0	0	8	25	16	11.3	64	58.2	96	58.5	0	0	16	50
Ankistrodesmus falcatus	0	0	0	0	2	6.3	30	21.1	0	0	0	0	8	8.5	0	0
Actinastrum hantzchii	0	0	14	70	0	0	0	0	0	0	0	0	12	12.6	0	0

The leading blue-greens (No. of cells x105 L^{-1}) and its percentage abundance to total Cyanophyceae

	El-Kanater		El-Rahawy		Tamelay		Sobel		Kom-Hamada		Kafr-El-Ziat		Edfina (1)		Edfina (2)	
Dominant species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Lyngbya limnetica	12	35.2	14	36.8	6	9.68	6	17.6	0	0	2	1.5	2	14.28	4	100
Cylindrospermopsis raciborskii	1	2.9	10	26.3	16	25.8	16	47	6	60	4	3	0	0	0	0
Microcystis aeruginosa	20	58.8	0	0	38	61.2	0	0	0	0	120	92.3	0	0	0	0
Merismopedia tenuissima	0	0	14	36.8	2	3.2	4	11.7	4	40	4	3	12	85.71	0	0

Table (4): Concentrations of Fe, Mn, Ni, Pb and Co in water at the different sectors of Rosette Branch 1999-2000

seasons	El-Kanater	El-Rahawy	Tamely	Sobel	Kom-Hamada	Kafr El-Zial	Edfina (1)	Edfina (2)	Avg.
Iron concentrations ppm									
Winter	5.20	6.80	16.10	20.40	20.40	38.20	8.20	9.60	15.61
Spring	23.50	13.70	14.70	19.00	23.70	110.20	12.50	238.70	57.00
Summer	8.60	9.60	10.40	60.40	27.00	20.20	2.20	5.20	17.95
Autumn	5.40	23.00	18.20	154.00	35.20	45.00	2.80	5.00	36.08
Average	10.68	13.28	14.85	63.45	26.58	53.40	6.43	64.63	31.66
Manganese concentrations ppm									
Winter	1.80	6.60	4.20	4.20	5.00	24.40	2.40	2.80	6.43
Spring	3.50	6.40	4.17	1.90	7.10	14.60	2.50	25.90	8.26
Summer	3.50	10.40	6.40	14.00	8.40	27.20	9.20	33.60	14.09
Autumn	0.80	8.60	20.20	29.20	20.50	3.20	9.80	1.80	11.76
Average	2.40	8.00	8.74	12.33	10.25	17.35	5.98	16.03	10.13
Nickle concentrations ppm.									
Winter	0.8	21.2	3.1	1.5	1.7	6.5	1.2	9.8	5.73
Spring	0.4	29	5.9	2.8	1.8	9.8	1.65	17.4	8.59
Summer	0.8	13.2	0.2	0.4	1.6	3.2	1.2	4.4	3.13
Autumn	4.8	29.2	11.6	4.4	4.5	10.8	6.8	20.8	11.61
Average	3.35	23.15	5.20	2.28	2.40	7.58	2.71	13.10	7.26
Lead concentrations ppm									
Winter	0.20	0.40	0.60	1.00	1.60	1.50	2.00	6.00	1.66
Spring	7.50	3.20	3.50	3.90	1.50	5.00	1.05	28.20	6.73
Summer	1.50	2.20	2.40	3.20	2.80	9.60	4.80	6.40	4.11
Autumn	4.20	4.00	4.40	0.40	1.50	2.40	4.00	7.20	3.51
Average	3.35	2.45	2.73	2.13	1.85	4.63	2.96	11.95	4.00
Cobalt concentrations ppm.									
Winter	0.8	1	0.6	0.4	2.2	1.6	1.2	2	1.23
Spring	1	2.2	1.5	0.2	0.4	1.1	0.7	9.3	2.05
Summer	0.2	0.4	3.6	3.2	1.2	4	0	9.6	2.78
Autumn	0.56	2.96	2.76	0.96	1.2	5.36	2.28	9.36	3.18
Average	0.64	1.64	2.12	1.19	1.25	3.02	1.05	7.57	2.31

Table (5): Concentrations of Zn, Cd, Cu and Hg in water at the different sectors of Rosette Branch 1999-2000

Seasons	Sectors								Avg.
	El-Kanater	El-Rahawy	Tamely	Sobel	Kom-Hamada	Kafr El-Zial	Edfina (1)	Edfina (2)	
Zinc concentrations ppm.									
Winter	0.2	0.7	0.9	1.1	0.8	2.4	1	0.9	1.00
Spring	0.3	1.2	0.6	0.7	0.9	4.2	1	1.3	1.30
Summer	0.5	0.6	0.4	0.8	1.4	2.8	0.4	0.9	0.98
Autumn	0.4	3.2	2.4	2	1.4	21.2	2.8	6.4	4.98
Average	0.35	1.43	1.13	1.15	1.13	7.65	1.30	2.38	2.06
Cadmium concentrations ppm									
Winter	0.1	0.2	1	1.6	0.8	1.8	0.2	1.6	0.91
Spring	0.5	0.9	0.5	0.8	0.3	2.1	0.2	0.6	0.71
Summer	0.2	0.4	2	1.6	0.2	3.6	1.6	4.8	1.80
Autumn	0.2	4	0.4	0.8	0.5	1.6	0.4	4.4	1.54
Average	0.25	1.38	0.98	1.15	0.45	2.28	0.60	2.85	1.24
Copper concentrations ppm.									
Winter	0.02	0	0	0	0.04	1.42	0	0	0.19
Spring	0.3	0.25	0.1	0.1	0.1	2	0.1	1.1	0.51
Summer	0.6	0.88	0.64	1.08	1.24	2.16	0.12	1.2	0.99
Autumn	1.2	1.44	0.44	1.44	1.32	3.64	1.12	2.4	1.63
Average	0.53	0.64	0.30	0.66	0.68	2.31	0.34	1.18	0.83
Mercury concentrations ppm.									
Winter	0.17	0.15	0.08	0.009	0.05	0.031	0.018	0.027	0.07
Spring	0.09	0.08	0.04	0.01	0.05	0.028	0.012	0.041	0.04
Summer	0.014	0.024	0.003	0.014	0.003	0.025	0.005	0.005	0.01
Autumn	0.026	0.073	0.075	0.065	0.059	0.052	0.039	0.061	0.06
Average	0.08	0.08	0.05	0.02	0.04	0.03	0.02	0.03	0.04

Table (6): Concentrations of Fe, Mn and Ni at the flesh of *Oreochromis niloticus* mg/kg.

Parameter	El-Kanater	El-Rahawy	Sobel	Kafr El-Zial	Edfina (2)
Weight gm	150	170	160	140	150
Fe	64.52	416.7	107.42	85.45	114.5
Mn	2.34	20.8	6.7	4.51	8.13
Ni	3.82	16.7	4.16	4.15	10.82