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TRACE METALS CONCENTRATION OF AQUATIC MACROPHYTES IN LAKE MANZALAH, EGYPT.

BY

W. M. EL-SARRAF*

National Institute of Oceanography and Fisheries, Alexandria, Egypt.

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ABSTRACT

Lead, cadmium, zinc, manganese, iron and copper concentrations in five macrophytes were measured during the period from 1990 to 1992 in Lake Manzalah. The study revealed that temporal and spatial variation in the levels of trace metals would be correlated to the influence of Land-based sources of pollution. High content of lead and zinc reached up to 26.6 and 117.9 $\mu g.g^{-1}$ dry weight for Potamogeton pectinatus was observed, while Najas armata showed high level of cadmium (3.7 $\mu g.g^{1}$). In Ceratophyllum demersum, high concentration of manganese (1150.0 $\mu g.g^{-1}$), iron (1149.7 $\mu g.g^{-1}$) and copper (16.9 $\mu g.g^{-1}$) were detected. The mean trace metal concentrations in macrophytes from Lake Manzalah are ranked in the following sequence:

Fe >> Mn>> Zn>>Pb >> Cu>> Cd.

INTRODUCTION

Lake Manzalah is situated along the northern Mediterranean coast of Egypt and eastern Nile Delta between the Damietta Branch and Suez Canal (long 31° 45′; 32° 15′ E, Lat. 31° 00′; 31° 35′ N). It has an area about 230,643 feddans (968.7 Km^2 as measured by landsat in 1990), with mean depth of about one meter (Figure 1). The Lake annually receives about 6,68 x 10^6 of fresh and drain water, most of which is discharged into the south-eastern part of the lake (Hadus, Bahr El-Bakar and Ramsis drains) as given by Abdel-Moati and

Dowidar (1988). The lake has also a limited communication with the Mediterranean Sea through Boughaz El-Gamil. The lake is covered with macrophytes such as submerged ***Potamogeton pectinatus*** L., ***Ceratophyllum demersum*** L. and *Najas armata* Lind. F. The emergent species ***Phragmites communis*** (L.) Trin. has been met with everywhere, particularly along the shore. The floating plant as *Eichhornia crassipes* (Mart.) Solms-Laub. is also found. The macrophytes are characterized by assimilation of nutrients and minerals from the sediment by rhizomes as well as from the water (Nichols and Keeney, 1976). There is potential contamination of macrophytes by trace metals in Lake Manzalah (Pb, Cd, Zn, Mn, Fe and Cu). The metal content assimilated by macrophytes is used to detect the pollution of water bodies (Baudo *et al.*, 1981). The vegetation may play the role of biological filters and thus contributes the control of water pollution (Ozmiek, 1978). Several studies have been carried out on Lake Manzalah, (Dowidar *et al.*, 1984; Ibrahim, 1989 and Abdel-Baky and El-Serafy, 1990).

Due to the fact that macrophytes are becoming increasingly important for heavy metals research, hence the present study aims to formulate a database study about the heavy metal content of these aquatic plants in Lake Manzalah.

MATERIALS AND METHODS

Five species of macrophytes were collected during the period from 1990 to 1992 at nine stations located in Lake Manzalah (Figure 1 and Table 1). These species are ***P. pectinatus, C. demersum, N. aramta, E. crassipes*** and ***P. communis***. The aquatic plants were washed carefully to remove epiphytes and foreign matter and dried in an oven at 110±5 °C to a constant weight and then ground to fine powder in a mortar. About 1 g dry weight samples were digested in a mixture of concentrated nitric and perchloric acids (4:1 V/V) as described by Sawicka-Kapusta (1978). The analysis of trace metals was done during Flame Atomic Absorption Spectrometer Perkin Elmer Model 23 80, after calibration with standards prepared with the same acid mixture.

Fig

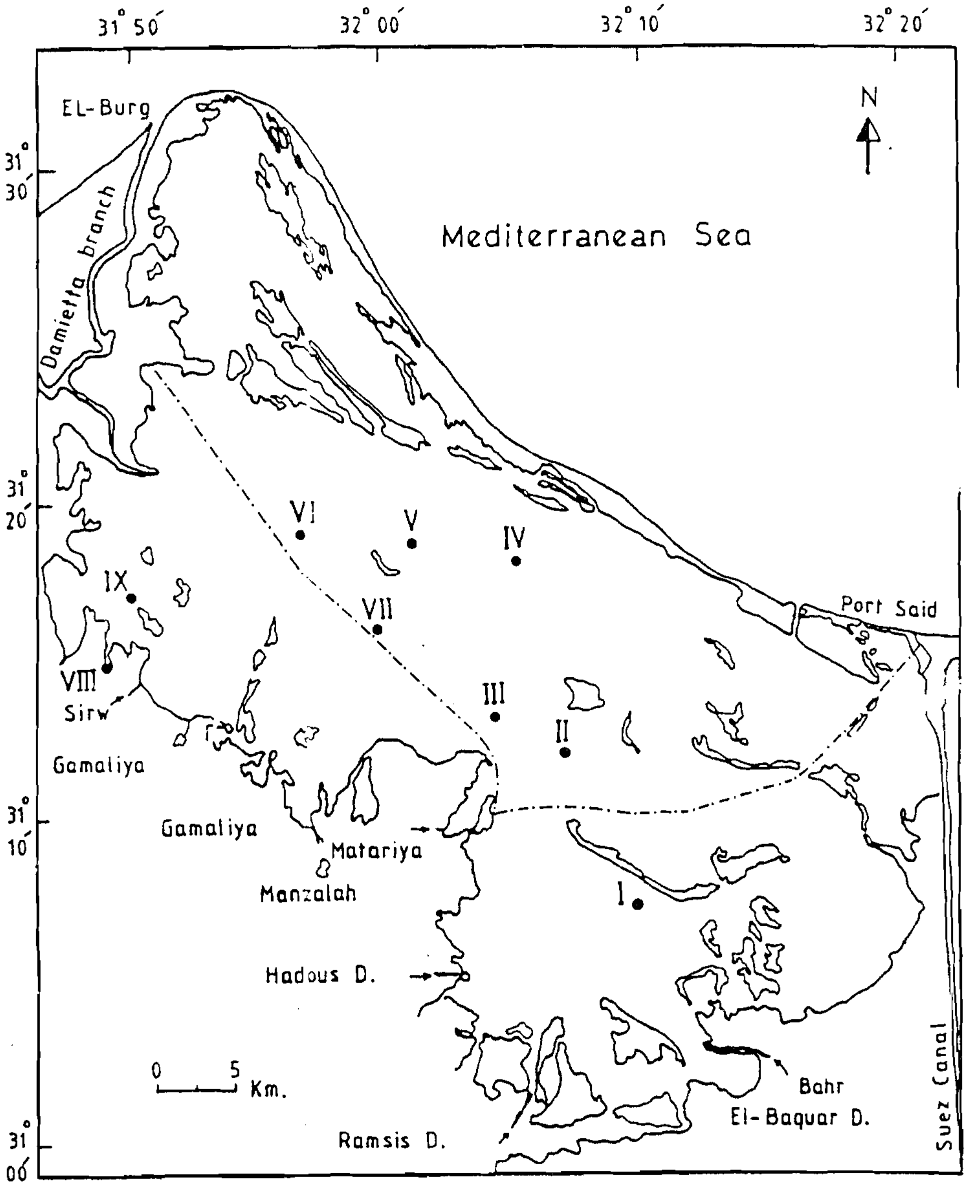

Figure (1): Map of investigated area

I- Ebn-Salam, II- Lagan, III- Dishdy, IV- Temsah V- Hamra, VI- Zarka, VII- Abwat, VIII- El-Sirw Drain, IX- Front of Sirw Drain.

Table (1): Heavy metal concentrations (µg.g^{-1} dry weight) of macrophytes at various stations.

Station	*Date*	*Pb*	*Cd*	*Zn*	*Mn*	*Fe*	*Cu*
	Potamogeton pectinatus						
I	2/91	10.5	1.7	81.9	87.7	740.0	15.1
II	9/91	8.2	0.0	24.1	437.7	121.7	5.0
III	10/90	23.9	1.9	97.3	491.6	642.5	7.0
	10/92	26.6	3.1	33.5	129.0	234.5	5.8
IV	12/91	11.8	3.0	103.9	349.0	702.2	11.5
	10/92	19.0	1.4	79.1	250.1	154.4	5.0
V	8/90	5.7	0.34	42.2	172.2	343.2	4.1
	10/90	9.5	0.0	53.2	102.5	89.6	8.1
	9/92	2.5	0.0	70.6	74.7	221.0	9.1
	10/92	5.2	1.1	89.2	77.9	128.0	3.9
VI	9/92	12.0	0.57	92.1	199.0	392.9	5.1
	10/92	9.8	0.0	.1	97.6	156.0	3.3
VII	10/90	8.2	0.37	117.3	229.5	400.3	5.8
	10/91	12.5	1.3	29.7	76.6	472.8	7.7
	10/92	14.1	0.24	40.5	209.7	174.0	4.3
VIII	10/90	2.3	0.0	57.7	246.9	943.0	6.7
IX	10/90	9.2	1.0	96.5	909.5	1015.0	11.6
	Ceratophyllum demersum						
V	1/91	5.3	0.75	63.3	321.8	672.6	5.4
	10/91	7.8	0.69	16.7	588.3	1122.5	2.1
VII	11/90	9.2	0.0	49.4	1150.0	1033.0	9.5
VIII	11/90	6.8	0.38	110.9	915.1	621.9	8.1
IX	11/90	8.7	1.9	97.9	721.0	1149.0	16.1
	Najas armata						
II	2/91	6.8	0.0	18.5	86.9	460.7	2.4
IV	9/92	24.8	3.7	57.1	696.3	397.8	5.7
	Eichhornia crassipes						
III	10/91	3.7	0.7	56.1	1017.0	484.0	13.7
VI	10/92	18.8	0.22	38.5	257.5	151.0	5.6
	Phragmites communis						
III	10/90	8.4	0.39	25.8	302.9	292.4	2.3

RESULT AND DISCUSSION

The heavy metals concentrations measured in dry plant of the five species of macrophytes are given in Table 1.

Generally, low concentration was observed in macrophytes at the central part of the lake. High concentration of trace metals was found in southeastern in addition to those stations while are affected by the different drain water.

Lead:

The concentration of lead fluctuated according to the spatial and temporal distribution. Low lead concentration was 2.5 $\mu g.g^{-1}$ at station V, while the high concentration (26.6 $\mu g.g^{-1}$) was measured at station III for ***P. pectinatus*** during September and October 1992, respectively (Table 1). The variation of lead content in macrophytes depends on the inflow of many sources of pollution from sewage and industrial wastes (Bahr El-Bakar drain) and agricultural (Hadus and Ramsis drains). Abo-Rady (1977) mentioned that ***P. pectinatus*** is a good lead contamination indicator. Thus ***P. pectinatus*** could be a good indicator for lead in Lake Manzalah.

Cadmium:

High level was found in ***N. armata*** (3.7 $\mu g.g^{-1}$) in September 1992 at station IV. Cadmium concentration in ***P. pectinatus*** without roots varied from 0.13 to 1.29 $\mu g.g^{-1}$ (Heydt, 1997). Mayes ***et al.*** (1977) mentioned that cadmium and lead were translocated from roots to shoots and leaves of ***Elodea canadensis.*** Accordingly, the cadmium concentration during a growth period in aquatic plants is recycled by degradation when the plant material is in senescence.

High significant correlation was found between lead and cadmium concentrations in aquatic plants ($r = 0.72$) which is probably attributed to their association in the same phase during assimilation.

Zinc:

The macrophyts have different levels of zinc, the high level was recorded for *P. pectinatus* (117.3 μg.g^{-1}) in October 1990 at station VII. While, the low value (16.7 μg.g^{-1}) was found in ***C. demersum*** during October 1991 at station V. Heydt (1977) found that ***P. pectinatus*** has zinc content ranged between 165.0 and 517.0 μg.g^{-1} dry weight in Elsenz River. Abo-Rady (1977) found that the zinc content of ***P. pectinatus*** ranged between 137.0 and 213.0 μg.g-1 dry weight in Lein River. Baudo ***et al.*** (1981) recorded that the mean concentration of zinc level for ***Potamogeton*** sp. is 168.0 μg.g-1 dry weight in Lake Mezzola.

Manganese:

The concentration of manganese was 74.7 μg.g-1 for ***P. pectinatus*** at station V during September 1992, while it was 1150.0 μg.g-1 for ***C. demersum*** at station VII during November 1990, (Table 1). In Lake Mezzola, Manganese content of ***Potamogeton*** sp. fluctuated between 96.0 and 5281.0 μg.g^{-1} as previously reported by Baudo ***et al.*** (1981).

Iron:

The concentration of Fe showed wide range in aquatic plants, the highest level was recorded in ***C. demerusm*** (1149.7 μg.g-1) at station IX during November 1990, while the lowest was found in ***P. pectinatus*** (89.6 μg.g^{-1}) at station V during October 1990. In ***Potamogeton*** spp. of Lake Mezzola, iron content varies between 1077 and 13829 μg.g^{-1} (Baudo ***et al.***, 1981).

Significant correlation was found between iron and manganese (r = 0.57). This is related to ultimate presence of Mn and Fe in macrophytes, also, it appears that the aquatic plants actually respond to accumulation when they are coupled to play their biological role. Whereas photosynthesis and growth are stimulated by the increase of manganese (Khalil, 1991), and iron is considered as a key element in metabolism (Round, 1973).

Copper:

Copper content showed a small range of fluctuation with irregular concentration in aquatic plants, in *C. demersum* the highest level was 16.1 $\mu g.g^{-1}$ at station IX in November 1990, while the lowest one was 2.1 $\mu g.g^{-1}$ at station V in October 1991. Haydt (1977) recorded that the copper content lies between 5.1 and 34.3 $\mu g.g^{-1}$ for *P. pectinatus* in Elsenz Riveer. Also, Abo-Rady (1977) found that the copper concentration fluctuated between 14.6 and 34.3 $\mu g.g^{-1}$ in ***P. pectintus*** in Leine River. While the copper content varied from 5.0 to 37.6 $\mu g.g^{-1}$ for ***Potamogeton*** sp. in Lake Mezzola (Baudo, ***et al.*** 1981).

Positively significant correlations were recorded between copper and zinc (r=0.44), Mn (r= 0.42) and Fe (r = 0.48), whereas the associations of Cu with the heavy metals (Zn, Mn, and Fe) may be attributed to the same biological behaviours during assimilation in macrophytes.

The concentration of trace metals (Pb, Cd, Zn, Mn, Fe, and Cu) in aquatic macrophytes varies according to locations of stations and time of sampling. This depends on the sources of pollution invading the lake from several directions (Bahr El-Bakar and agriculture drains). Seidel (1966) found that a high content of trace elements in macrophytes found in habitats affected by industrial effluents.

Station I is relatively affected by Bahr EL-Bakar Drain which carries high content of inorganic pollutants and sewage material. Abdel-Moati and Dowidar (1988) recorded that the metals are enriched in the area affected by Hadous and Bahr El-Bakar Drains. The effect of sewage and industrial wastes on the chemical composition of aquatic macrophytes is very obvious (Ozimek, 1978).

The magnitude of aquatic plants to assimilate heavy metals would be largely dependent upon the levels of them found in water/sediment. Also, the macrophytes have been predicted to reduce rates of pollution by decreasing external inputs of trace metals. Removal of certain minerals from water reservoirs by submerged macrophytes is observed as a practical method for water purification (Hillman and Culley, 1978).

The high variations found in the element content of aquatic macrophytes, both between species and within species, were related to different locations. Crowder and Painter (1991) inferred that the variation of metals content in macrophytes do not necessarily bioaccumulate or biomagnify these metals from the sediment may be attributed to site-specific and species-specific differences in metal uptake have been found. From this hypothesis, it is important to mention that, the nonessential trace metals such as lead and cadmium were highly concentrated in stations I, III, IV, VII and IX. The solubility of Cd, Pb and Zn under oxic conditions may be increased due to the formation oh higher soluble solids (Dowidar, *et al.*, 1984).

The industrial wastes may also be responsible for the elevation of Pb and Cd in lake Manzalah (Abdel-Moati and Dowidar, 1988).

The essential trace metals (Cu, Fe, Mn, and Zn) have important biochemical function in the organisms. However, the difference in the elemental relationships suggests that the macrophytes assimilation would be correlated affected by the influence of ecological conditions such as metal availability and interactions.

O'Kelley (1968) mentioned that Zn can be rapidly removed from some algal cells after accumulation., The differential tolerance of increasing or decreasing metal concentrations in sediment/water may be attributed to the decline of submerged species, thereby favouring of emergent or floating plants. Klopatek (1978) suggested that emergent macrophytes function as "nutrient pumps" extracting nutrients from the soil and immobilized than for various period of time in below-ground and above-ground tissues. Also, the metal content of different marcophytes species depends on the specific mechanisms of absorption, distribution and utilization (Hewitt and Smith, 1974).

Generally, the mean values of trace metals in aquatic macrophytes were ranked in the following sequence:

Fe >> Mn>> Zn>> Pb>> Cu>> Cd.

The order of abundance of the mean trace metals in these species of aquatic plants were:

Lead in: *Najs armata > P. pectinatus > E. crassipes > P. communis > C.demersum.*

Cadmium in: *N. armata > P. pectinatus > C. demersum > E. crassipes > P. communis.*

Zinc in: *P. pectinatus > C. demersum > E. crassipes > N. armata > P. communis.*

Manganese in: *C. demersum > E. crassipes > N. armata > P. communis > P. pectinatus.*

Iron in: *C. demersum > N. armata > P. pectinatus > E. crassipes > P. communis.*

Copper in: *E. crassipes > C. demersum > P. pectinatus > N. armata> P.communis.*

It can be concluded that the differentiation in heavy metals concentrations found in macrophytes is not between submerged, emergent and floating plants, but also, among the aquatic plants belonging to the same species.

The floating plant shows obvious different metal content depending on the type of lake water as primary source of metals. The high correlation between lead and cadmium in macrophytes may be attributed to the fact that plants growing down or near the source of pollution. However, the present study indicates that adsorption of metals by some aquatic plants may be useful as pollution control of such ecosystems.

Whereas, the heavy metals accumulation in macrophytes of the lake, indicates that the macrophytes can be considered as a good target for monitoring contamination in Lake Manzalah. Trace metals concentration of macrophytes species is widely deferent. This can be more significant if one species used for heavy metal monitoring within one or different areas.

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