FLUORIDE IN COMMON REEDS (*PHRAGMITES AUSTRALIS*) SAMPLED FROM THE OLD WARTA RESERVOIRS NEAR LUBOŃ AND RADZEWICE, POLAND

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SUMMARY: Fluoride levels were determined in roots, stalks, and leaves of common underwater reeds (*Phragmites australis*) harvested in 2001 from a polluted reservoir near Luboń and an unpolluted reservoir near Radzewice, Poland. The mean fluoride concentrations in the roots, stalks and leaves of the polluted reservoir were, respectively, 213, 36.8, 51.1 mg F/kg dry mass. In the unpolluted reservoir they were 5.4, 7.4, and 15.35 mg F/kg dry mass.

Keywords: Common reeds; Environmental F^- in aquatic vegetation; Luboń, Poland; *Phragmites australis;* Post-production waste; Warta reservoirs; Water pollution.

INTRODUCTION

The phytotoxicity of fluorine depends on its concentration in the atmosphere, on the duration of exposure, and on the sensitivity of the plant species.[1,2] Oftentimes, harmful levels of fluoride accumulated by plants are passed on to higher organisms, including humans, with a negative impact. The toxic activity of fluorides on plants is demonstrated by their adverse effects on the basic physiological functions, such as photosynthesis, as well as metabolic cycles.[3-6]

The present study was undertaken to determine the amount of fluoride accumulation in the roots, stalks, and leaves of common reeds (*Phragmites australis*) growing in a fluoride-contaminated and an uncontaminated reservoir in Poland – 52º19’6”N and 16º53’5’’E.

The first old Warta reservoir S1 is located near the town of Luboń and is heavily polluted with fluoride compounds caused by the wastes from a nearby chemical plant. The second old Warta reservoir S2 is located near the village of Radzewice and is not influenced by this type of contamination.

MATERIALS AND METHODS

Description of study area: The first reservoir S1, situated near the Luboń Ltd chemical plant, has for many years been subject to pollution by fluoride compounds owing to post-production disposal by the plant of lye (aluminum fluoride and fluosilicic acid) on the open ground located about 200 m from the reservoir. The second reservoir S2 is located about 10 km up river to the south from the chemical plant and is not subjected to direct pollution by fluoride compounds.

Material sampling and analysis: Samples of plant material were harvested in 2001, along the shore of each reservoir at 50-m intervals. The plant sam-

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ples were segregated into morphological parts: roots, stalks, leaves, and parts submerged in water. The samples were averaged for each locality and dried at room temperature to air-dry mass. The fluoride content was determined as the sum of the ionic fluoride directly soluble in water (F_{H_2O}) plus the fluoride liberated by acids (F_{ac}).

$$F_{total} = F_{H_2O} + F_{ac}$$

Determination of fluoride soluble in water (F_{H_2O}) was preceded by several sample preparation steps. Ten grams of air-dried plant material was crushed, mixed with 0.1 g of $CaSO_4$, and combined with 200 mL of deionized water. The slurry was shaken for 30 min, and the suspended material was removed by filtration through hard filter paper.

For assay of F_{ac}, 10 g of dried and milled plant material was mixed thoroughly with CaO and ashed by heating in a muffle furnace at 300°C for 1 hr and then for 2 hr at 600°C. A parallel 10 g plant sample was dried at 105° to measure fluoride/kg of dry mass.

The ashed samples were quantitatively transferred into distillation flasks; 25 mL of 57% v/v sulfuric acid and 5 mL of saturated $AgSO_4$ (to inhibit distillation of chlorides) were added to each flask. The contents of each flask were steam distilled at 135°C ± 2°C.[7]

The fluoride content in the foregoing filtrates and distillates was measured with a fluoride ion selective Orion Ion Plus electrode and an Orion A720 ion analyzer.

RESULTS

As seen in the Figure, stalks of common reeds (*Phragmites australis*) in the polluted reservoir S1 had a mean fluoride concentration of 36.8 mg/kg dry mass. Moderately higher levels were found in the leaves, and significantly higher accumulations of fluoride were detected in the stalk section growing under water as well as in roots. The roots accumulated on the average 213 mg F/kg dry mass. The highest quantities of fluoride were found in submerged parts of the plants averaging 950.5 mg F/kg dry mass.

During the sampling, it was noticed that the condition of reeds growing in the old Warta reservoir S1 was very poor. Many leaves showed symptoms of chlorosis and necrosis. The belt of plants constituting the littoral was very narrow (0.2 – 1.0 m). Some sections of the reservoir bank were devoid of any reeds at all.

The fluoride analyses of particular morphological parts of reed sampled from the unpolluted reservoir S2 located near village Radzewice revealed considerably lower accumulations of fluoride than in reservoir S1. As seen in the Figure, in the reservoir S2, the stalks of reeds contained an average of only 7.35 mg F/kg dry mass, the submerged parts and roots 5.4, and the leaves 15.35 mg F/kg dry mass. Reeds growing in the reservoir S2 appeared normal without evidence of pathological changes.

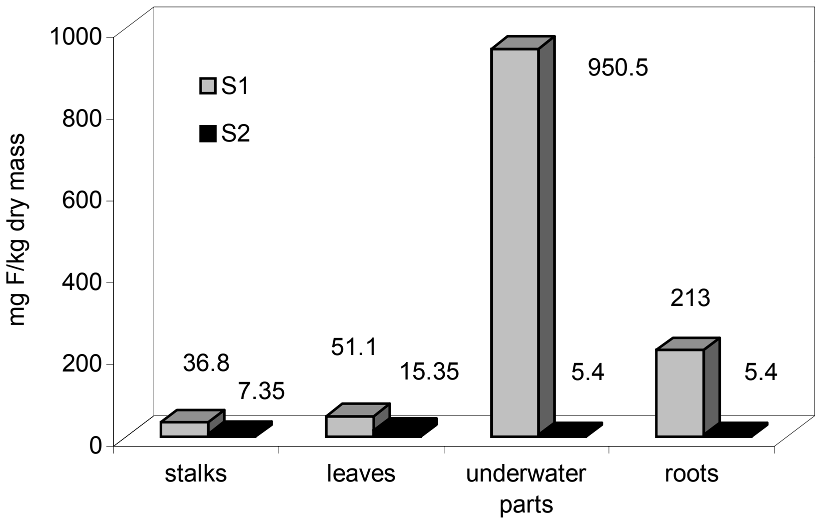

Figure. Fluoride content (mg/kg dry mass) in different parts of reeds (*Phragmites australis*) sampled during 2001 from old Warta reservoirs S1 and S2.

DISCUSSION

The majority of studies on the effects of fluoride on vegetation are concerned mainly with agricultural and forest ecosystems.[7] There are few research studies dealing with effect of fluoride on the plants of water ecosystems. As might be expected, the fluoride content of the common reeds (*Phragmites australis*) in the two reservoirs was quite different. The high fluoride levels in plants growing in the S1 reservoir clearly reflect a greater pollution by fluoride.[8] Parts of submerged plants from this reservoir accumulated over 170 times more fluoride than the same plant parts from the old Warta reservoir S2. These findings are in agreement with studies conducted since 1995 by the Department of Inland Fisheries and Aquaculture, who report a significant fluoride increase in the water and bottom sediments of reservoir S1 from 1.5 to 6.8 mg/L in the water to as much as 18,600 mg/kg of dry mass in sediment.[9,10] On the other hand, in the unexposed reservoir S2, the fluoride concentrations in the water and sediments were, on the average, only 0.3 mg/L and 4.95 to 53.85 mg/kg dry mass, respectively.[11]

Cowgill, who investigated different water plant species in two small lakes in Connecticut (USA), found a fluoride accumulation (dry mass basis) ranging from 263 ppm in *Decodon vericillatus* and 516 ppm in *Pontederia cordata.*[12] It was also shown that high fluoride concentrations might have a detrimental effect on *Cyperus papyrus*.[13]

From the results presented here and in the light of what has been reported by others, it is clear, that fluoride contamination of reservoir S1 caused significant accumulation of fluoride in its common reeds (*Phragmites australis*). Submerged parts of the reeds are affected most severely.

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