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**PHOSPHORUS AND CALCIUM IN THE MUSSELS *SINANODONTA WOODIANA* (LEA) AND *DREISSENA POLYMORPHA* (PALL.)  
IN THE KONIN LAKES**

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ABSTRACT. The aim of the study was to analyze the phosphorus and calcium content of the soft tissues and shells of two mussel species, *Sinanodonta woodiana* (Lea) and *Dreissena polymorpha* (Pall.), that inhabit the Konin lakes. It was determined that the accumulation of these elements in both of these species was comparable to the levels noted in mussels from the family Unionidae and the species *D. polymorpha* from other freshwater basins. The loads of the accumulation of these two elements in mussels inhabiting the Konin lakes was estimated.

Key words: *SINANODONTA WOODIANA*, *DREISSENA POLYMORPHA*, PHOSPHORUS, CALCIUM, ACCUMULATION, KONIN LAKES

## INTRODUCTION

Mussels play a special role in the cycling of elements in aquatic environments. As filter feeders, mussels remove suspensions and plankton algae from the water column, which leads to improved water quality (Stańczykowska 1977, Lewandowski and Stańczykowska 2000). By accumulating nutrients and heavy metals in soft tissues and shells, they lower the trophic status of aquatic basins, while simultaneously lowering the degree of environmental contamination (Jurkiewicz-Karnkowska 1994). The Konin lakes are inhabited abundantly by the Chinese mussel, *Sinanodonta woodiana* (Lea), which comprise over 90% of the biomass and abundance of the all of the mussels of the family Unionidae (Kraszewski 2004). *S. woodiana* is accompanied by a large share of the mussel *Dreissena polymorpha* (Pall.). In the zones where the two species co-occur, the biomass of Bivalvia is as high as 15 kg m<sup>-2</sup> (Protasov et al. 1994, 1997, Kraszewski and Zdanowski 2001).

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The aim of the present study was to evaluate the roles of *S. woodiana* and *D. polymorpha* in the accumulation of phosphorus (P) and calcium (Ca) in the Konin heated lakes system.

## MATERIALS AND METHODS

Samples of *S. woodiana* and *D. polymorpha* were collected for study in July 2001 from lakes of Pałnowskie, Gosławskie, Licheńskie, Ślesieńskie, the initial cooling reservoir, and the canals connecting the various lakes. Samples of bottom sediments for analysis were collected at the same depth at which the mussels were collected. The mussels were preserved in alcohol, and then dried at a temperature of 60°C to a constant weight. The soft tissues were separated from the shells and the samples were homogenized. Sub-samples of the processed soft-tissue (0.5 g) and shell (1.0 g) samples were mineralized in 4 cm<sup>3</sup> of concentrated nitric acid and 2 cm<sup>3</sup> hydrogen peroxide, and then moved quantitatively to a measuring flask and distilled water was added to a volume of 50 cm<sup>3</sup>. The bottom sediments were dried at a temperature of 60°C, following which 2 g sub-samples were weighed out and subjected to dry mineralization at a temperature of 420°C. They were then dissolved just like the sub-samples of mussel tissue. In the solutions obtained from mineralization the phosphorus content was determined with the molybdenum method according to Polish Norm PN-76/R-64781 using a Novaspec 2 spectrophotometer (Pharmacia LKB), and the calcium contents were determined with the AAS method and a Carl-Zeiss Jena 30 analyser.

The following were determined in the tested samples: the percentage share of soft tissue in the dry weight (d.w.) of the mussels, the phosphorus and calcium of the soft tissues and the shells, and the accumulation of both elements recalculated per 1 g d.w. per individual. Based on the biomass of the studied mussel samples, the accumulation of phosphorus and calcium by the population of both of the species inhabiting the Konin lakes was determined. The variation coefficients of the measurements for both of the elements in the studied samples were calculated as the ratio of the standard deviation to the mean values.

## RESULTS

The mean content of phosphorus in the soft tissues of *S. woodiana* and *D. polymorpha* was 30.1 and 6.6 mg g<sup>-1</sup>, respectively. The shells of *D. polymorpha* contained approximately twofold more phosphorus than did those of *S. woodiana* at 0.45 and 0.24 mg g<sup>-1</sup>, respectively (Fig. 1a). In contrast, the accumulation of calcium in the soft tissues of the mussels was similar at a mean of 23.2 mg g<sup>-1</sup> in *S. woodiana* and 25.5 mg g<sup>-1</sup> in *D. polymorpha*. The calcium accumulation in the mussel shells was 280.1 and 300.4 mg g<sup>-1</sup>, respectively (Fig. 1b). Measurements of phosphorus and calcium content in the mussels sampled from different sites exhibited little variation (variation coefficient value < 30%).

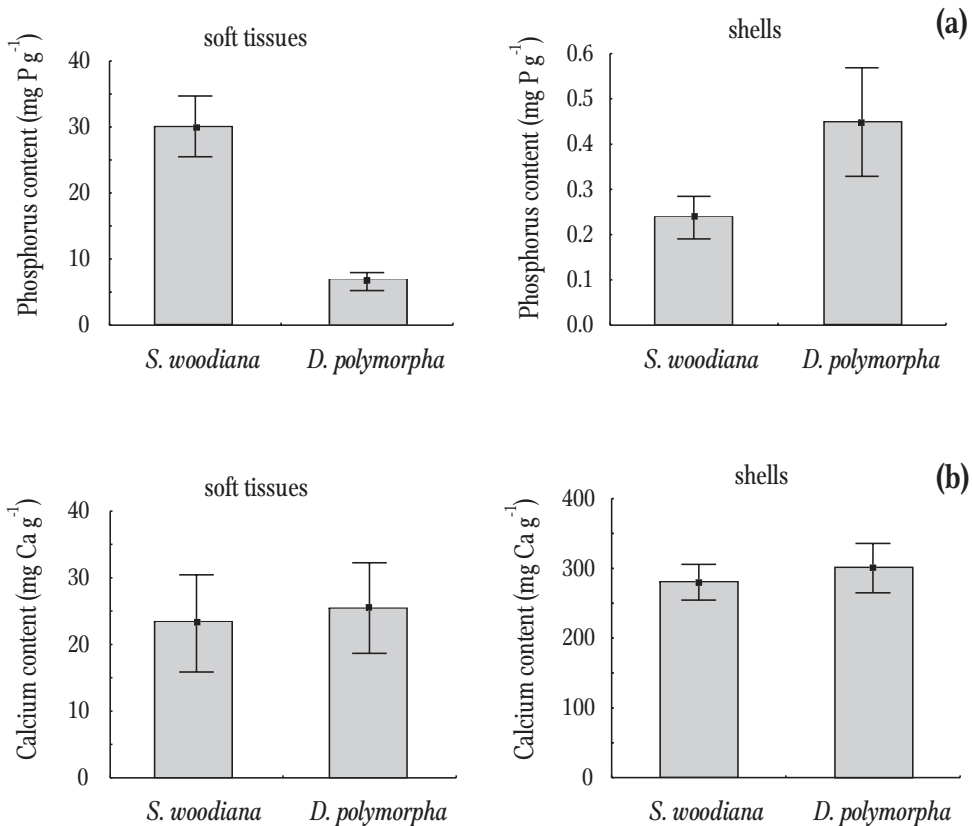


Fig. 1. Mean  $\pm$  SD contents of phosphorus (a) and calcium (b) in the soft tissues and shells of the mussels *S. woodiana* and *D. polymorpha* from the Konin lakes.

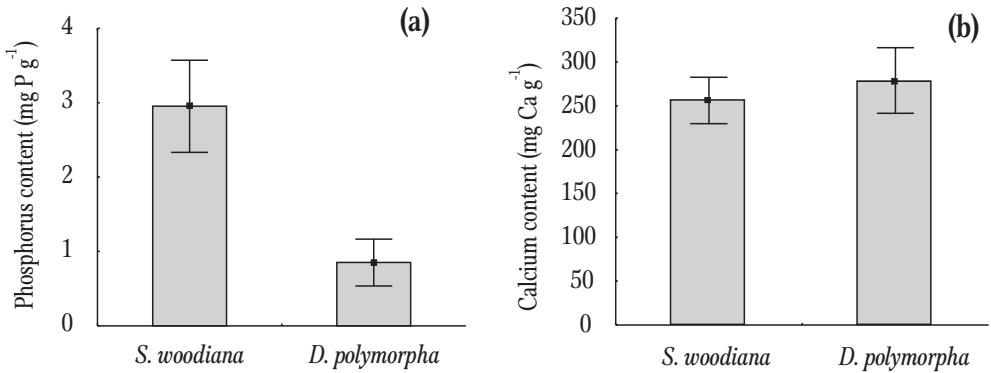


Fig. 2. Mean  $\pm$  SD contents of phosphorus (a) and calcium (b) in 1 g d.w. of *S. woodiana* and *D. polymorpha* from the Konin lakes.

The mean percentage share of soft tissues to total *S. woodiana* weight was 9.4%, while in *D. polymorpha* it was 6.9%. These values and the data presented in Figure 1 permitted calculating the accumulation of P and Ca in 1 g d.w. of the studied mussel species (Fig. 2). The phosphorus accumulation in 1 g d.w. of mussel was clearly higher in *S. woodiana*, while the quantity of calcium accumulated was similar in both species.

The content of phosphorus and calcium in the bottom sediments of the Konin lakes and canals that connect them ranged from a mean of  $0.39 \pm 0.28 \text{ mg g}^{-1}$  to  $53.4 \pm 48.6 \text{ mg g}^{-1}$ , respectively. The results of the measurements of these elements in the bottom sediments were far more variable in comparison with those obtained from the measurements on the soft tissues and shells of the two mussel species studied (Table 1).

TABLE 1

Values of the variation coefficient of measurements of phosphorous and calcium in samples analyzed (%)

Element	<i>Sinanodonta woodiana</i>		<i>Dreissena polymorpha</i>		Bottom sediments
	soft tissues	shells	soft tissues	shells	
Phosphorus	15.2	20.4	26.0	20.8	71.8
Calcium	31.4	26.6	9.1	11.8	91.0

## DISCUSSION

The content of phosphorus in the tissues of *S. woodiana* and *D. polymorpha* inhabiting the Konin lakes are comparable with those noted in the soft tissues and

shells of mussels from other freshwater basins. The amount of phosphorus determined in the soft tissues of mussels of the family Unionidae was about 2.5% d.w. of tissue (Stańczykowska and Planter 1985, Stańczykowska and Lewandowski 1993, Markowska 2000, Jurkiewicz-Karnkowska 2002, 2004). *S. woodiana* is larger in comparison to other species of mussel from the family Unionidae, and so its filtration capability is also greater. This is also why slightly higher contents of phosphorus (about 3%) were noted in the soft tissues of this species than in those of other species from the family Unionidae. The quantity of phosphorus determined in the soft tissues of *D. polymorpha* inhabiting Mazurian lakes did not exceed 1% d.w. (Stańczykowska and Planter 1985, Stańczykowska and Lewandowski 1993, Markowska 2000). A similar level was noted in the same mussel species inhabiting a lowland dam reservoir (Jurkiewicz-Karnkowska 2002, 2004). The amount of phosphorus in the shells of the studied mussels fell within the range of the mean values (0.045-0.062%) reported in the literature for mussels of the family Unionidae and for the species *D. polymorpha* (Stańczykowska and Planter 1985, Jurkiewicz-Karnkowska 2002, 2004). The phosphorus content in the bottom sediments of the Konin lakes system is comparable to that measured in Mazurian lakes from 0.1 to 0.6 mg g<sup>-1</sup> (Planter et al. 1983, Zdanowski 1983, Markowska 2000), or in lakes located in the Wielkopolska National Park from 0.04 to 0.15 mg g<sup>-1</sup> (Sobczyński et al. 1996).

Mollusks also play an important role in the accumulation of nitrogen, carbon, and calcium (Stańczykowska 1984, Stańczykowska and Planter 1985, Stańczykowska and Lewandowski 1993, Jurkiewicz-Karnkowska 2005). In both species of mussel the accumulation of calcium in the shells was in excess of tenfold that of the soft tissues. Shells are the main repository of calcium in mollusks (Beeby 1993). It is deposited mainly as calcium carbonate (Piechocki and Dyduch-Falniowska 1993). After recalculating the amount of calcium determined in the shells into calcium carbonate, it was revealed that this element comprises about 70% of the shells of *D. polymorpha* and about 75% of those of *S. woodiana*.

In the zones where *S. woodiana* and *D. polymorpha* occur, the total mussel biomass is approximately 15 kg m<sup>-2</sup> (Protasov et al. 1994, 1997, Kraszewski and Zdanowski 2001). Under these conditions, they together deposit about 60 g P m<sup>-2</sup> and 8 kg Ca m<sup>-2</sup>. Considering the fact that the juvenile *S. woodiana* specimens comprise just about 10% of the abundance of this mussel species (Kraszewski 2004), and the

accumulation of elements increases with mussel age (Królak 1997, Jurkiewicz-Karnkowska 2002), the huge role they play in immobilizing phosphorus, among other elements, for the duration of the individual's life and even after its death, must be emphasized. The data presented in this paper leads to the conclusion that the phosphorus accumulated in the shells of the studied species means that about 25% of the entire pool of this element is deposited in the mussels.

The results of the study conducted suggest that there is a lack of differentiation in the accumulation levels of phosphorus and calcium in the tissues of the mussels from the Konin lakes and other freshwater basins. These elements are accumulated in mussels in quantities that probably stem from their physiological needs. Clear differences happen in the accumulation of other heavy metals, including Cu, Zn, and Pb (Królak et al. 2007). The substantial share of base elements emitted along with power plant dust (Kwasowski 1996, Wojcieszczuk et al. 1996) cause the alkalization of the environment around the power plant, as is evidenced by the pH of the surface waters at  $\text{pH} > 8.2$  (Kraszewski 2004). This simultaneously decreases the pool of toxic substances that are available to living organisms.

## CONCLUSION

1. Under similar environmental conditions, the content of phosphorous recalculated as 1 g d.w. per individual is greater in the soft tissues of *S. woodiana* and the shells of *D. polymorpha*.
2. The accumulation of calcium in 1 g d.w. of soft tissue and shell is similar in the two species.
3. The mean values of the studied elements in the tissues of *S. woodiana* and *D. polymorpha* occurring in the Konin lakes are comparable with values noted in the tissues of other species from the family Unionidae and the species *D. polymorpha* occurring in other freshwater basins.
4. *S. woodiana* and *D. polymorpha* inhabiting the Konin lakes accumulate phosphorous and calcium in amounts of about  $60 \text{ g P m}^{-2}$  and  $8 \text{ kg Ca m}^{-2}$ .

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## STRESZCZENIE

### FOSFOR I WAPŃ W MAŁŻACH *SINANODONTA WOODIANA* (LEA) I *DREISSENA POLYMORPHA* (PALL.) JEZIOR KONIŃSKICH

Jeziora konińskie zaliczane do jezior eutroficznych są licznie zasiedlane przez małże *Sinanodonta woodiana* (Lea) i *Dreissena polymorpha* (Pall.). Małże te jako aktywne filtratory przyczyniają się do poprawy czystości wody. *S. woodiana* kumuluje fosfor w tkankach miękkich w ilościach ok. 30 mg g<sup>-1</sup> s.m., a *D. polymorpha* na poziomie ok. 6,6 mg g<sup>-1</sup> s.m. (rys. 1). Zawartość fosforu w muszlach obu gatunków nie przekracza 0,5 mg g<sup>-1</sup> s.m. Średnia zawartość wapnia w tkankach miękkich oraz w muszlach obu gatunków jest zbliżona; wynosi odpowiednio ok. 25 mg g<sup>-1</sup> i ok. 300 mg g<sup>-1</sup> (rys. 2). Uwzględniając biomasy obu gatunków małży w jeziorach konińskich oszacowano, że w małżach zasiedlających jeziora kumulacja fosforu wynosi ok. 60 g m<sup>-2</sup>, a wapnia ok. 8 kg m<sup>-2</sup>.