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Co-occurrence of *Sinanodonta woodiana* with native Unionidae in the lower Oder

by

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Abstract

The Asiatic bivalve *Sinanodonta woodiana* (Lea, 1834), which is more and more widespread in all parts of Europe, in Poland has been mostly reported from lentic waters, especially fish ponds. In contrast to some other European countries, no data have been published on its presence in rivers of Poland. In 2015, monitoring was carried out in the lower Oder River and in the mouth of the Warta River, as a result of which *S. woodiana* was recorded there for the first time. This was possible due to prolonged drought, which led to extremely low water levels in most of the inland water bodies and watercourses, so that other research methods could be used. The presented results confirm that the species spreads easily by colonizing waters of various types, which in the future may lead to the formation of large populations.

Key words: Chinese pond mussel; invasive species; mussels; river; Poland; biodiversity

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Sinanodonta woodiana (Lea, 1834), known as the Chinese pond mussel, originates from Asia but has been spreading all over Europe since the early 1980s, also in Polish waters. In Poland, it was recorded in at least 25 localities (Urbańska & Andrzejewski 2014), and the number of localities has been increasing as evidenced by numerous reports (Gąbka et al. 2007; Ożgo et al. 2010; Najberek et al. 2011; Urbańska et al. 2012; Andrzejewski et al. 2013; Urbańska et al. 2013; Spyra et al. 2012; Domagała et al. 2013; Soroka et al. 2014). In Poland, apart from lakes, the species was found primarily in fish ponds (Mizera & Urbańska 2003; Andrzejewski et al. 2013). In other European countries, however, its numerous populations often colonize rivers and lakes (Popa et al. 2007; Pou-Rovira et al. 2009; Lajrner & Crnčan 2011; Douda et al. 2012; Beran 2013; Colomba et al. 2013; Kamburska et al. 2013; Guarneri et al. 2014; Horáčková et al. 2014; Beran 2015).

Scanty information on the presence of *S. woodiana* in the Polish lotic waters applies to the Narew River (Böhme 1998). Moreover, the species was also reported in a discharge canal (so-called Thermal Canal) with heated water from a power plant, in canals of the Oder (Domagała et al. 2007), as well as in the Postomia River (Domagała et al. 2013). Information on the malacofauna of the Oder is presented in numerous publications (e.g. Domagała et al. 2004; Łabęcka et al. 2005; Piechocki & Szlauer-Łukaszewska 2013). Mollusks of the Oder have been studied since the 1990s and any information on the presence of *S. woodiana* in the main course of the Oder has been reported. This paper is the first report on the colonization of a river by *S. woodiana* in Poland. It also presents a brief description of the unionid community that co-exists with this invasive species.

On the 7th October 2015, we sampled the waters of the lower Oder. Four sampling sites were selected: (1) at the confluence of the Warta and the Oder; (2) on the Oder, at 618 km from the river's source; (3) in an open oxbow lake of the Oder; and (4) on the Oder, 624 km from the river's source (Figure 1). At sampling sites 1, 2, and 4, samples were collected between groynes. At each site, 6-10 plots (0.25 m^2 each) were randomly designated and searched manually with the use of a square frame. Due to the fact that the water level was extremely low in that period (23 cm in 2015, i.e. more than 200 cm lower compared to 2014), we were able to search the bottom directly to a depth of 80 cm. We estimated the density (D) and frequency (F) of the collected *S. woodiana* specimens, as well as we made basic biometric measurements and identified the coexisting bivalve species.

In total, 18 individuals of this species were found at all sampling sites. Their averaged biometric data

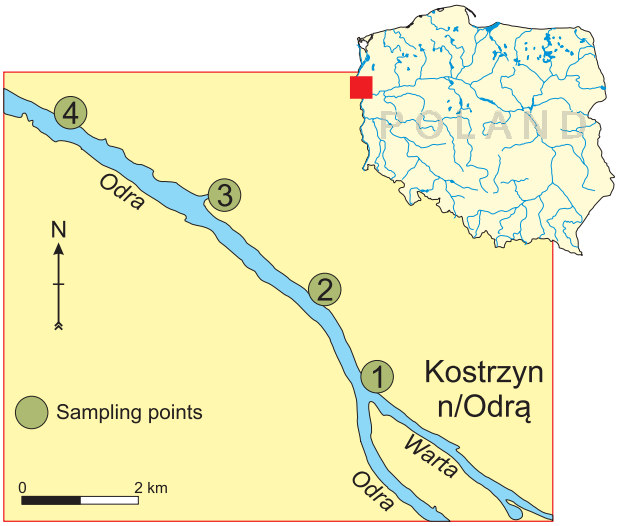


Figure 1
Distribution of sampling sites in the lower Oder River

are presented in Table 1. Their length and mass varied considerably. Apart from the live specimens, also numerous empty shells of this species were found at all the sites.

The estimated densities of *S. woodiana* at the studied sites varied significantly but were generally low (Table 1). The lowest density of 0.3 ind. m^{-2} was recorded in the oxbow lake of the Oder (site 3), while the highest one of 2.6 ind. m^{-2} – at 624 km from the river's source (site 4) (Figure 2). The distribution of this species was uneven at all the sites, with frequencies ranging from 16 to 25%.

In the collected samples, *S. woodiana* coexisted with native species of Unionidae: *Anodonta anatina*, *Unio pictorum*, *U. tumidus*, and *Pseudanodonta complanata*. Moreover, some samples included infrequent specimens of *Dreissena polymorpha* (Dreissenidae), while another alien and invasive species – *Corbicula fluminea* (Cyrenidae) – was found near the main current of the Oder. *U. tumidus* was the dominant species at two sites (2 and 3), *A. anatina* – at one site (1), while two species co-dominated at site 4: *U. tumidus* and *A. anatina*. *P. complanata* was an accessory species (the only one less numerous than *S. woodiana*), present at three sites (1, 2 and 4). Densities of Unionidae varied significantly between samples within the investigated sites. The maximum density was 516 ind. m^{-2} at site 2, and the average values varied from 37.3 in the oxbow lake (site 3) to 98.3 ind. m^{-2} in the main current of the Oder (site 2).

The discovery of *S. woodiana* in the Oder and the Warta confirms the suggestions of Domagała et al. (2013) who, after finding live specimens in the Postomia River, hypothesized that the occurrence of

Table 1

Biometric data of *Sinanodonta woodiana* in the lower Oder River

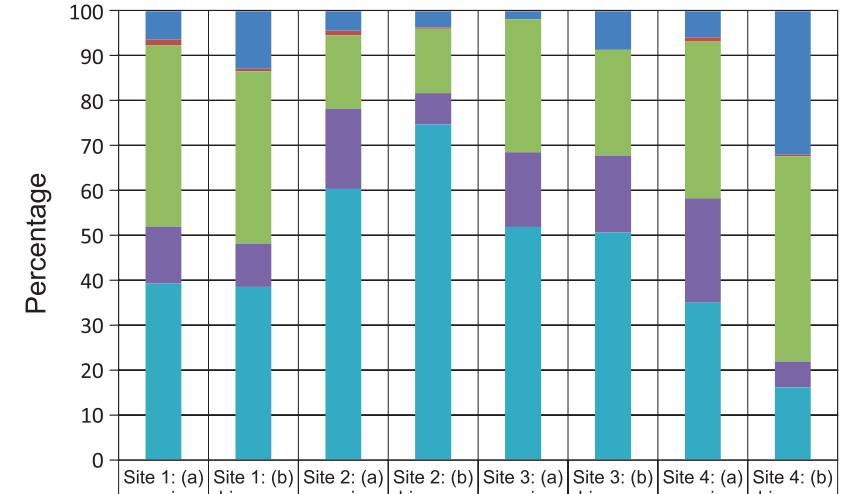
No.	Sampling site	GPS	Average length ± SD (mm)	Average height ± SD (mm)	Average width ± SD (mm)	Average mass ± SD (g)
1	Oder/Warta D = 2.5 F = 25	52°35′50.37″N 14°36′46.20″E	85.4 ± 22	57 ± 12	35.2 ± 13	91.6 ± 64
2	Oder, 618 km D = 2.0 F = 25	52°36′44.06″N 14°35′39.23″E	73.3 ± 10	49.6 ± 7	30.9 ± 8	54.6 ± 27
3	Oxbow lake of Oder D = 0.3 F = 16	52°37′36.07″N 14°33′54.03″E	100 ± NA	66 ± NA	36 ± NA	115 ± NA
4	Oder, 624 km D = 2.6 F = 25	52°38′08.93″N 14°31′59.61″E	95.8 ± 20	59.3 ± 8	37 ± 10	107 ± 60

D = density [ind. m^{-2}]; F = frequency [%]; SD = standard deviation; NA = not available.

this species in the Warta was only a matter of time or had already happened and required confirmation. The cited authors also emphasized that it is necessary to thoroughly examine these issues.

The lowest density in our study was recorded in the oxbow lake of the Oder, but according to Zając et al. (2013) – who found *S. woodiana* in oxbow lakes of the Vistula together with abundant native malacofauna (*Anodonta anatina* and *Unio pictorum*) – such habitats may be equally important to Unionidae. Our findings also indicate yet another route of expansion to local ecosystems and the tolerance of *S. woodiana* to adverse environmental conditions, i.e. colder waters in summer (as compared to fish ponds) and partial freezing in winter.

Our results differ from the reports of Douda et al. (2012) and Beran (2013), who found that *S. woodiana* is a dominant species at some sites in Czech rivers (e.g. Kyjovka and Dyje), which indicates that the species finds favorable conditions in rivers of Central Europe,



	Site 1: (a) species	Site 1: (b) biomass	Site 2: (a) species	Site 2: (b) biomass	Site 3: (a) species	Site 3: (b) biomass	Site 4: (a) species	Site 4: (b) biomass
S. woodiana	6.1	12.84	4.35	3.64	1.85	8.65	5.83	32.01
P. complanata	1.2	0.56	1.09	0.31	-	-	0.97	0.37
A. anatina	39	38.47	16.3	14.32	29.63	23.55	34.95	45.77
U. pictorum	12.2	9.67	17.93	7.01	16.67	17.16	23.3	5.76
U. tumidus	37.8	38.45	60.33	74.71	51.85	50.64	34.95	16.08

Figure 2

Percentage contribution of the number of specimens per individual species of Unionidae at the sampling sites (a) and of their biomass (b) in the lower Oder River

so it may pose a threat to the populations of native species. Currently, native species are most abundant in the Oder – mainly *U. tumidus* and *A. anatina* – but changes similar to those observed in Czech rivers cannot be excluded, considering the observations made in Lake Balaton (Benkő-Kiss et al. 2013), which show changes in unionid communities, indicating that *S. woodiana* considerably increased its density and biomass, and gradually replaced the co-existent *A. cygnaea*. Because of the local populations of *S. woodiana* in rivers, the species can spread even more effectively, but there are still no clear answers to questions concerning its impact on new habitats, especially on native species of Unionidae. The results of this study indicate that *S. woodiana* is able to colonize a large lowland river in Poland, but so far has not dominated this ecosystem.

The impact of this alien species on the native ones was too short, so it is impossible to provide any evidence or to evaluate the effects of *S. woodiana* on native species of mussels. To confirm the impact of *S. woodiana*, the long-term research and regular monitoring are needed. They have been performed at many sites in Poland, including new habitats and locations.

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