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THE CONTINUING EXPANSION OF *SINANODONTA WOODIANA* (LEA, 1834) (BIVALVIA: UNIONIDAE) IN POLAND AND EUROPE

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ABSTRACT: The mussel *Sinanodonta woodiana* (Lea, 1834), which is an alien species to European malacofauna, was introduced in Europe in the early 1960s (Romania, Hungary) from Asia along with stocking material of herbivorous fishes. Subsequently, the species expanded to Austria, France, Yugoslavia, Poland, Slovakia, the Czech Republic, and Germany. For over a dozen years, the only site in Poland where this mussel was documented was the heated lake system near Konin. In 2003, *Sinanodonta woodiana* was found in the warm water canal of the Szczecin power plant, and from 2002 to 2006 it was observed in basins with natural thermal regime, including fish ponds in Great Poland and the Warta-Gopło Canal near Konin. In recent years, the species has also been recorded from the eastern and southern European countries through which the Danube River flows.

KEY WORDS: alien species, *Sinanodonta woodiana*, expansion, distribution, heated waters

The natural range of occurrence of *Sinanodonta woodiana* (Lea, 1834) includes the systems of two large Asian rivers – the Amur and the Yangtze. Fish farming has been largely responsible for the expansion of this species in South and Southeast Asia (Cambodia, Taiwan, Thailand, Malaysia, Japan, Hong Kong) and in South America (Dominican Republic, Costa Rica) (WATTERS 1997).

This alien species was introduced into European waters in the early 1960s, first to Romania and then to fish ponds in Szarvas, Hungary in the 1963–1965 period (PETRO 1984, KISS & PEKLI 1988, KISS & PETRO 1992). *Sinanodonta woodiana* was subsequently confirmed in other regions of Romania and Hungary (the Danube, Tisza, and Körös rivers) and in France (fish ponds near Arles in the Bouches du Rhône region), Yugoslavia (Tisza River), Austria (Dyje River, Lower Austria), Slovakia (Danube River catchment area, near Čičov), the Czech Republic (Dyje River, near Břeclav), Poland (the heated lake system near Konin), Germany (Lake Seiler, near Iserlohn, Rhine-Westphalia) (PETRO 1984, SÁRKÁNY-KISS 1986, GIRARDI & LEDOUX 1989, FALKNER 1990, GUELMINO 1991, KISS & PETRO 1992, REICHHOLF & STEINBACH 1992, KISS 1995, KOŠEL 1995, ZDANOWSKI 1996, BERAN 1997, REICHLING 1999) (Fig. 1).

In recent years, *Sinanodonta woodiana* has been noted in Ukraine (Danube-Sasyk Canal in the Danube Delta, YURYSHYNETS & KORNYUSHYN 2001, LYASHENKO et al. 2005) and Italy (River Po near Bologne, FABBRI & LANDI 1999) as well as in new sites in countries where it was already present. These include Holland (Province of Limburg), Germany (fish ponds, Bavaria, TAPENBECK 2000, MIENIS 2002), Austria (the Danube tributaries of Thaya, Perschling, Stockerauer Arm, Lower Austria, EDLINGER & DAUBAL 2000, MIENIS 2002, FISCHER et al. 2002, TAURER 2003), the Czech Republic (Žehuňsky and Chropyňsky fishponds, NOVAK 2004), Slovakia (Laborec River, SÁRKÁNY-KISS et al. 2000), Serbia (Danube, Tisza and their tributaries, PAUNOVIC et al. 2006), Hungary (Danube, Tisza and their tributaries, JUHÁSZ et al. 2004, SZEKERES & CSÁNYI 2006), Romania (Bihor County and Transylvania, the rivers Bega, Timis, Caras, Ier, Crisul Alb, Tur and fish ponds, SIRBU et al. 2005, SIRBU & BENEDEK 2006) (Fig. 1).

Sinanodonta woodiana was introduced in Poland from Hungary with the stocking material of herbivo-

Fig. 1. Localities of *Sinanodonta woodiana* in Europe arranged chronologically: 1 – Romania, 2 – Hungary, 3 – France, 4 – Serbia, 5 – Austria, 6 – Slovakia, 7 – Czech Republic, 8 – Poland, 9 – Germany, 10 – Italy, 11 – Ukraine, 12 – Holland

rous fishes in the mid 1980s. The fish with the attached glochidia of *Sinanodonta woodiana* were released into a lake which is part of the cooling system of two electric power plants near Konin. Due to favourable environmental conditions (primarily the thermal regime of the water), the species is now very abundant in the lake, canals, initial cooling basin, and the cultivation ponds of this system (AFANASYEV et al. 2001, KRASZEWSKI & ZDANOWSKI 2001, in press, KRASZEWSKI 2006). For nearly twenty years, this remained the only site in Poland at which the occurrence of *Sinanodonta woodiana* was documented. However, it is suspected that in the 1980s the species invaded also natural water bodies. The shells of this mussel were noted by BÖHME (1998) in the Narew River not far from the village of Topilec. The occurrence the Chinese mussel was next noted in fish ponds in the Sierakowski Landscape Park near Samita in Great Poland (2002) as well as in the heated water discharge canal of the Dolna Odra Power Plant in Nowy Czarnów not far from Szczecin in Pomerania (2003) (MIZERA & URBAŃSKA 2003, DOMAGAŁA et al. 2004). In 2006, this mussel was found to inhabit two more sites, and while they were both artificial basins they had natural thermal regime. These sites are in the Warta-Gopło canal near Konin (through which water from the Warta River is directed to the system of heated lakes) and the fish ponds in the Dolina Baryczy Landscape Park near the village of Janisławice and Kondratów in Great Poland (GĄBKA et al. 2007) (Fig. 2).

In most cases, the expansion of this species into new areas in Poland and the remaining part of Europe occurred through the introduction of new fish

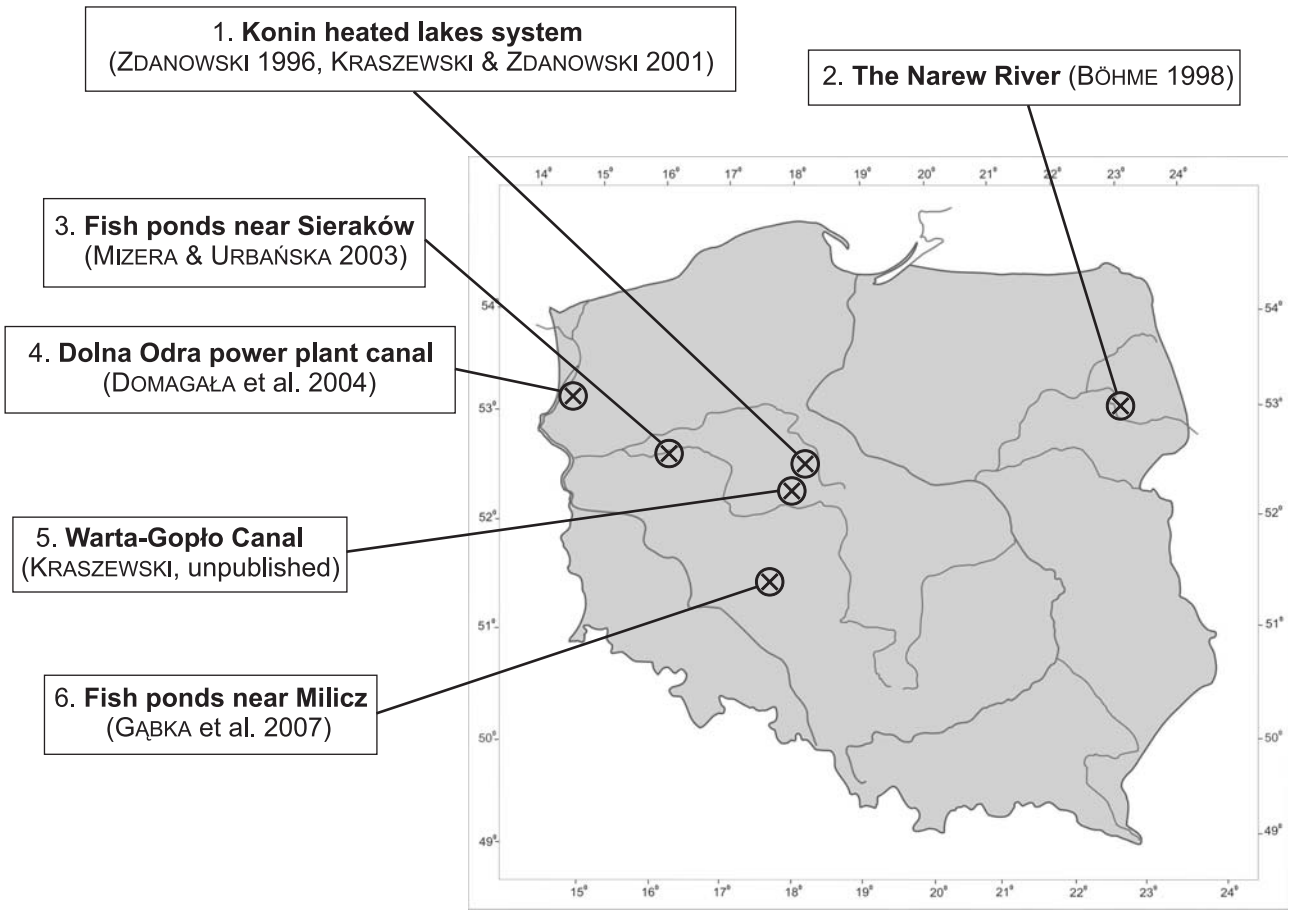

Fig. 2. Localities of *Sinanodonta woodiana* in Poland arranged chronologically

species, primarily herbivorous ones, including silver carp, *Hypophthalamichthys molitrix* (Valenciennes, 1844), bighead carp, *Aristichthys nobilis* (Richardson, 1836), and grass carp, *Ctenopharyngodon idella* (Valenciennes, 1844). The aim of introducing these species was to help fight the effects of eutrophication.

Currently, *Sinanodonta woodiana* occurs most frequently in Hungary, Romania, and Serbia in the Danube River and its tributaries (Tisza, Bodrog, Körös, Bega, Timus, Caras, Crisul Alb, Ier, Sava, Begej, Velika Morava) and in Poland in the Konin heated lake system (ANDREI & POPA 2001, KRASZEWSKI & ZDANOWSKI 2001, 2007, SIRBU et al. 2005, PAUNOVIC et al. 2006, POPA & POPA 2006). In some lowland rivers, such as the Tisza and Körös, *Sinanodonta woodiana* has become the decided dominant among the freshwater mussels (SÁRKÁNY-KISS 1997). This is due to its ecological and physiological characters.

Although the Polish climate may appear too severe for the occurrence of *Sinanodonta woodiana* in waters with natural thermal regime, the recent observations contradict this. Not only heated waters provide favourable habitat conditions for this species; it is possible that the particular conditions in fish ponds in Greater Poland, the Narew River, and the Warta-Gopło Canal have allowed the mussels to survive for a certain period, but not one long enough to support the reproductive process or, consequently, to establish permanent populations.

The future expansion of *Sinanodonta woodiana* appears to be predictable. It will most likely continue expanding widely in the Danube River and its tributaries in Romania and Hungary, as has been observed to date (ANDREI & POPA 2001, SIRBU et al. 2005, PAUNOVIC et al. 2006), but also in other countries through which the Danube flows. In the cooler lowland rivers of central Europe such as the Odra, Vistula, Elbe or Rhine, its distribution may be limited by disadvantageous thermal conditions. In addition to its natural expansion, *Sinanodonta woodiana* is likely to increase its range of occurrence through planned introductions of ichthyofauna into cultivation ponds or other waterbodies. In this respect, they will comprise isolated and unstable populations; however, these might become sources of colonisers for further expansion.

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