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AQUATIC MACROPHYTES AND MACROBENTHOS AS BIOMARKERS FOR HEAVY METAL POLLUTION IN LAKE BURULLUS

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ABSTRACT

An aquatic macrophytes and benthos are unchangeable biological filters and they carry out purification of the water bodies by accumulating dissolved metals and toxins in their tissue. In view of their potential to entrap several toxic heavy metals, 3 groups of benthos and 5 macrophytes were collected from 15 different physiographic locations representing Lake Burullus and analyzed for estimation of 6 heavy metals. So the major concern of this work is to use the benthos and aquatic plants in Lake Burullus as biomarkers for heavy metals pollution and determine the ability of these biota for bioaccumulation of these metals, so the concentrations of heavy metals (Fe, Zn, Ni, Cu, Pb, and Cd) were determined in water, sediments, benthos (Arthropoda, Annelida and Mullusca) and some common aquatic plant species growing in Lake Burullus (*potamogeton pectinatus, Ceratophyllum demerssum, Najas armata ,Lemna gibba, Eichhornia crassipes root and shoot, phragmites australis shoot).*

The distribution of the investigated metals in water, sediments, benthos and plants of the lake showed that, the eastern and eastern southern parts of the lake are generally have higher concentration of heavy metals than the western and middle ones, which may be attributed to the impact of the pollution sources in this area as 6 drains and pumping station in the eastern and southern parts of the lake. *Potamogeton pectinatus* showed high contents of Pb, Cd and Zn (15.4, 4.7, 107.0μg/g dry wt.) respectively while *Eichhornia crassipes* show high level of Copper (13.9μg/g dry wt.). In *Ceratophyllum demerssum* high concentration of Iron was detected (98μg/g dry wt.).

The present study revealed that the aquatic macrophytes and benthos play a very significant role in removing the different metals from the aquatic environments. They probably play a major role in reducing the effect of high concentration of heavy metals. *Bioaccumulation factor values showed that the trend of accumulation of most metals in the benthos was as follows: Mullusca > Arthropoda > Annelida > and in aquatic plants as:*

Lemna gibba> Potamogeton pec. > Ceratophyllum demer. > Eichhornia Root > Najas armata>phragmites shoot > Eichhornia Shoot. which make them suitable candidates to be used in biomonitoring surveys, as biomarkers for heavy metals pollution, in the biological treatment of the polluted water and in sustainable development of Lake Burullus.

Key **words:** Lake Burullus, water, sediment, heavy metals, biomarkers, bioaccumulation, macrobenthos, aquatic plants, sustainable management.

INTRODUCTION

The term heavy metal refers to any metallic chemical element that has a relatively high density and is highly toxic or poisonous at low concentrations. [**Harris & Santos (2000)**]. Macrophytes are aquatic plants, growing in or near water that are emergent, submerged or floating. Macrophytes are considered as important component of the aquatic ecosystem not only as food source for aquatic invertebrates, but also act as an efficient accumulator of heavy metals [**Devlin (1967), Chung & Jeng (1974)**].They are unchangeable biological filters that play an important role in the maintenance of aquatic ecosystem.

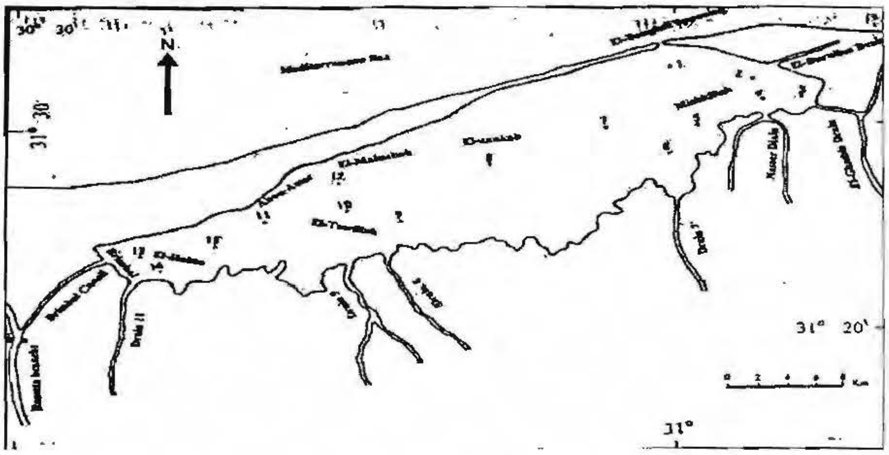
Some sources of heavy metals are industry, municipal wastewater, atmospheric pollution, urban runoff, river dumping, and shore erosion. High levels of Cd, Cu, Pb, and Fe can act as ecological toxins in aquatic and terrestrial ecosystems. Some of these metals (Cu, Ni, Cr and Zn) are essential trace metals to living organisms, but become toxic at higher concentrations. Others, such as Pb and Cd have no known biological function but are toxic elements, [**Guilizzoni (1991) and Balsberg-Påhlsson (1989)**]. Many of the aquatic macrophytes and benthos are found to be the potential scavengers of heavy metals from water and wetlands sediments [**Gulati et al., (1979)**]. The present investigation was planned and executed considering the potentials of benthos and macrophytes as biological filters for metals that become bound to living materials.

The biomonitoring of pollutants using accumulator species is based on the capacity which has some plant and animal taxa to accumulate relatively large amounts of certain pollutants to concentration many times higher than those of the surrounding waters, [**Nafea (2005)**]. In addition, the pollutant concentrations in sediments and the organisms are the result of the past as well as the recent pollution level of the environment in which the organism lives, while the pollutant concentrations in the water only indicate the situation at the time or seasons of sampling.

Although, Lake Burullus attracts attention of many authors because of its economic and scientifically importance to study its unique ecosystem but, the studies dealt with the accumulation of heavy metals in different ecosystem components are still scarce except few studies e.g. **[Elsaraf (1995); Radwan & lotfy (2002) and Nafea (2005)]**. Here in our paper we will deals with the aquatic plants and macro benthos as biomarkers and bioaccumulators for heavy metals pollution, in order to use these aquatic plants and benthos in sustainable development and management of Lake Burullus.

Location and Description of Lake Burullus:

Lake Burullus is situated along the Mediterranean coast ,occupies a more or less, a central position between the two branches of the Nile and extends between 31° 22' – 31° 26' N and 30° 33' – 31° 07' E Fig. (1). It is a shallow brackish lake connected with the sea by a small outlet (Boughaz), about 44 m. width and 150m length. The length of the lake is about 65 km., and its width varies between 6 and 16 km, with an average of about 11km. The depth of the lake ranges between 0.42 and 2.07 m. The eastern sector of the lake is the shallowest, showing an average depth of 0.8m. The present area of the lake is about 410 km2 (100,000 feddan), of which 370 km^2 is open water. The capacity of the lake is about 330 million cubic meters. The eastern and southern parts of the lake receives agricultural sewage drainage water through 8 drains and one brackish water canal, while saline water enters the lake from the sea through El-Boughaz **[Nafea (2005)]**.



The study focused primarily on metal investigation in water, Sediments, benthos and aquatic plants. The sampling program was carried out in the summer of 2008. Aquatic plants and benthos were collected from the 15 sites by grab methods from the surface layers and five samples were prepared for each species at every sampling site. At the same time water and sediments samples were collected at the corresponding sampling locations. The collected water was filtered through a Whatman glass-fiber filter (0.45 μm). The filtered water was stored in a 0.5 L polypropylene bottle to avoid any adsorption of metals on the wall of the sample bottles; the filtered water was preserved by acidifying with 1.0 ml, concentrated nitric acid.Water analysis for heavy metals according to (Solvent extraction method) **[APHA (1992)]**. The sediment samples were air dried in room temperature (25 °C) for 10-15 day, then grinded in a mortar and sieved in 0.5 mm sieve and stored for analysis according to [**Moore & Chapman (1986)**].

Five plant samples were mixed with each others and analyzed for heavy metals where the dry samples of macrophytes were wet-digested in a mixture of concentrated nitric acid and perchloric acid (4:1 v/v) [**Sawicka-kapusta (1978)**]. Samples were analyzed with a Perkin Elmer model 2380 atomic adsorption spectrophotometer (A.A.S.). Bottom fauna were classified to three main groups (Mullusca, arthropoda and Annelida), and digested after drying according to [**Metcalfe-Smith** (1994)] method. Metals were determined using atomic absorption (Perkin Elemer Model 3700) with flameless graphite furnace (GA-2). The bioaccumulation factor was calculated according to [**Klavinš *et al.*, (1998)**] as follow: BAF = M_tissue / M_water or sediments where: M_tissue: metal concentration in plant tissue M_water: metal concentration in water or sediments.

RESULTS

As showed in **tables (1 & 2)** copper content in water of Lake Burullus ranged between 19.7 µg/l) in the western parts and 35.8 µg/l in the eastern part. It's values in sediment ranged from 19.4 µg/g dry wt.and 47.9 µg/g dry wt.in the western and eastern sites, respectively.Iron content in water ranged between 25.3 µg/l in station 8 and 60.4 µg/l in station 4.its values in sediments ranged between 42.4 µg/g dry wt. in site 15 and 97.5 µg/g dry wt in site 4. *Cadmium* contents ranged between2.9 µg/l in station10 and8.5 µg/l in station4 while in sediments ranged between 3.2 µg/g in station 10 and 8.5 µg/g in station 6.Zinc contents in water ranged between 20.6 µg/l in station15 and 55.3 µg/l in station 4 while in sediments it ranged between 24.2 µg/g in station15 and97.2 µg/g in station4.Lead content showed its high values in water at site4 10.1 µg/l and low value 4.5 µg/l in station 15 while in sediments high value was27.5 µg/g in station1 and 6.5 µg/g in station15.Nickel shows its high value in water 10.3 µg/l in station 2 and the low one 4.3 µg/l in station 6 while in sediments high value recorded 19.7 µg/g in station 2 and 7.1 µg/g in station 15.

Copper contents in the aquatic plants showed high range of variation ranged between 13.9 µg/g in *Eichhornia* root in eastern site and 5.1 µg/g in *Ceratophyllum* in western site. Iron contents in aquatic plants ranged between 107 µg/g in *potamogeton* and 50 µg/g in *Najas*, while *cadmium* content ranged between 1.0 µg/g in *Ceratophyllum* and 4.7 µg/g in *potamogeton*. On the other hand nickel ranged between 15.3 µg/g in *Lemna* and 5.8 µg/g in *Najas*. High value of Lead observed at *potamogeton* 15.4 µg/g and low value 5.5 µg/g at *Eichhornia* shoot. *Zinc* contents ranged between 98 µg/g in *Lemna* and 43 µg/g in *Eichhornia* shoot Table (3). Inspection of table 4 revealed that the three are Benthos *mullusca* showed high ranges of metal content in their bodies and tissues more than *Arthropoda* and *Annelida*.

The bioaccumulation factors values of heavy metals by aquatic plants in relation to water ranged between (260-548), (1256-5370),(200-913),(1111-2392),(1171-2722) and (850-2220) for (Cu,Fe,Cd,Zn, Pb and Ni), respectively Table (3), while in benthos in relation to sediments ranged between (0.59-0.69),(0.96-1.3), (0.32-0.62), (1.1-1.44), (0.63-0.75) and (0.93-1.2) for Cu, Fe, Cd, Zn, Pb and Ni respectively Table (4).

Table (1): the concentration of heavy metals in water (µg/l) at 15 stations at Lake Burullus.

Metal conc. stations	**Cu** µg/l	**Fe** µg/l	**Cd** µg/l	**Zn** µg/l	**Pb** µg/l	**Ni** µg/l
1	24.5	32.3	4.1	28.2	7.4	6.2
2	33.6	45.2	5.2	35.7	7.2	10.3
3	18.2	52.3	6.1	33.1	8.5	5.3
4	30.1	60.1	8.5	55.3	10.1	5.4
5	20.2	33.2	6.1	50.6	7.1	5.2
Mean eastern	25.32	44.6	6.0	40.58	8.06	5.64
6	22.3	30.2	7.3	42.3	8.6	5.2
7	23.5	34.5	6.5	36.2	4.3	6.5
8	24.6	25.3	5.3	42.3	8.5	4.3
9	18.6	35.2	4.2	26.4	5.1	5.3
10	11.3	55.3	2.9	25.3	6.6	5.9
Mean middle	20.6	44.45	5.24	18.8	6.62	5.38
11	21.6	40.2	5.5	23.5	6.9	5.2
12	26.4	42.3	4.6	22.6	4.5	4.6
13	18.3	59.2	5.1	27.5	5.3	5.3
14	12.9	41.3	4.2	25.7	7.2	6.1
15	16.2	39.2	4.0	20.6	6.3	4.9
Mean western	19.1	44.4	4.6	24	6.1	5.22

Table (2): The concentration of heavy metals in sediment (µg/g) dry weight at 15 stations at Lake Burullus.

Metal conc. Station	**Cu µg/g**	**Fe µg/g**	**Cd µg/g**	**Zn µg/g**	**Pb µg/g**	**Ni µg/g**
1	29.5	71.3	5.2	58.6	27.5	18.4
2	47.6	92.4	6.1	72.4	18.2	19.7
3	29.6	94.5	5.9	65.3	27.1	10.2
4	39.5	97.5	7.8	97.2	19.7	14.2
5	32.2	58.9	7.2	94.7	20.4	11.6
Mean eastern	35.7	83	6.5	77.64	22	15
6	39.1	81.1	8.2	81.2	17.4	12.9
7	35.4	44.2	5.9	57.9	11.4	10.2
8	29.5	61.3	6.1	64.3	18.6	8.7
9	22.7	57.5	5.2	36.1	15.7	9.7
10	20.8	75.7	3.1	25.3	17.4	12.8
Mean middle	29.5	64	5.7	53	16.1	11
11	31.2	52.1	5.3	37.2	12.3	9.2
12	34.1	51.3	5.2	34.4	9.7	8.7
13	27.3	60.2	5.4	31.2	11.2	9.1
14	19.7	52.3	4.1	27.1	10.9	8.2
15	19.4	42.1	5.0	24.1	9.6	7.1
Mean western	26.4	51.6	5	30.1	10.8	8.5

Table (3): The mean concentrations of heavy metals (µg/g) dry weight and the bioaccumulation factor values for the aquatic plants in the (east, middle and west) of Lake Burullus.

Metal Conc. µ g/g. → plants	Cu µg/g	Fe µg/g	Cd µg/g	Ni µg/g	Zn µg/g	Pb µg/g
Ceratophyllum d. East	6.6	94	1.2	10.5	98	8.5
M	5.4	84	1.1	9.5	92	7.8
W	5.1	81	1.0	8.2	84	6.4
Bioaccumulation factor	263	3268	368	1853	2234	1102
Potamogeton pectinatus	10.2	107	4.7	13.4	64	15.4
East	9.1	78	2.7	12.5	61	11.4
M	8.3	83	2.3	10.2	52	9.7
W	426	3469	679	2116	1459	1780
Bioaccumulation factor						
Lemna gibba East	11.8	104	4.2	14.2	92	14.2
Middle	10.4	101	3.6	15.3	98	14.7
West	9.2	87	4.2	11	87	14.2
Bioaccumulation factor	484	3852	766	1822	2247	1807
Phragmites aus. Shoot	9.1	72	2.0	8.5	75	10.2
East	8.2	71	1.7	5.8	71	10.1
Middle	7.2	66	2.0	8.5	64	8.9
West	392	2323	401	1418	1698	1480
Bioaccumulation factor						
Eichhornia crass. Shoot	8.6	62	1.5	7.6	53	7.5
East	7.3	63	1.6	6.4	52	6.9
Middle	6.5	54	1.5	7.6	43	5.5
West	436	2879	300	1344	1223	1266
Bioaccumulation factor						
Eichhornia crass. Root	13.9	95	3.5	8.7	86	9.1
East	8.3	91	2.7	7.4	75	9.3
Middle	8.7	82	3.5	8.7	56	5.1
West	417	3081	575	1558	1724	980
Bioaccumulation factor						
Najas armata East	11.5	51	1.4	6.2	76	11.6
Middle	9.5	46	1.5	5.8	78	10.2
West	9.3	50	1.4	6.2	66	10.0
Bioaccumulation factor	469	2371	274	1132	1868	1615

Table (4): the mean concentrations and bioaccumulation of heavy metal in the benthos (µg/g) dry weight in the (east, middle and west) of lake burullus in relation to sediment concentration.

metals conc. benthos	Cu µg/g	Fe µg/g	Cd µg/g	Zn µg/g	Pb µg/g	Ni µg/g
Mullusca : east	27	72	4.5	83	13	15
Middle	22	69	3.2	76	12	13.5
West	13	63	2.9	73	11.6	12.7
Bioaccumulation	.69	1.03	.62	1.44	.75	1.2
Arthropoda: east	23	72	2.3	75	11	12
: Middle	19	65	1.4	69	10.5	11.7
: west	11	57	1.9	71	10.1	11.3
bioaccumulation	0.59	0.98	0.32	1.34	0.65	1.02
Annelida :east	21	68	3.2	67	11	11
:Middle	19	62	1.2	58	10	10.9
:west	17	60	1.1	49	9.7	10
bioaccumulation	0.63	0.96	0.32	1.1	0.63	0.93

DISCUSSION

Generally the high concentrations of heavy metals were measured in the sediments, benthos and macrophytes in the eastern sites of the lake, while the low concentrations were detected in the middle and western sites of the lake .The concentration of lead varied from site to site where the high concentrations were detected in water, sediments, Mullusca and *Potamogeton pectinatus* in the eastern site (8.06 µg/l , 15,15 & 13 µg/g dry wt) respectively while the low concentrations were measured in the western parts of the lake(6.1 µg/l, 8.5,10 and 5.5 µg/g dry wt) respectively, Tables (1,2,3, &4) . The variation of lead content in benthos, sediments and macrophytes depends on the inflow of many sources of pollution from sewage, agricultural and industrial wastes into the lake.[**El-Sarraf (1995)**] mentioned that in Lake Manzala *Potamogeton pectinatus* had high lead concentration (26 .6 µg/g dry wt) and thus it is a good lead contamination indicator. This agrees with the conclusion of [**Abo-Rady (1977)**] that *Potamogeton pectinatus* may be considered as an indicator for lead in Lake Manzala. Our results in burullus confirm this conclusion.

High levels of cadmium contents were found in *Lemna gibba* and *Eichhornia root, Mullusca* and sediments of the eastern parts (4.5, 6.5 &4.2 µg/g) dry wt. while the lowest concentrations of cadmium were observed in *Ceratophyllum demerssum* (1µ g/g) dry weight. El-Sarraf (1995) mentioned that there was high significant correlation between lead and cadmium concentration in aquatic plants which is probably attributed to their association in the same phase during assimilation, Tables (2, 3 and 4).

The macrophytes and benthos have different levels of zinc concentrations in their organs where the high levels were recorded in *Lemna gibba* , *potamogeton pectinatus* and Mullusca (83,77.6,107 & 104, µg/g dry wt.) respectively, while the low concentrations were found in *Najas armata* , *Eichhornia crassipes* shoot and Annelida (50, 46& 49 µg/g dry wt.) respectively. [**Heydt (1977)**] found that *Potamogeton pectinatus* has high zinc content ranged between 16.5 and 517µ g/g dry. Weight in Elsenz River. [**Bauda *et al.*, (1981)**] recorded that in Lake Manzala the mean concentration of Zinc level in the same species is 168µ g/g dry wt. [**El-Sarraf (1995)**] found that the concentration of Zinc in *potamogeton pectinatus* was 117 µg/g dry weights. Whereas [**Abo-Rady (1977)**] found that the zinc content of *potamogeton pectinatus* ranged between 137 and 213 µg/g dry weight in Leine River.

The copper concentrations fluctuated within the range 5.4 and 35 µg/g dry wt. in plants, benthos and sediments. The copper content in Lake Manzala varied from 5.0 to 37.6 µg/g wt. In potamogeton *pectinatus*. On the other hand [**El-Sarraf (1995)**] found that copper content showed a small range of fluctuation with irregular concentration in aquatic plants. In *Ceratophyllum demerssum* the highest level was 18.5 µg/g dry wt. The positive correlation between Cu and Zn was attributed to the same biological behaviors during the assimilation in macrophytes [**El-Sarraf (1995)**].

The concentrations of trace metals (Cu, Zn, Pb, Fe, Ni & Cd) in the aquatic macrophytes, benthos and sediments varied according to their locations at the different parts of the lake, this depends on the source of pollution invading the lake form several directions. [**Seidal (1996) and Ozimek (1978)**] recorded high contents of trace metals in the macrophytes growing in habitats affected by industrials effluents and effect of sewage and industrial wastes on the chemical composition of aquatic macrophytes is very obvious. The magnitude of aquatic plants and benthos to assimilate heavy metals would be largely dependent upon the levels of these metals in the water and sediment. The removal of certain mineral from water reservoirs by submerged macrophytes and benthos is observed as practical methods for water purification [**Hillman & Cully (1978)**]. The high variations found in the element content of the aquatic macrophytes both between species and within species were related to different location. [**Crowder & Painter (1991)**] inferred that the variation of metals content in macrophytes is not necessarily bioaccumulations or biomagnified these metals from the sediment and it may be attributed to site-specific and species specific differences in metals uptake. From this hypothesis it is important to mention that the non essential trace metals such as lead and cadmium were highly concentrated in Lake Burullus eastern side [**Nafea (2005)**] and the industrial wastes may also be responsible for the elevation of the Pb and Cd in Lake Burullus. The order of abundance of the trace metals in the macrophytes benthos of Lake Burullus were:

(1) Lead: *Lemna > Potamogeton > Eichh. Root > Ceratophyllum > phragmites sh. >Najas > Eichh. Sh., Mullusca>Arthropoda> Annelida.*

(2) Cadmium: *Lemna > potamogeton > Najas>phragmites > Eichhornia Root > Eichh. Shoot > Ceratophyllum.*
And in benthos: Mullusca>arthropoda> Annelida
(3) Zinc: *Lemna > Ceratophyllum > Potamogeton > Eichh. Root >phragmites shoot > Eichh. Shoot > Najas*
And in benthos: Mullusca>arthropoda> Annelida
(4) Copper: *Lemna > Eichh. Root > Najas >phrag. shoot >Eichh.Shoot >Ceratophyllum. > Potamogeton*
And in benthos: Mullusca > Annelida> arthropoda.
(5)Nickel: *Lemna > Potamogeton > Ceratophyllum > Eichh. Root > Najas > phrag. Shoot > Eichh. Shoot*
And in benthos: Mullusca > arthropoda > Annelida.
(6)Iron: *Lemna > Ceratophyllum >Eichh. Root > Najas > phrag.shoot> Potamogeton > Eichh. Shoot*
And in benthos: Mullusca>arthropoda> Annelida.

Lemna gibba, potamogeton pectinatus and Mullusca showed the higher capacity of heavy metal accumulation than the other aquatic plants and benthos groups. Aquatic macrophytes and benthos can be used as bio-indicator and biomarkers for water and sediment pollution as they can trap micro- and macro-elements (inorganic pollutions) as investigated by **[Fayed & Abdel-Shafy (1985)]. [El-Khatib & Sawaf (1998)]** reported that the concentrations of heavy metals in macrophytes were positively related to its concentration in the environment and the macrophytes have high potential power for pollution monitoring **[SZ Yamanowska *et al.*, (1999)].**

Depending on the heavy metals concentration in the aquatic macrophytes and benthos, it can be concluded that the aquatic macrophytes and benthos can accumulate heavy metals and have a restricted role in the treatment and control of pollution of the aquatic ecosystems. Accordingly, the macrophytes and benthos can be considerable as reliable way for biomonitoring the heavy metals contamination in Lake Burullus. Trace metals concentration in macrophytes and benthos species is widely differ. This can confirmed if a species is used for heavy metals monitoring within one or different areas. **[Ghobrial (2000b)]** reported that *Ceratophyllum demerssum* can accumulate zinc more than Cu, Pb and Cd and acts as a potential biological filter for trace metals removal from domestic effluents and has a capacity to retain heavy metals in its tissues.

High range of the heavy metals concentration in the studied aquatic plants and benthos indicates different extent of pollution; this high variability is associated with the different absorption rate for the heavy metals by the aquatic plants and benthos.

Recently, there has been growing interest in the use of metal-accumulating plants or benthos for the removal of heavy metals from contaminated aqueous streams, in the biological purification of waste water and in biomonitoring of heavy metals pollution in the Egyptian lakes **[Nafea (2005)]**.The biomonitoring of pollutants using accumulator species is based on the capacity which has some plant and animal taxa to accumulate relatively large amounts of certain pollutants, even from much diluted solutions without obvious noxious effects. The use of this type of monitoring is widespread in marine and freshwater environments, because the measuring of the pollutant content in the organisms is the only way of evaluating the bioavailability of a pollutant present in the environment. In addition, the pollutant concentrations in the organism are the result of the past as well as the recent pollution level of the environment in which the organism lives, while the pollutants concentrations in the water only indicate the situation at the time of sampling. The Polychaeta *Nereis diversicolor* (which form the major component of, Annelida in this study) used in many studies as a useful indicator for Ni, Cd, Cu and Fe. The concentration of metals in this species is small compared with other benthos groups (*Mullusca* and *Arthropoda*).The bioaccumulation rate values are higher in aquatic plants than the benthos this is due to that the aquatic plants are fixed and stable than the benthos. So the aquatic plants can be used as good tools for biofiltration and biomonitoring for heavy metal pollution in Lake Burullus.

From the present observations, it is concluded that there is a uniform pattern of heavy metal variation in the macrophytes, sediments and benthos of Lake Burullus. In general, values of some metals like iron, zinc and copper are higher in almost all the specimens. This shows the universal importance of these macrophytes, sediments and benthos in cleaning up of the aquatic environment. The results presented here could be very useful for environmental monitoring and checking the health of the water body. The aquatic macrophytes and benthos were found to be the potential source for accumulation of heavy metals from water and sediments and act as biofilters for metals, accordingly they could be used in sustainable development , management and pollution assessment program in the northern deltaic lakes of Egypt especially lake burullus.

REFERENCES

Abo-Rady, M.D. (1977): Die Belastungder oberch Leine mits chwermetallen.Durc Kommunate and.Industrielle Abwasser,ermittelt and hand von wasser, sediment, F.shared prlanzenunt,enchungen. Dess. Univ. Gyttingen (FRG) 120

APHA (1992): Standard methods for the examination of water and waste water, Washington, 18 Ed.

Balsberg-Påhlsson, A. M.,(1989):Toxicity of heavy metals (Zn, Cu, cd, Pb) to vascular plants.A literature review.Water, Air and Soil Pollution. 47: 287- 319

Bauda, R.; Galanti, p.;Guilizzoni, p. and Varini, P. (1981): Relationship between heavy metals and aquatic organisms in Lake Manzala hydrograph systems (Northern Italy): Mem. IST. Ital. Hydrobiol;, 39: 203 – 225.

Chung, I. H., Jeng, S. S (1974): Heavy metal pollution of Ta-Tu River. Bulletin of the Institute of Zoology, Academy of Science,13: 69-73

Crowder, A. and Painter, P. (1991): Submerged macrophytes in Lake Ontario: current know edge, importance, threats to stability and needed studies, Can. J. fish. Aquatic .Sci. 48: 1539-1545.

Devlin, R. M., (1967): Plant Physiology. Reinhold, NewYork, 564.

Dewidar, Kh. And Khedr,A.(2001):Water quality assessment with simultaneous lands atm5 at Manzala lagoon, Egypt. Hydrobiology, 427: 49-58.

El-Khateb, A. and El-Sawaf, N. (1998): Differential trapping of heavy metals by macrophytes in different water bodies near Sohag, Upper Egypt. Acta Hydrobiologica, 40: 67-73.

El-Sarraf, W.M. (1995): Trace metals concentration of aquatic Macrophytes in Lake Manzalah, Egypt. Bull. Nat. Inst. Ocean. And Fish. A.R.E.; 21(1): 171-181

Environ. Toxicol. And Chem., 13: 1433-1443.

Fayad, S. and Abd-El-Shafy, H. (1985): Accumulation of Cu, Zn, Cd and Pb by aquatic Macrophytes. Environ. International, 11(1): 77-88.

Ghobrial, M.G. (2000b): Treatment of Cadmium, Copper, Zinc and Iron in waste water by the Horn wort Ceratophyllum demerssum. Egypt. J. Aquat. Biol. & Fish. 4 (1): 35 – 46.

Guilizzoni, P. (1991):The role of heavy metals and toxic materials in the

Gulati, K. L., Nagpaul, K.K., Bukhari, and S.S: (1979): Uranium, boron, nitrogen, phosphorus and potassium in leaves of mangroves, Mahasagar - Bull. of the Nat. Inst. of Ocean. 12:183-186.

Harris, R.R., Santos,M.C.F. (2000) Heavy metal contamination and physiological variability in the Brazilian mangrove crabs Ucides cordatus and Callinectes danae (Crustacea: Decapoda). Marine Biology Vol 137, 691-703.

Heydt, G. (1977): Schwermetallg chalteven Wasser, wasser.p franzen, chironomikae and Mullusca der. Elsenz. Dipl. Arbeituciv, Heidelberg. 143.

Hillman, W.S. and Culley, D.D. (1978): The used of Duck weed-Am. Sci., 66: 442-451.

Klavinš, M.; A. Briede, E. Parele,V. Rodinov, and I. Klavina, 1998. Metal accumulation in sediments and benthic invertebrates in Lakes of Latvia. Chemosphere, 36 (15): 3043 – 3053.

Metcalfe -Smith, J.L. (1994): Influence of species and sex on metal residues in fresh water mussels (family Unionidae) from the St. Lawrence River, with implications for biomonitoring programs.

Moor, P. and Chapman, S. (1986): Methods in plant ecology. Second edition, Blackwell Scientific Publication.

Nafea, E., M., A. (2005): On the ecology and sustainable development of the northern delta lakes, Egypt. PhD Thesis, Mans.Univ. fac. of sci.

Ozimek, T. (1978): Effect of municipal Sewage on the submerged macrophytes of Lake Littoral. Ekal. Pol. 26 (1): 3-39.

Physiological ecology of submersed macrophytes. Aquatic Botany, 41: 87-109.

Radwan, A.R. and I.H. Lotfy, (2002): On the pollution of Burullus Lake water and sediments by heavy metals. Egypt. J. Aquat. Biol. and Fish, 6(4): 147 - 164.

Sawicka- Kapusta, K.(1978): Estimation of the content of heavy metals in atlas of rae-deer from silesian Woods.Arch.Ochr.Sord.1:107-121.

Seidal, K. (1966): Biologischer seenschutzpfan zer wasser filter-foederation Europaischer Gewasser schutz. Symp. 76: 357 – 195.

Szymanwska, A.; Sameckacymerman, A. and Kempers, A. (1999): Heavy metals in three Lakes in West Poland, Ecoto. and Environ. Safety, 43(1): 21-29.

Untawale, A.G., Wafar, S., Bhosale, N. B (1980): Seasonal Variation in Heavy Metal Concentration in Mangrove Foliage. Mahasagar Bull. of the Nat. Inst. of Ocean. 13(3): 215-223

الملخص العربى

النباتات المائية واللاصقات الحيوانية كدلائل حيوية على التلوث بالمعادن الثقيلة فى بحيرة البرلس

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يهدف هذا البحث الى استخدام النباتات المائية و اللاصقات الحيوانية الموجودة فى بحيرة البرلس كدلائل حيوية على تلوث المياه والرسوبيات بالمعادن الثقيلة مثل (الكادميوم ، النحاس، الرصاص ، الزنك ، النيكل والحديد) ومدى قدرتها على امتصاص هذه العناصر من المياه وتراكمها داخل انسجتها، لذلك تم اختيار ١٥ موقع داخل بحيرة البرلس تمثل البحيرة تمثيلا جيدا وتم تعيين هذه العناصر فى المياه وكذلك تم اختيار ٣ مجموعات من اللاصقات الحيوانية وهى (Arthropoda,Annelida and Mullusca) وكذلك ٥ أنواع من النباتات المائية المغمورة والطافية والبارزة السائدة فى البحيرة: مثل الحامول *Potamogeton pectinatus* ونخشوش الحوت *Ceratophyllum demersum*، عدس الماء *Lemna* gibba، والحريشة *Najas* armata, وورد النيل *(الجذر والمجموع الخضرى)* *Eichhornia crassipes* البوص*(المجموع الخضرى)* *Phragmites australis* وتقدير العناصر الثقيلة بها فى المواقع المختلفة وتعيين معدل التراكم الحيوى لهذه العناصر داخل النباتات واللاصقات الحيوانية للوقوف على مدى قدرة اللاصقات الحيوانية والنباتات المائية على امتصاص المعادن الثقيلة من المياه والرواسب وتراكمها داخلها بدرجة عالية بها ومن ثم يمكن استخدامها كدلائل حيوية على التلوث و ايضا مرشحات حيوية للملوثات والمعادن الثقيلة الموجودة فى بحيرة البرلس.

واوضحت الدراسة أن أكثر مناطق البحيرة تلوثا هى المناطق الشرقية والجنوبية شرقية ويرجع ذلك الى أن هناك ٦ مصارف زراعية وصناعية وآدمية تصب مباشرة فى البحيرة من هذه الناحية على عكس النواحى الأخرى للبحيرة. وأن النباتات المائية واللاصقات الحيوانية يمكنها ان تمتص العناصر الثقيلة مثل النحاس والزنك والنيكل والحديد والرصاص والكادميوم بدرجة عالية جدا من المياه والرسوبيات وتخزنها فى انسجتها مما يجعلنا نؤكد على إمكانية استخدامها كدلائل حيوية للتلوث بالعناصر الثقيلة وللتحكم الحيوى فى هذه من البحيرة العناصر وازالتها من المياه والرسوبيات بطريقة امنة وذلك عن طريق اخراج هذه النباتات واللاصقات فتخرج ومعها المعادن والعناصر المتراكمة داخلها .

الماء فى واكدت الدراسة على انه يمكن استخدام نبات الحامول ونخشوش الحوت وعدس تنقية مياه البحيرة حيث ان لهم قدرة عالية على امتصاص المعادن الثقيلة من المياه. لذلك تقترح الدراسة استخدام هذه الانواع النباتية واللاصقات الحيوانية كدلائل حيوية على التلوث بالمعادن الثقيلة والتحكم الحيوى والادارة المستدامة لبحيرة البرلس.