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Non-indigenous bivalve − the Atlantic rangia *Rangia cuneata* − in the Wisła Śmiała River (coastal waters of the Gulf of Gdańsk, the southern Baltic Sea)

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Abstract

The present paper reports on the occurrence of the Atlantic rangia *Rangia cuneata* in the Wisła Śmiała River (coastal waters of the Gulf of Gdańsk, the southern Baltic Sea) from around 2012-2014.

INTRODUCTION

Until 2010, six species of Bivalvia were recorded in the coastal waters of the Gulf of Gdańsk (Polish Baltic waters). These are either very abundant species: the Baltic clam *Macoma balthica* Linnaeus, 1758, the cockle *Cerastoderma glaucum* (Bruguiére, 1789), the soft shell clam *Mya arenaria* Linnaeus, 1758 and the blue mussel *Mytilus edulis* Linnaeus, 1758 or very rare in this area, non-indigenous species − the zebra mussel *Dreissena polymorpha* (Pallas, 1771) (e.g. Warzocha & Gostkowska 1991, Janas et al. 2004, Janas & Kendzierska 2014). *Parvicardium hauniense* (Petersen & Russell, 1971) although observed in the past (Wołowicz 1977) was not found in 2000 yr. and has probably disappeared from the Gulf of Gdańsk.

In 2010, two non-indigenous species of bivalves were found for the first time in the southern part of the Baltic Sea: the Conrad's false mussel *Mytilopsis leucophaeata* (Conrad, 1831) in Puck Bay and the Atlantic rangia *Rangia cuneata* (G.B. Sowerby I, 1831) in the Vistula Lagoon (Dziubińska 2011, Rudinskaya & Gusev 2012, Warzocha & Drgas 2013). Both species come from the Atlantic coast of North America (Howells et al. 1996). *R. cuneata* was first recorded in European waters in the harbor of Antwerp (Belgium) in 2005 during monitoring studies of invasive *M. leucophaeata* (Verween et al. 2006).

The aim of this paper was to present the first observation of *R. cuneata* and preliminary results of the research on this species in relation to other bivalves in the Wisła Śmiała River (the southern Baltic Sea).

MATERIALS AND METHODS

On the 1st August 2014 bivalve individuals were collected during macrofauna sampling in the Wisła

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Śmiała River. Salinity was 5.8 PSU and temperature 23°C.

Four samples at a depth ranging from 5.5 to 7.7 m were collected using a Van Veen grab, sieved through a 1 mm mesh sieve and preserved with 4% formalin.

The individuals of *R. cuneata* were identified using the identification key (Verween et al. 2006). The valves are thick and heavy, with a pale brown periostracum. The shells are equivalve, but inequilateral with the prominent umbo curved anteriorly (Fig. 1). Shells of the new species are most similar to shells of *M. balthica*. However, the prominent umbo curved anteriorly is visible in both young and adult individuals of *R. cuneata* and it can be easily distinguished from *M. balthica* (Fig. 1).

The shell length was measured with a caliper (for individuals >5 mm) and stereoscopic microscope with NIS-Elements BR 3.0 microscope software (for individuals <5 mm) to the nearest 0.1 mm. Later, the number of individuals in every 2 mm length classes were calculated.

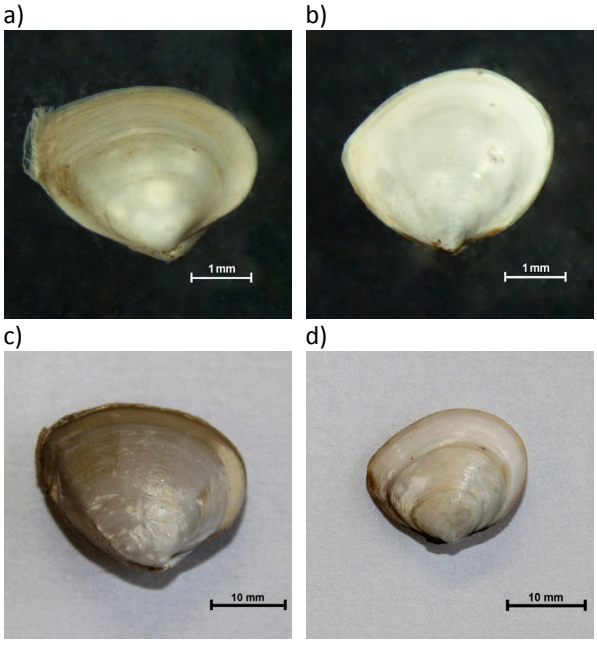

Fig. 1. Young individuals of *Rangia cuneata* (a) and *Macoma balthica* (b) and adult individuals of *Rangia cuneata* (c) and *Macoma balthica* (d) from the Wisła Śmiała River (Photographs H. Kendzierska)

Results And Discusion

R. cuneata was found in each sample (frequency 100%) in the Wisła Śmiała River. The abundance varied from 40 to 540 ind. m^{-2}. In autumn, the abundance in the Vistula Lagoon was 80-920 ind. m^{-2} with the maximum of 4040 ind. m^{-2} (Rudinskaya & Gusev 2012). In the Wisła Śmiała River, besides *R. cuneata,* also other bivalves were observed: *M. balthica, M. arenaria* and *C. glaucum*. *R. cuneata* was the dominant species among bivalves − the percentage in the total abundance of bivalves was 49%, and in the biomass 62% (Fig. 2).

In total, 70 individuals of *R. cuneata* were collected, the length of shells varied from 2.8 to 24.8 mm, with one individual 36.1 mm long. The maximum length was similar to that reported for *R. cuneata* in the Vistula Lagoon and the harbor of Antwerp (Verween et al. 2006, Rudinskaya & Gusev 2012, Ezhova 2012, Warzocha & Drgas 2013), but smaller than in North America, where the length of shells range within 46.7-80.0 mm in the Gulf of Mexico (Lane 1986, Howells et al.1996).

The size – frequency distribution of *R. cuneata* in the Wisła Śmiała River ranged from 2 to 26 mm (except one large individual), with the dominance of young individuals (<8 mm) indicating the expansion of the population (Fig. 3). In the Vistula Lagoon, young individuals of *R. cuneata* were able to grow by

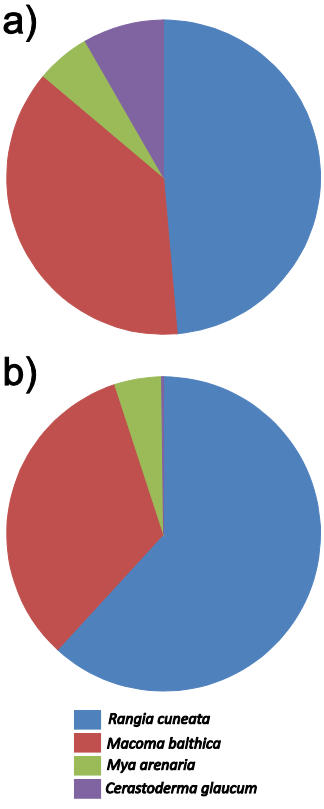

Fig. 2. The contribution in the abundance (a) and biomass (b) of each bivalve species in the Wisła Śmiała River

14 mm during the first year (Rudinskaya & Gusev 2012). In the North American coastal waters, individuals reach 15-20 mm during the first year of their life and increase around 5-9 mm during the second year and around 5 mm during the third one (LaSalle and de la Cruz 1985). Another bivalve in the Wisła Śmiała River, *M. balthica,* reached the length of 22 mm with the dominance of young (2-4 mm) and adult individuals (16-18 mm) (Fig. 3). In the Gulf of Gdańsk, the Baltic clam reaches the length of 23 mm at the age of around 8 years (Wenne & Klusek 1985). Only single individuals of *M. arenaria* and *C. glaucum* were found, both young and adults.

R. cuneata prefers coastal areas at a depth usually less than 6 m and lives in various types of sediment (LaSalle and de la Cruz 1985, Auil-Marshalleck et al. 2000), including silty and silty-sandy sediment in the Vistula Lagoon and silt in the inlet pipes of an industrial cooling water system in the harbor of Antwerp (Verween et al. 2006, Rudinskaya & Gusev 2012, Warzocha & Drgas 2013). *R. cuneata* inhabits estuaries with salinity ranging usually from 0 to 15 PSU (LaSalle & de la Cruz 1985). Laboratory studies showed that the species does not spawn in the salinity around 0 PSU and that embryos and larvae are intolerant of freshwater and survive best in salinity up to 10 PSU (Cain 1975). The Atlantic rangia lives in a broad range of temperature, i.e. 2-30°C (Cain 1975), but it was observed that low temperature in winter negatively affects the survival of *R. cuneata* in Chesapeake Bay and the Vistula Lagoon (Gallagher & Wells 1969, Rudinskaya & Gusev 2012).

How and when *R. cuneata* arrived in the Wisła Śmiała River? The distance of around 90 km separates those waters from the Pilawska Strait connecting the Gulf of Gdańsk and the Vistula Lagoon, where *R. cuneata* has been observed since 2010. However, the adult individuals of the Atlantic rangia have not yet been found in the more open part of the Gulf of Gdańsk. The species must have arrived in the Wisła Śmiała River after summer 2010, because it was not found in macrofauna samples from that period (authors' unpublished observations). The presence of *R. cuneata* individuals in all size classes up to 26 mm (at least 2 years old) confirms this assumption. However, the presence of individuals, such as the one with 36.1 mm length and empty shells longer than 30 mm found in sediments, may indicate even earlier arrival of the first Atlantic rangia organisms or the transfer of adult individuals into the waters of the Wisła Śmiała River after 2010.

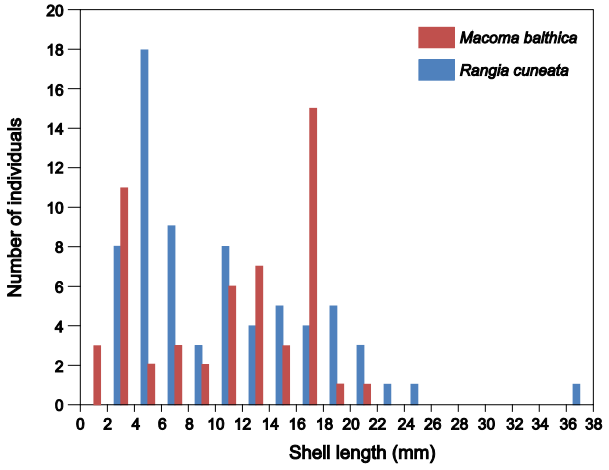

Fig. 3. Size distribution of *Rangia cuneata* and *Macoma balthica* in the Wisła Śmiała River

All this can be connected with dredging works, which started in 2012 in the area of the Martwa Wisła River and in 2013 in the Wisła Śmiała River. This possible correlation between the occurrence of *R. cuneata* and dredging of the waterway in the Vistula Lagoon by a dredger from western Europe has been mentioned and proposed already by Rudinskaya & Gusev (2012).

High abundance of *R. cuneata* observed in the Wisła Śmiała River and the Vistula Lagoon, and appropriate environmental parameters (like temperature and salinity) for the reproduction and the growth suggests that the species will spread in the southern Baltic Sea and will affect the functioning of the ecosystem. *R. cuneata* is a suspension feeder ingesting large quantities of detritus and phytoplankton, and could be an important food source for crabs, fish from the family of Cyprinidae, and birds like the goldeneye *Bucephala clangula,* the velvet scoter *Melanitta fusca,* the common scoter *Melanitta nigra* and the long-tailed duck *Clangula hyemalis* (Darnel 1958, Eie and Borgstrøm 1981, LaSalle & de la Cruz 1985, Bonsdorff & Blomqvist 1993, Skilleter & Peterson 1994, Kube 1996, Perry et al. 2007).

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