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The story of one clam. Probably the oldest location of the Chinese pond mussel *Sinanodonta woodiana* (Lea, 1834) (Bivalvia, Unionidae) in Poland

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Abstract

The discovery of a shell of the Chinese pond mussel in 1998 and further confirmation of this species indicate that a reservoir with natural thermal conditions is the oldest species location in Poland. Growth increments of an archival shell do not fall within the ranges obtained by this species in Konin lakes. They are, however, close to population ranges from Hungary. In contrast to other specimens found, the analyzed shell has a very high *H/L* ratio and is thicker. The observed features might result from the founder effect or they might point to a considerable plasticity of the species.

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INTRODUCTION

Sinanodonta woodiana penetrated with fish shipments from Asia not only the European, but also the American continent (Watters 1997). In Europe the first specimens of this species were found in Romania in 1979, and a year later in Hungary (Sark-Kiss 1986). It is believed that the population in Poland was made possible by fish transports of the bighead carp (*Aristichthys nobilis*) and silver carp (*Hypophthalamichthys molitrix*) in the late 80's from Hungary, (Kraszewski, Zdanowski 2001) and its presence was limited to reservoirs with increased thermal trophic dynamics and water supplied by the Konin power plant. It was also argued that the spreading of the species to other open waters in Poland would not be possible due to harsh winter conditions in the climate zone (Kolodziejczyk, Koperski 2000). For the first time the possibility of further expansion to lakes of a temperature typical of our climate was proved experimentally by Domagała et al. (2004a).

Currently, based on the malacofauna research conducted in Poland, there are nine confirmed locations of the Chinese pond mussel in different parts of the country (Böhme 1998; Domagała et al. 2004b; Gąbka et al. 2007; Kraszewski 2007; Mizera, Urbanska 2004; Najberek et al. 2011; Ożgo et al. 2010; Urbanska et al. 2011; Zdanowski 1996). In order to verify whether spreading of the Chinese pond mussel is still progressing, the monitoring works across country had been initiated that led to identification of its new location.

The information collected in the presented study also shed new light on the beginnings of the species' introduction and allow to argue − with a high degree of probability − that the newly discovered location is by far the oldest place of its occurrence in unheated waters in Poland.

MATERIALS AND METHODS

Based on the survey The Department of Fishing and Angling Industry (in Polish: Zakład Gospodarki Rybacko-Wędkarskiej, abbreviated ZGR-W) PZW Osieczna was selected to verify the data contained in the survey carried out in 250 fish farms in Poland on the presence of mussels (Andrzejewski, Urbanska 2010). In November 2010 after draining the water from the farm ponds called Zgliniec and Wojnowice, mussels were collected from their bottoms.

Zgliniec is a complex of seven ponds located between Lake Jezierzyckie and Lake Wojnowickie near the village of Zgliniec. The total area of the pond complex is 69.59 ha. Due to the depth loss caused by the overgrowth of semi-aquatic plants, the present production area of the ponds is only 31.8 hectares. The mean thickness of bottom sediments ranges from 20 to 50 cm.

The regulation of 21 July 2004 (Journal of Laws No. 229, item no. 2313) by the Ministry of the Environment designated a Special Protection Area Natura 2000 (Nature 2000) under the name of Wonieść Reservoir (site code PLB300005), which covers the area with the ponds Wojnowice and Zgliniec. Shallow water reservoirs, such as ponds and lake flood plains, have been since then considered bird sanctuaries in Europe.

A single piece of a shell of the Chinese pond mussel (*Sinanodonta woodiana*, Lea) was discovered in the farm's archival collections in November 2010 during an office visit at the Osieczna fish farm. The shell was collected in Zgliniec Pond by Mr. Andrzej Łakomy in autumn 1998. The age and the size of annual increments of the mussel were calculated on the basis of the annual growth rings. Biometric measurements of the shell were made (length L, height H, width W) with the aid of Helios electronic caliper, with an accuracy of up to 0.01 mm and the ratios of H/L, W/L and W/H were calculated. Also, the average thickness of the shell was determined by a mechanical thickness gauge (accuracy of 0.1 mm), with measurements being made in the lateral line of the shell. Spaces of the balanced growth between the beginning of the third ring and the end of the fourth ring were chosen for the measurement (Fig. 1). The results were averaged and compared with similar measurements carried out at randomly selected shells of *S. woodiana* in the Barycz Valley, the specimens of Samita included in the collections of the Institute of Zoology of the Poznań University of Life Sciences and the newly discovered location at Wojnowice Pond. The results were statistically analyzed with the *F*-test in order to verify the homogeneity of variance (Statistica package 5.0 PL).

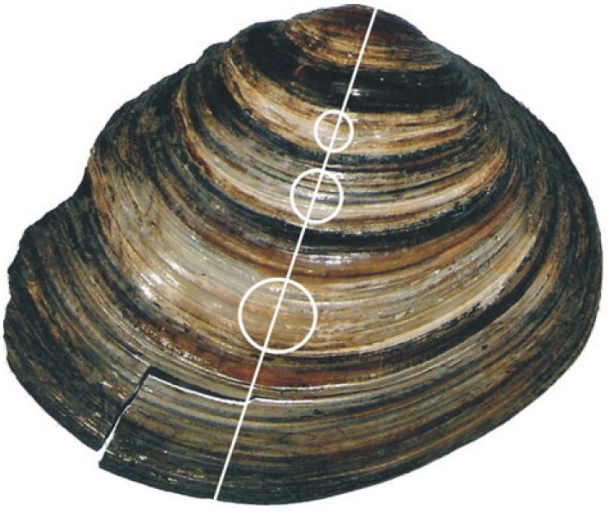

Fig. 1. A photograph of the specimen of *Sinanodonta woodiana* found in 1998 in Zgliniec Pond with marked spots of shell thickness measurements.

RESULTS

After determining the species of mussels in the ponds of Wojnowice and Zgliniec, the presence of the following species was confirmed: the duck mussel (*Anodonta anatina*), the swan mussel (*Anodonta cygnea*) and the Chinese pond mussel, as well as the swollen river mussel (*Unio tumidus*). At randomly selected areas, all living specimens were collected and mussels were counted. The Chinese pond mussel is a numerous species in the community of Zgliniec Pond, occurring in the quantitative ratio of 1:3 to other *Unioniidae* species, and the age heterogeneity of the collected specimens indicates that it has created a stable population. The species is already dominant in areas with milder climate. The Serbian reports state that in some reservoirs it occurs in the ratio of 2:1 (Paunovic et al. 2006). In Poland, the highest levels of biomass are reported from precooling tanks of the Konin Power Plant (Kraszewski, Zdanowski 2001).

The shell stored in the collections of the farm, the age of which was estimated to be 7+, was found at the bottom of the pond and was not the only, or even the largest specimen of this species seen at that time. According to anecdotal information received

from Mr. Andrzej Łakomy, an overwhelming number of similar-looking bivalve shells found at that time were of a much smaller size. Detailed characteristics of the archival shell are given in Table 1.

The most likely way for this species to get into the fish ponds were fish shipments from Hungary. As the Chinese pond mussel shell discovered in 1998 was seven years old, its appearance in the ponds should be dated at 1992.

Table 1

Biometric features of the archival shell found in October 1998 in Zgliniec Pond belonging to the fish farm in Osieczna.

Age (years)	Length L (mm)	Height H (mm)	Width W (mm)	H/L	W/H	W/L	Growth pattern (mm)
7+	162.51	128.81	61.96	0.79	0.48	0.38	37.15 51.16 65.01 89.20 99.76 108.88 122.82

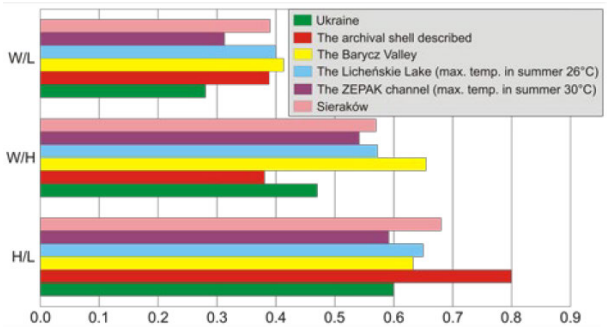

Fig. 2. Comparison of the shape coefficients for selected populations of *S. woodiana.*

Table 2

Comparison of the length of the archival shell with the literature data.

Age	Archival shell length (mm)	Shell length ranges		Average shell length in channels (Afanasiev et al. 2001)
		The Lakes of Konin (Soroka, Zdanowski 2001 quoting Kośmider 2000)	Hungary (Kiss 1995)	
3	65.01	101-162	70-95	112.7
4	89.20	128-176	85-100	138.8
5	99.76	145-168	95-115	157.2
6	108.88	>162	110-120	164.8

DISCUSSION

There is little data on the dimensions of *S. woodiana* depending on the age, most information relates to the average size of the whole population. Therefore, to compare the shell of the specimen found to those from other habitats, the shape aspect ratios were compared (H/L, W/L and W/H) (Fig. 2). The H/L ratio was the highest for the analyzed shell, which means that its shape most closely resembles the shape of a circle.

The size of annual increments was also compared with the available data for the age ranges from 3+ to 6+ coming from three different populations (Table 2).

The obtained increments of the archival shell do not fall within the ranges obtained by this species in the Konin lakes (Soroka, Zdanowski 2001 after Kośmider 2000) and the average lengths of specimens from the channel system of these lakes (Afansiev et al. 2001). They are, however, close to the ranges of the Hungarian population (Kiss 1995). The rate of annual growth in *S. woodiana* varies depending on the age - the young individuals with shells of up to 8 cm are characterized by large annual increments (Afanasjev et al. 2001), in subsequent years, the growth rate decreased. Differences in the size may also result from physiological conditions, or changing climatic and habitat conditions, which were confirmed by studies on other mussel species (Chojnacki et al. 2007; Fenger et al. 2007; Gärdenfors 1987; Jokela, Mutikainen 1995; Kesler, Van Tol 2000; Schöne et al. 2005).

Fragility and thinness of *S. woodiana* shells are defined as characteristic features of this species (Kraszewski 2006b; Piechocki, Dyduch-Falniowska 1993), which draws attention to the fact that throughout the storage period in the collection of the farm, the analyzed shell suffered only one fracture. Therefore, the thickness of the archival shell was measured − which, starting from the end of the second growth ring, amounted to 2.2, 2.3 and 2.0 mm, respectively − and compared with the available archival material (Table 3).

Based on the *F*-test it was determined that the average thickness of the shell for the archival mussel differs substantially from the average thickness of the shell of the three other populations analyzed. Obviously on the basis of average values, it can be inferred that the historical shell is thicker than the current population at the level of significance given above. The same conclusion can be reached by

Table 3

Comparison of the shell thickness of the Chinese pond mussel.

	The analyzed shell from Zgliniec	Shells currently present at Zgliniec	Shells from the Czesławicki pond	Shells from the Samita pond
Number of individuals	1	38	56	5
Average thickness calculated from 3 years (mm)	2.2	1.3	0.9	0.95
Standard deviation SD	0.15	0.34	0.21	0.21
Range (mm)	2.0 – 2.3	0.7 – 2.1	0.45 – 1.3	0.5 – 1.3

analyzing separately the old shell and the population of Czesławicki Pond ($p \approx 10\text{-}5$), Samita Pond ($p \approx 10\text{-}5$) and Zgliniec Pond ($p < 0.3$). There is, however, no difference in the thicknesses of the shells from Czesławicki and Samita ponds. Thus, this feature persists in Zgliniec Pond and individuals with shells thicker than those from Czesławickie and Samita ponds (where the analyzed material did not exceed the thickness of 2 mm) can still be found. Additional studies need to be carried out in order to determine the background of these differences. The founder effect may be a possible cause explaining these differences, or the presence of a specific phenotypic form, the possible presence of which in the Konin lakes was skeptically discussed by Afanasjev et al. (2001). Whereas taking into account the research of Soroka and Zdanowski (2001), in which the main measurable parameters were analyzed in comparison with genetic differences, and the work of Kraszewski (2006a), it can be assumed that the differences in biometrics have an environmental background and, like other morphological characteristics, illustrate a significant plasticity of the species towards the environmental conditions.

Thanks to accurate data on the time when the shell of the Chinese pond mussel was found, it can be confidently stated that the location discovered is by far the oldest known location of this species in unheated surface waters in Poland. On this basis, it can be assumed that in the locations known before, the species might have appeared earlier than estimated and that it is better adapted to our climate than expected. Therefore it can be assumed that more locations are going to be discovered in Poland, inhabited by numerous and multi-aged populations, and that the Chinese pond mussel will spread to become a common species of benthic fauna in natural reservoirs (Paunovic et al. 2006, Popa 2004).

REFERENCES

Afanasjev, S.A., Zdanowski, B. & Kraszewski, A. (2001). Growth and population structure of the mussel Anodonta woodiana (Lea, 1834) (Bivalvia, Unionidae) in the heated Konin lakes system. *Arch. Pol. Fish,* 9, 123-131.

Andrzejewski, W. & Urbańska, M. (2010). Opinion pool aplication for applaing the pool method in the research on distribution of the *Sinanodonta woodiana* in ponds. In Problemy współczesnej malakologii 2010. XXVI Krajowe Seminarium Malakologiczne, 20-23.04 (pp.56). Kudowa Zdrój (in Polish)

Bőhme, M. (1998). Ein neuer Fundort der Chinesichen Teichmuschel (Sinanodonta woodiana) in Mitteleuropa. *Heldia,* 2 (5/6), 166.

Chojnacki, J.C., Lewandowska, A. & Rosińska, B. (2007). Biometrics of the mussel Anodonta cygnea (L.) inhabiting in 2005 the Binowo and Bobolin Lakes near Szczecin. *Ocean. and Hydrobiol. Stud. Vol. XXXVI*, 3, 21-37.

Domagała, J., Łabęcka, A.M., Soroka, M., B. Zdanowski, B. & Skrzypkowska, A. (2004). Anodonta woodiana (Lea, 1834) from the heated Konin lakes matured in aquaria. In *The 20-th Polish Malacological Seminar. Folia Malacol,* 12(2), 83-106.

Domagała, J., Migdalska, B., Łabęcka, A.M. & Pilecka-Rapacz, M. (2004). Anodonta woodiana (Lea, 1834) on Western Pomerania. *Zeszyty Naukowe Uniwersytetu Szczecińskiego. Acta Biologica,* 10, 199-202. (in Polish with English summ.)

Fenger, T., Surge, D., Schöne, B. & Milner, N. (2007). Sclerochronology and geochemical variation in limpet shells (Patella vulgate): A new archive to reconstruct coastal sea surface temperature. *Geochemistry, Geophysics, Geosystems,* 8/7, 1-17.

Gärdenfors, U. (1987) Impact of airbone pollution on terrestrial invertebrates, with particular reference to molluscus. National Swedish Environmental Protection Board Report 3362

Gąbka, M., Dolata, P.T. & Antonowicz, R. (2007). New localities of the Chinese clam Sinanodonta woodiana (Lea, 1834) (Bivalvia, Unionidae) in the Barycz River Valley (Wielkopolska Region). *Folia Malacologica*, 15, 71-74.

Jokela, J. & Mutikainen, P. (1995). Phenotypic plasticity and priority ruled for energy allocation in freshwater clam: a field experiment. *Oecologia.* 104, 122-132.

Kesler, D.H. & Van Tol. N. (2000). Growth of the freshwater mussel Pyganodon grandis (Unionidae) in two west Tennessee borrow pits. *J. Tennessee Acad. Sci*, 75(3-4), 71-75.

Kiss A. (1995). The propagation, growth and biomass of the chinesse huge mussel (*Anodonta woodiana* Lea, 1834) in Hungary. University of Agricultural Sciences of Godolo. Hungary. Privat Edition, Second Ed.

Kołodziejczyk, A. & Koperski, P. (2000). The freshwater

invertebrate of Poland. The key and basics of macrofauna biology and ecology. *Wyd. Uniwersytetu Warszawskiego,* 15, 207-217. (in Polish)

Kośmider, A. (2000). An estimation of the genetic variation level of bivalves of the genus Anodonta from the Konin lakes system (pp. 72). M.Sc. Thesis, Uniwersytet Szczeciński. (in Polish)

Kraszewski, A. (2006a). Morphological variation in the Chinese clam Sinanodonta woodiana (Lea, 1834) in the heterogeneous conditions of the Konin heated lake system in central Poland. *Folia Malacologica*, 14, 11-23.

Kraszewski, A. (2006b). Alien, water species expansions – threats or chance to increase biodiversity? (pp.25-28). Olsztyn: Kom. Ryb. IRŚ. (in Polish)

Kraszewski, A. (2007). The continuing expansion of Sinanodonta woodiana (Lea, 1834) (Bivalvia: Unionidae) in Poland and Europe. *Folia Malacologica*,. 15(2), 65–69.

Kraszewski, A. & Zdanowski, B. (2001). The distribution and abundance of the Chinese mussel Anodonta woodiana (Lea, 1834) in the heated Konin lakes. *Folia Malacologica*, 9, 253-265.

Mizera, T. & Urbańska, M. (2003). A record of Anodonta woodiana (Lea) from the Sierakowski Landscape Park. In B. Pokryszko (Ed.), *The 19-th Polish Malacological Seminar. Folia Malacologica*, 11 (3/4), 103-114.

Najberek, K., Strzałka, M. & Solarz, W. (2011). Alien Sinanodonta woodiana (LEA,1834) and protected Anodonta cygnea (LINEAEUS, 1758) Bivalia Unionidae in the Spytkowice pond complex. *Folia Malacologica*, 19(1), 31-33.

Ożgo, M., Bogucki, Z. & Janulis, E. (2010). Sinanodonta woodiana in a natural watter body in the buffer zone of the Słowiński National Park. In B. Pokryszko (Ed.), *The 26th polish malacological seminar. Folia Malacologica,* 18(3), 123–145.

Paunovic, M., Csanyi, B., Stojanowvic, B. & Cakic, P. (2006). Distribution of Anadonta (Sinanodonta) woodiana (Rea, 1834) in inland waters of Serbia. *Aquatic Invasions*, 1(3), 154-160.

Piechocki, A. & Dyduch-Falniowska, A. (1993*). Molluscs* (Mollusca). *Mussels* (Bivalvia). In Fauna Słodkowodna Polski 7A. Warszawa: PWN. (in Polish)

Popa, O.P. (2005). Contributions to the knowledge of the Mollusks from the romanian sector of the Danube Between calafat and oltenita. *Travaux du Museum National d'Histoire Naturelle "Grigore Antipa",* XLVIII, 7–19.

Schöne, B.R., Houk, S.D., Castro, A.D., Fiebig, J., Oschmann, W., et al. (2005). Daily Growth Rates in Shells of Arctica islandica: Assessing Sub-seasonal Environmental Controls on a Long-lived Bivalve Mollusk. *Palaios*, 20, 78-92.

Soroka, M. & Zdanowski, B. (2001). Morphological and genetic variability of the population of Anodonta woodiana (Lea, 1834) occurring in the heated Konin lakes system. *Folia Malacologica*, 9: 239-252.

Watters, T. (1997). A synthesis and review of the expanding range of the Asian freshwater mussel Anodonta woodiana (Lea, 1834) (Bivalvia: Unionidae). *Veliger,* 40, 152-156.

Urbańska, M., Andrzejewski, W. & Białowąs, H. (2011). Giant clam. *Przegląd Rybacki*. 2, 32. (in Polish)

Zdanowski, B. (1996). Unknown clam (Anodonta sp.) in heated Konin lakes. XII Krajowe Seminarium Malakologiczne, 25-27.04.1996 (pp. 43). Łódź. (in Polish)