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BIOACCUMULATION OF SELENIUM IN CHOSEN WATER PLANT FROM THE DRAWA RIVER

BIOAKUMULACJA SELENU W WYBRANYCH ROŚLINACH WODNYCH RZEKI DRAWY

Abstract: The Drawsko Military Training Ground is located in the area of the Drawienski National Park and the Drawsko Landscape Park. The Ground may be a serious source of natural environmental contamination with heavy metals. Researchers collected and examined water plant samples – Floating pondweed (*Potamogeton natans*) and Common reed (*Phragmites australis*). The samples were taken from places situated along the Drawa River (before and below the Military Training Ground). Selenium (Se) content in these plants was determined. The received results did not show essential difference of the metal content between plants from various places. The Training Ground does not cause contamination of the Drawa River with the investigated metal.

Keywords: military training ground, water plants, selenium, contamination

The Drawienski National Park (DNP) was founded in 1990 in the south-western part of Poland in Pomerania Lake District and it is one of 23 national parks in this country. Situated in the catchment of the Drawa River with its side stream – the Plociczna, the DNP is one of the forms of nature protection areas richest in rare species [1, 2]. Within this zone the *Drawsko Military Training Ground* (DMTG) is located – a place where ground and air forces have their tranings (Fig. 1). Such location of a military zone is rather rare. It has an area 36111 ha and it is one of the biggest military traning grounds in Europe [1, 3].

Deployment of the military action at this controversial site has an impact on the environment. Despite the implementation of the plan for compensation of damage and reduction of the harmful impact on the environment by the army, the influence of

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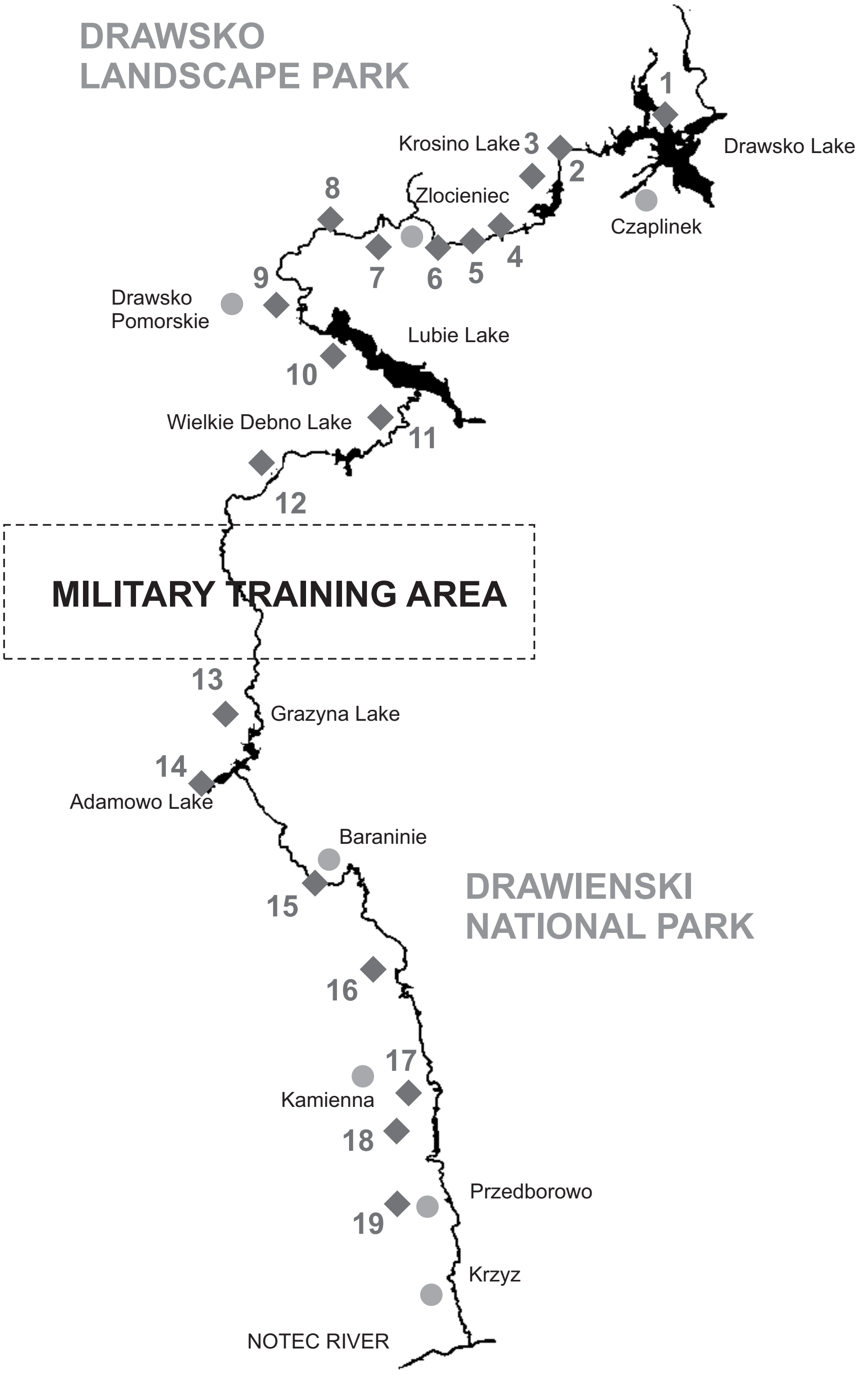

Fig. 1. Location of places where the tests plants were taken from

military training ground on the environment is significant [3]. The authors' last investigation suggests DMTG is a source of environmental contamination by Cu, Zn, Ni, Pb and Cd [4]. In addition, IOS studies in 2005 and 2006 showed the raised content of other toxic elements including selenium (Se) in the waters of the Drawa river flowing through the military area [5, 6]. Polish army refused giving any detailed information about this situation [3].

The aim of the work was to verify the hypothesis that the DMTG has a big influence on the Drawa River contamination by Se. The military zone is entirely closed for civilians and unavailable for environmental research, that is why authors used water plants, which have the ability to accumulate this metal.

Materials and methods

To achieve the purpose of the research 2 water plant species were used – Floating pondweed (*Potamogeton natans*) and Common reed (*Phragmites australis*). The plants were taken from 19 different places, which were situated along the Drawa River (12 places located before DMTG and 6 below it).

500 mg of material was put to special teflon containers. All samples were flooded by 5 cm^3 of concentrated nitrogenous acid 1:1 (SIGMA) and mineralized in microwave stove MARS-5. Addition HCl (SIGMA) caused Se reduction to the 4^{th} oxidation state.

Selenium concentrations were determined using hydride generation atomic absorption spectrophotometry (HG AAS) by means of a VARIAN Spectra 220 FS [7].

The results were verified statistically (calculation of average values, standard deviations, significance of differences) using Statgraphic ver. 5.0 and GraphPad Prism ver. 5.1.

Results and discussion

Selenium concentrations in water plants are included in Table 1 and 2.

Pontweed (submerged plant) accumulated significantly more ($p \leq 0.01$) Se than reed (emers with a green mass drawn over the water). The Se average concentration in reed was (107.43 ± 35.42) $\mu g \cdot kg^{-1}$, in pondweed's tissues – (182.04 ± 42.21) $\mu g \cdot kg^{-1}$. For positions located above DMTG pontweed accumulated about 60.6 % more Se than the reed. Below military sources of pollution – difference in the Se content reached to 87.3 %. This results from the multiple absorption surfaces of weed in relation to the cane. First of them gathers all the components by the whole body surface, the second one – with just submerged root system [8–10].

There was no statistically significant difference ($p \leq 0.01$) in the Se content in the samples collected above and below DMTG. The lowest concentration of the element was at position number 3 (inflow to the Krosino Lake) and 5 (Zerdno Lake). Drawa in this section has a wide shoreline covered with abundant water plants. There is also large quantity of submerged plants from both lakes. Due to the presence of such organisms the water reservoirs play the role of effective natural places where fitoremediation takes place [11, 12].

Table 1

The Se concentrations in water plants collected from places located above the military area [$\mu g \cdot kg^{-1}$]

Location number	Location name	River mileage	Common reed (*Phragmites australis*)	Floating pondweed (*Potamogeton natans*)
1	Drawsko Lake	167+700	83.208	206.473
2	below Drawsko	163+100	117.128	l.d.
3	above Krosino Lake	157+600	123.781	257.044
4	below Krosino Lake	154+600	108.873	l.d.
5	Zerdno Lake	152+900	175.240	176.547
6	Wilczkowo Lake	151+100	118.130	128.131
7	Złocieniec	149+800	134.149	137.827
8	below of inflow to Kokna	144+800	75.325	146.363
9	below Drawsko	128+200	93.350	162.318
10	Lubiec Lake	119+600	145.547	156.835
11	below Lubiec Lake	111+200	20.359^{A}	235.199
12	beginning of DMTG area	99+800	97.657	124.150
Average			*107.729^{AB}*	*173.089^{B}*
SD			*39.004*	*45.688*

l.d. – lack of data, not collected plants from the post; A, B, C – statistically significant differences ($p \leq 0.01$).

Table 2

The Se concentrations in water plants collected from places located below the military area [$\mu g \cdot kg^{-1}$]

Location number	Location name	River mileage	Common reed (*Phragmites australis*)	Floating pondweed (*Potamogeton natans*)
13	Grazyna Lake	78+100	157.353	246.720
14	Adamowo Lake	75+300	l.d.	234.120
15	Baraninie	72+600	l.d.	249.040
16	inflow to Pstrag	39+300	95.396	179.317
17	above Kamienna	34+900	97.083	205.167
18	below Kamienna	30+400	87.845	166.677
19	above Przedborowo	15+700	95.918	201.800
Average			*106.719^{C}*	*199.936^{C}*
SD			*43.441*	*31.763*

l.d. – lack of data, not collected plants from the post; A, B, C – statistically significant differences ($p \leq 0.01$).

The largest amount of Se was showed in the plants collected from the position number 11 and 12 (respectively for reed and pondweed). Both of them are under the direct influence of the military zone. The coastline of this section of is deeply anthropologenic transformed. A large supply of toxic elements limits development of water vegetation. Low Se capture from water of the Drawa River is the likely cause of the observed increase in the concentration of this element in the test plants [13–15].

Conclusions

An estimated amount of Se in the tissues of reed and pondweed correlated with the amounts of this element in aquatic plants presented by other authors [16–23]. Values considered to be reference in Poland [24, 25] do not show exceeding of the limit value for Se in investigated plants.

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Abstrakt: W obrębie Drawskiego Parku Krajobrazowego oraz Drawieńskiego Parku Narodowego zlokalizowany jest "Poligon drawski" – Centrum Szkoleniowe Wojsk Lądowych. Może on stanowić poważne źródło skażenia środowiska naturalnego parków metalami ciężkimi. Zebrano i przebadano próbki wybranych roślin wodnych, tj. rdestnicy pływającej (*Potamogeton natans*) i trzciny pospolitej (*Phragmites australis*). Materiał badawczy pobrano ze stanowisk leżących powyżej i poniżej poligonu, poprzez który przepływa rzeka Drawa. Oznaczono w nich zawartość selenu. Otrzymane wyniki nie różnią się istotnie statystycznie między badanymi lokacjami. Ilość pierwiastka nie przekracza dopuszczalnej normy zawartości Se w roślinach wodnych. Poligon wojskowy nie powoduje zanieczyszczenia rzeki Drawy selenem.

Słowa kluczowe: poligon wojskowy, rośliny wodne, selen, zanieczyszczenie