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MANGANESE, ZINC, CADMIUM AND LEAD IN PLANTS OF DOŁGIE GREAT LAKE

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Abstract

In this assay it is shown the results of examination about the content of zinc, cadmium, manganese, lead in chosen plants *Myriophyllum spicatum, Potamogeton lucens, Acorus calamus, Nuphar luteum* Dołgie Great Lake in years 1999 – 2000. First were given information about accumulation those metals in makrofitch of Dołgie Great Lake. The biggest concentration examined metals was observed in *Nuphar luteum* Zn – 27.6 $\mu g \cdot g^{-1}$, Pb – 2.60 $\mu g \cdot g^{-1}$, Cd – 0.34 $\mu g \cdot g^{-1}$, and Mn in *Acorus calamus* 450 $\mu g \cdot g^{-1}$.

Key words: Dołgie Great Lake

INTRODUCTION

Economic active, particularly industrial, causes introduction to environment (water, soil, air) organic or inorganic compounds in quantity that frequently crosses admissible concentration. If in that conditions, contents individual elements cross application for makro – or microelements organisms of alimentary canal in water ecological system, in consequences they can exert toxic influence on biocoenosis and brake process self – cleaning. Particularly harmful are heavy metals like zinc, lead, manganese and cadmium. Consistent with division Kabata-Pendias and Pendias (1993) zinc, lead and cadmium belong to the group of metals witch hare very high level of potential imminence for environment and manganese belongs to the group of metals witch hare high level of potential imminence. Zinc, lead, cadmium is particularly susceptible to bioaccumulation from water environment.

From among of a group chemical pollution, witch occurs in environment, heavy metals prove easiness in creation various groups in biological system and because of that they can surge in environment for a long time. They reveal toxic action on organisms. Toxicity metals depend on concentration and dissolvability their compounds in water and also of chemical reactivity (Lelend in 1979, Wong 1988). Most of heavy metals don't persist in water for a long time in dissolvable form, because they are subjected precipitation in consequence of oxygenation process or created various chemical compounds. Biological action this metals and their compounds grow up the more is accumulated in tissues of organisms. Concentration of them in organisms are frequently higher than in surrounding their water. Andrzejewski (1990) revealed that the concentration of zinc in phytoplankton and zooplankton is thirty times more large than in water. Zink, lead and manganese are metals that are easily absorbed from water by vascular plants (Grzybowski at al. 2000, Brundin at al. 1987, Kufel 1984) which accumulation them in their tissues unequally.

In consideration of harmful influence of heavy metals witch are in water ecosystems, very important is to know the ways of migration metals in environment is necessary to prognosis their influence on biodegradation organic compounds occur in water. Very important participation in migration those metals take vascular plants.

The aim of this essay was defined participation and ability chosen water plants of Dołgie Great Lake to accumulating zinc, lead cadmium and manganese and estimate correlation between metals in this process.

DESCRIPTION OF AREA AND METHODIC

Dołgie Great Lake is situated in coastal zone of Baltic Sea in area of Slowinski National Park (the middle of Maritime Providence). This is shallow lake – average depth 1,4m (Tab. 1).

Table 1

Morphometrical information about Dołgie Wielkie

Parameter	Value
The area surface of water level [ha]	156,4
The maximum depth [m]	2,9
The average depth [m]	1,4
The average capacity [thousands m^3]	2151,8
The maximum length [m]	2650
The real length [m]	2650
The maximum width [m]	930
The real width [m]	930
The length of shore line [m]	6675
The expansion of the shore line	1,51

The shore line is underdeveloped, bottom of the lake little varying. This lake is under control of reservation and it is numbered to the third category susceptibility to degradation, and its water characterizes the low quality (III/II class of cleaning) (The rapport of WIOŚ 1995).

The four main plants in this lake was examined: *Myriophyllum spicatum*, *Potamogeton lucens*, *Acorus calamus*, *Nuphar luteum*. The arrangement particular makrophits and their biomass stated during their maximum development (July, September) in years 1999, 2000, using methods of Tarczyk (1967).

Collected samples of plants after washing distilled water in order to clear sediments and suspensions, they were dried in temperature 100°C for 6 hours. Dried vegetable material was mineralized with the aid of the compounds HNO_3, $HClO_4$ (mixed in comparison 7 : 3).

Contents Zn and Mn in vegetable material was determined by flame atomic absorption spectrophotometer method, however contents Cd and Pb using apparatus GBC Avanta $\sum$ with graphite furnace GBC GF 3000 and autosampler PAR 3000. Each metal was measured in fire samples.

Obtained results were subjected statistics analysis according to test-t correlation coefficient was counted and the regression curve was drawn.

THE RESULTS AND DISCUSSION

Natural scope of lead in different plants contained within the bounds of 0.1 to 0.9 $\mu g \, g^{-1}$ (Zimdahl, Arvik 1973). However Marchwińska at al. (1982) give the scope 0.1 – 1.0 $\mu g \, g^{-1}$. The average level of lead in the fodder plants at the polluted area is 0.4 – 2.5 $\mu g \, g^{-1}$ for the grass, 0.2-0.9 for corn and 1.3-3.6 $\mu g \, g^{-1}$ for trefoil (Kabata-Pendias, Pendias 1993). Polluted environment causes that the concentration of this metal in tissues of plants grows up to hundreds $\mu g \, g^{-1}$ (Karweta 1976, Burton 1986). It is hard to qualify the critical concentration of lead for plants, it usually fluctuates between 30 and 300 $\mu g \, g^{-1}$ (Kabata-Pendias, Pendias 1993). The plants are usually tolerated for surplus of lead. Their tolerance grows up in polluted environment (Woźny, Krzesławska 1993).

In examined plants of Dołgie Great Lake the lowest level of lead was observed in *Potamogeton lucens* 0.72 $\mu g \, g^{-1}$, and the highest in *Nuphar luteum* 2.60 $\mu g \, g^{-1}$ (Tab. 2).

There weren't stated any essential differences in arrangement the samples, which contain a great deal of lead in examined plants. The samples were characterized by the fate disposition; it suggested that lead in Dołgie Great comes from atmosphere. The average level of lead in tissues examined plants was tens more lower than analogous plants in lake placed in Tucholski Landscape Park (Gabryelak at al. 1992) however comparable with plants from Wadąg Lake (Grzybowski, Endler 2000). Contents of lead in *Myriophyllum spicatum* from Wadąg Lake were almost twice higher (1,98 $\mu g \, g^{-1}$) than in *Myriophyllum spicatum* from Dołgie Great, in *Potamogeton lucens* five times higher (3.55 $\mu g \, g^{-1}$). However in *Acorus calamus* and *Nuphar luteum* the higher level of lead was observed in Dołgie Great, *Nuphar luteum* contains tree times more of lead than in Wadąg Lake (0,87 $\mu g \, g^{-1}$).

The concentration of zink in most of plants, resulting from 15 to 30 $\mu g \, g^{-1}$ (Kabata-Pendias, Pendias 1993). However the average contents zinc in plants, which are free from pollution, amounts to 10-70 $\mu g \, g^{-1}$ (Endler at al. 1989, 1991). The values, which respond concentration of zinc in examined plants of Dołgie Great, are in this range that means that this Lake and its bay is free of pollution of zinc.

Table 2

The summary composition of contents – Zn, Pb, Mn and Cd in chosen species from Dołgie Great Lake. Values in $\mu g\,g^{-1}$.

Metal	Plant	mean	min.	max.	standard deviation
Cd	*Myriophyllum spicatum*	0,07	0,005	0,143	0,04
	Potamogeton lucens	0,14	0,050	0,184	0,05
	Acorus calamus	0,16	0,069	0,312	0,10
	Nuphar luteum	0,34	0,060	1,199	0,48
Pb	*Myriophyllum spicatum*	1,03	0,59	2,28	0,71
	Potamogeton lucens	0,72	0,44	0,87	0,19
	Acorus calamus	1,24	0,70	2,02	0,48
	Nuphar luteum	2,60	0,31	8,92	3,69
Mn	*Myriophyllum spicatum*	196,18	7,73	429,02	160,52
	Potamogeton lucens	198,53	98,36	264,44	73,36
	Acorus calamus	450,60	284,24	725,44	173,55
	Nuphar luteum	246,55	83,68	819,47	320,82
Zn	*Myriophyllum spicatum*	9,19	0,02	18,50	7,18
	Potamogeton lucens	16,53	3,22	27,41	11,37
	Acorus calamus	18,14	8,13	42,66	14,24
	Nuphar luteum	66,76	10,93	262,01	109,22

Myriophyllum spicatum contains the least zinc 9,19 $\mu g\,g^{-1}$, the most zinc contains *Nupha luteum* 66.76 $\mu g\,g^{-1}$. Several times higher level of zinc is also is analogous plants in Piaseczno Lake (Kowalik at al. 1991), but not more higher than in lakes Tucholski National Park (Gabryelak at al. 1992) and in Wadąg Lake (Grzybowski at al. 2000). The value of zinc in plants from Wadąg Lake: *Myriophyllum spicatum* – 28.81 $\mu g\,g^{-1}$, *Potamogeton lucens* – 30.15 $\mu g\,g^{-1}$, *Acorus calamus* – 21.95 $\mu g\,g^{-1}$ is twice more higher than in Wadąg Lake (23.20 $\mu g\,g^{-1}$).

The level of accumulation of zinc in plants of Dołgie Great Lake was similar at the whole area at littoral. The weren't any important differences in accumulation zinc for this same species of plants from different parts of lake.

The contents of manganese in examined plants of Dołgie Great Lake has an average level. It changed from 196.2 $\mu g\,g^{-1}$ (*Myriophyllum spicatum*) to 450.6 (*Acorus calamus*). Endler at al. (1989, 1991) announced that the average contents of manganese in plants from unpolluted areas fluctuates from 20 to 200 $\mu g\,g^{-1}$.

However Kabata-Pendias and Pendias (1993), for similar areas, announced presence of manganese in grass in the range of 20 – 665 $\mu g\,g^{-1}$. The concentration of this metal in examined plants of Dołgie Great Lake was in this range. Ozimek (1988) claimed that contents of heavy metals in water plants is higher than in land plants so Dołgie Wielkie isn't polluted by manganese.

In comparison with analogous plants from Wadąg Lake (Grzybowski, Endler 2000), the concentration of manganese in *Potamogeton lucens* (3197 $\mu g\,g^{-1}$) was sixteen times more higher than in Myriophyllum spicatum (602 $\mu g\,g^{-1}$), three times more higher than in Dołgie Great. However in *Acorus calamus* the content of manganese was five times more smaller in Wadąg Lake (94 $\mu g\,g^{-1}$), but in *Nupha luteum* seven times more smaller (37 $\mu g\,g^{-1}$). The level of this metal in examined plants was far more lower than in Piaseczno Lake (Kowalik at al. 1991).

The tolerance for surplus of manganese is very various and depends on the species of plants (Kabat –Pendias, Pendias, 1993). The application of plants for manganese is result of their metabolism, but in case of its high concentration at the environmental background, don't realized the obstacle of metabolism and manganese is socked in, although there isn't any application.

Cadmium is bounded in bottom sediment and easily penetrates to the alimentary canal because it has high dissolvability and assimilate by lower and higher type of plants. Although cadmium isn't necessary to the development of plants, it is absorbed easily to the concentration in solution or in soil (Endler, Grzybowski 1996). Most of plants characterize high level of contents at cadmium and don't prove toxical appearances even it is a high level of concentration of this metal.

The content of cadmium in plants changed in dependence on their species, but in unpolluted regions by this metal, pollution rarely corsses 1 $\mu g\,g^{-1}$ and Kabata – Pendias, Pendias (1993) say that if fluctuates between 0.02 – 1.20 $\mu g\,g^{-1}$, and in polluted regions from 0.1 to 44.5 $\mu g\,g^{-1}$. In examined plants of Dołgie Great Lake the contents of cadmium changed fro 0.07 $\mu g\,g^{-1}$ in *Myriophyllum spicatum* 0.34 $\mu g\,g^{-1}$ in *Nupha luteum* and it was situated in unpolluted areas. Similar concentration this metal was observed in plants of Wadąg Lake (Endler, Grzybowski 1996), however the higher concentration was in lakes in Tucholski Wood (Gabryjelak at al. 1992) and in Piaseczno Lake (Kowalik at al. 1991).

Comparing examined plants it is necessary to say that *Nupha lucens* and *Acorus calamus* prove the higher capability to accommodation zinc, lead, manganese and cadmium than *Myriphyllum spicatum* and *Potamogeton lucens*. Particularly high differences are in instance of zinc and cadmium. *Nuphar luteum* accumulated seven times more zinc and five times more cadmium than *Myriophyllum spicatum*. The contents of analyzed metals in examined plants was in following order Mn>Zn>Pb>Cd, but the highest concentration had manganese and the lowest cadmium.

The results of this correlational analysis and regression is shown in the 1-3 figure. The highest value of coefficient correlation (n = 40 and the level of the subsistence 0.05) were obtained interdependence between zinc and cadmium (r = 0.91) zinc and lead (r = 0.92) lead and cadmium (r = 0.87). This result testified that zinc favorers taking lead and cadmium by plants, and lead favorers taking cadmium, however between metals manganese and other metals in antagonism that it is thought as smaller taking zinc, lead and cadmium in increase of the contents of manganese in environment and drop of concentration of manganese in plants, which take much of other metals. The equations of regression (Fig. 1-3) make easier to count in plants the contents of one of the metals, if it is known the concentration of the second metal.

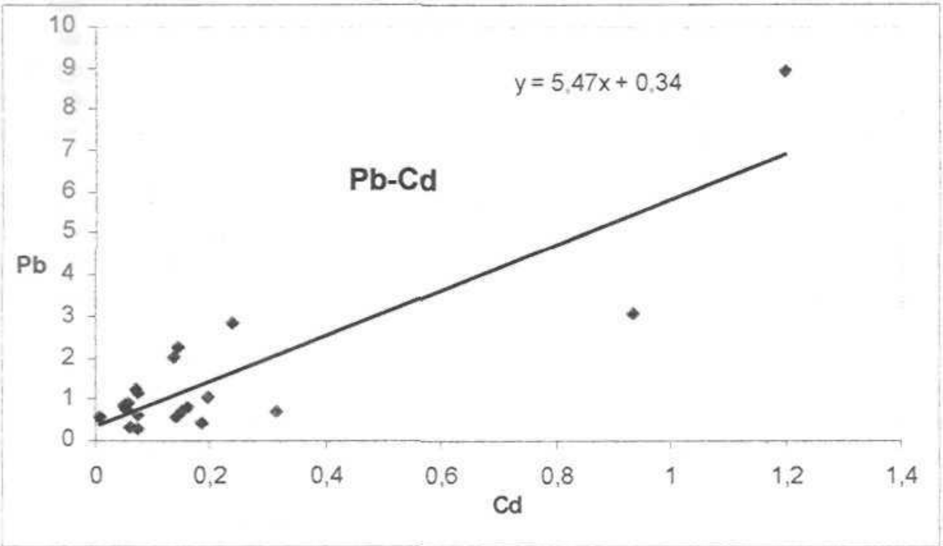

Fig. 1. The regression curve for Pb and Cd in vegetable material for Dołgie Great Lake. (r = correlation efficient)

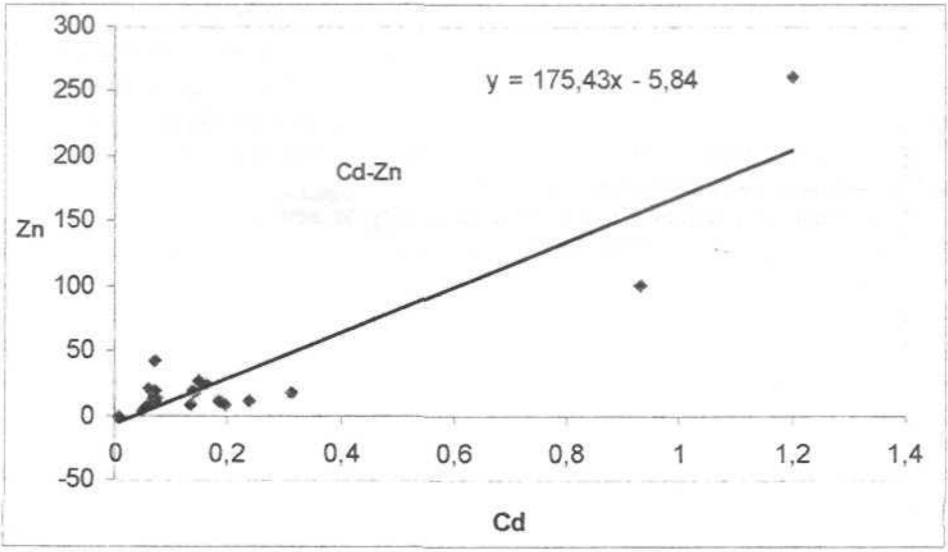

Fig. 2. The regression curve for Cd and Zn in vegetable material for Dołgie Great Lake. (r = correlation efficient)

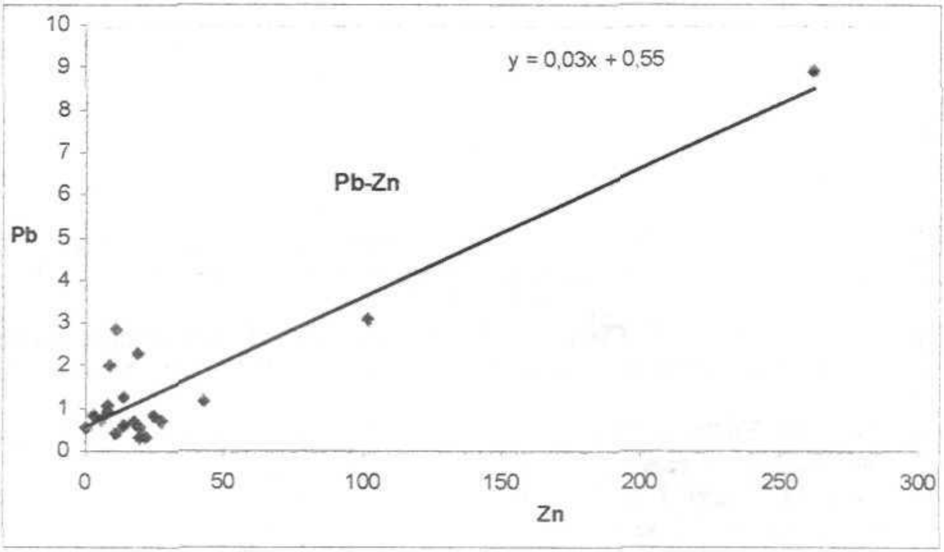

Fig. 3. The regression curve for Pb and Zn in vegetable material for Dołgie Great Lake. (r = correlation efficient)

CONCLUSIONS

1. It was claimed that the contents of zinc. lead. manganese and cadmium in chosen plants: *Myriophyllum spicatum, Potamogeton lucens. Acorus calamus. Nuphar luteum* from Dołgie Great Lake is comparable with the average value observed for eutrofic lakes.
2. The samples of plants which were used to qualify contents examined metals were take by chance. Steady concentration of metals shows that there they come from atmosphere. and there are not any sources of inflow of those metals in Dołgie Great Lake.
3. The higher concentration of those metals was seen in *Nuphar luteum. Acorus calamus* that shows the accumulated capability heavy metals. particularly zinc. cadmium. by this species.
4. *Nuphar luteum. Acorus calamus* play an important part in taking heavy metals from ecological systems Dołgie Great Lake.

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MANGAN, CYNK, KADM I OŁÓW W ROŚLINACH JEZIORA DOŁGIE WIELKIE

Streszczenie

W pracy przedstawiono wyniki badań nad zawartością cynku, kadmu, manganu i ołowiu w wybranych roślinach (wywłócznik kłosowy, rdestnica pływająca, tatarak, grążel żółty) jeziora Dołgie Wielkie w latach 1999 – 2000. Podano pierwsze dane dotyczące akumulacji tych metali w makrofitach jeziora Dołgie Wielkie. Największą koncentrację badanych metali obserwowano w grążelu żółtym Zn – 27,6 μg/g, Pb – 2,60 μg/g, Cd – 0,34 μg/g, i manganu w tataraku 450 μg/g.