

***Sinanodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae): a new non-indigenous species in Lake Garda (Italy)**

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Abstract

The first record of *Sinanodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae) in Lake Garda, the largest Italian lake located in the Southern Alps is reported. Empty shells of this alien bivalve, also known as the Chinese pond mussel, were observed in February 2009 along the southeastern shore.

Key words: *Sinanodonta woodiana*, Chinese pond mussel, invasive species, deep southern subalpine lakes

Lake Garda, the largest Italian lake (volume: 49 km³; surface: 368 km²; maximum depth: 350 m), along with other deep southern subalpine lakes (Iseo, Como, Lugano and Maggiore) constitutes one of the largest freshwater supplies in Europe (Pucciarelli et al. 2008). The lake is also an important resource for recreation and tourism with its attractions of landscape, mild climate, and water quality. Lake Garda is part of theILTER (International Long Term Ecological Research) network and its trophic condition ranges between oligotrophy and mesotrophy, based on OCDE metrics (Salmaso et al. 2009).

Recently, Lake Garda has been subject to an extensive introduction and colonization of alien species. In particular, among non-indigenous freshwater bivalves, *Dreissena polymorpha* (Pallas, 1771) was observed in Lake Garda since the 1970s (Giusti and Oppi 1972), and *Corbicula fluminea* (O.F. Müller, 1774) and *C. fluminalis* (O.F. Müller, 1774) were recently recorded (Nardi and Braccia 2004; Ciutti et al. 2007; Ciutti and Cappelletti 2009).

The Chinese pond mussel *Sinanodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae) was observed for the first time in Lake Garda in

February 2009, during a survey carried out to investigate the distribution and dispersal of *C. fluminalis*.

The investigated area is located along the south - east shore of Lake Garda from site 1, Padenghe, Porto (45°29'43,43"N, 10°30'43,90"E) to site 8, Bardolino (45°33'42,20"N, 10°42'47,83"E), where the banks are smoothly sloping (Figure 1). Only the fringe area was investigated. Shells were collected and their length was measured in the laboratory using a digital caliper to the nearest 0.01 mm.

S. woodiana was observed in low number and only with empty shells only in the following sites: 2 - Sirmione, Spiaggia Brema (45°28'13,95"N, 10°35'49,75"E), 3 - Sirmione, Punta Grò (45°27'37,82"N, 10°38'23,46"E), 4 - Peschiera del Garda, S. Benedetto (45°26'54,70"N, 10°40'23,12"E). Valves were very flimsy, with a light iridescent inner surface. They had an elongated form and their length ranged from 39.63 to 68.82 mm (Figure 2).

During the investigation, native unionids were also observed: *Unio mancus* Lamarck, 1819, and *Microcondylaea compressa* (Menke, 1830). *Anodonta anatina* (Linnaeus, 1758) was recorded

in the lake up to the 1980s but it seems not to be present any longer (Bodon et al. 2005).

S. woodiana, a large-sized representative of the family Unionidae, is native to East and South-East Asia (Zhadin 1952). Some authors classify this species as belonging to the genus *Anodonta*, but according to the latest taxonomy, it should be more appropriately assigned to the genus *Sinanodonta* (Falkner et al. 2001; Bogatov and Sayenko 2002).

S. woodiana was recorded in Europe for the first time in Romania in 1979, where it was probably introduced along with Chinese fish such as silver carp (*Hypophthalmichthys molitrix* Valenciennes, 1844), bighead carp (*Aristichthys nobilis* Richardson, 1844), and grass carp (*Ctenopharyngodon idella* Valenciennes, 1844) (Sárkány-Kiss 1986). Since then, it has rapidly spread in several other European countries: Austria, Belgium, Bulgaria, Czech Republic, France, Germany, Greece, Hungary, Italy, Poland, Romania, Serbia, Slovak Republic, Slovenia, and Ukraine (Cianfanelli et al. 2007). Since the first report in Italy in 1996 (Manganelli et al. 1998), it has rapidly colonized eight Italian regions, mainly related to the hydrographic basins of the Po, Adige, Piave, Reno, Arno, and Tiber rivers (Cianfanelli et al. 2007). Recently it is also spreading in South Italy (De Vico et al. 2007).

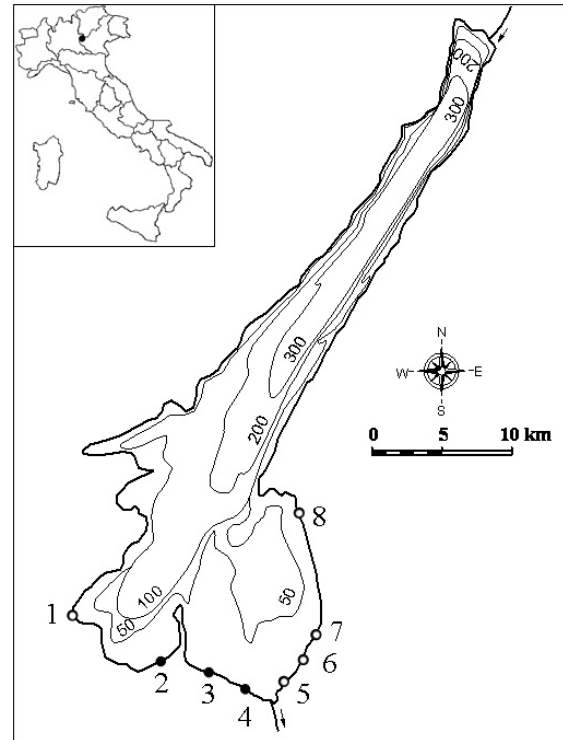


Figure 1. Study area (● - sites with *Sinanodonta woodiana*; ○ - sites without *S. woodiana*); 1: Padenghe, Porto; 2: Sirmione, Spiaggia Brema; 3: Sirmione, Punta Grò; 4: Peschiera, S. Benedetto; 5: Castelnuovo del Garda, Ronchi; 6: Lazise, Pacengo; 7: Lazise, Fossalta; 8: Bardolino)

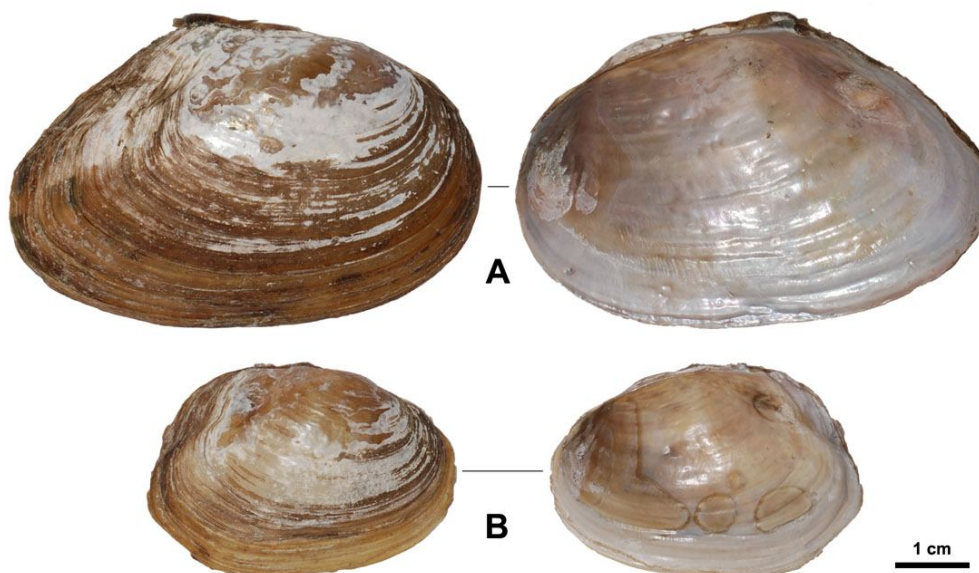


Figure 2. *Sinanodonta woodiana*: range of size classes: exterior view (left side), interior view (right side). A: valves collected in site 2 (Sirmione, Spiaggia Brema); B: valves collected in site 3 (Sirmione, Punta Grò) (photograph by R. Zorer)

Spread and distribution map of *S. woodiana* in Italy is available in Cianfanelli et al. 2007, and could be also downloaded from http://ckmap.fauna.italia.it/ckmap_2000.htm. As in other countries of Europe, the mode of arrival of the species is unintentional; the main vector of *S. woodiana* introduction is accidental transport in association with fish, and a possible pathway of spreading in Italy seems to be fish stocking (Gherardi et al. 2008).

The number of alien freshwater bivalve molluscs recorded in the last decades in Lake Garda (*C. fluminea*, *C. fluminalis*, *D. polymorpha*, *S. woodiana*), in addition to the recent record of the invasive amphipod *Dikerogammarus villosus* (Sowinsky, 1894) clearly shows the vulnerability of this lake to biological invasions (Casellato et al. 2006, 2007).

Among freshwater bivalve species recently introduced to Italy, *S. woodiana* is the fastest spreading (Cianfanelli et al. 2007). The presence of different length classes of *S. woodiana* in Lake Garda allows us to assume that the species is probably now present in the lake with a stable and naturalized population, but the low number of shells and lack of living specimens does not allow us to evaluate the consistency of the population.

The presence of *S. woodiana* could seriously influence the indigenous unionid populations, as has been already observed in other Italian locations. Fabbri and Landi (1999) reported that *A. anatina* has been replaced almost completely by *S. woodiana* in some channel with soft substrate and high trophic level; Niero (2003), in a channel with a high trophic level located in Venezia province, where a high density of *A. anatina* (up to 10 adult specimens m⁻²) was recorded in 1987, noted the exclusive presence of *S. woodiana* in 2002.

Fabbri and Landi (1999), Rashleigh (1995), and Watters (1997a, b) argue that native species reduction could be caused by competition for the host fish, because of the major infestation capacity of alien *Anodonta* species glochidia. Competition among larval stages is highly probable when *S. woodiana* becomes the dominant species (Beran 2008). Food and habitat competition between *S. woodiana* and native unionids was instead excluded by Kraszewski and Zdanowski (2007), in a peculiar artificial lake system heated by power plant discharge in central Poland.

An extensive study of *S. woodiana* in Lake Garda is advisable and necessary to date the introduction, and to study population dynamics in the entire lake perimeter, in order to define its impact on lake habitats and analyze possible competition with the local unionid communities for the same ecological niche.

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