

Travaux du Muséum National d'Histoire Naturelle «Grigore Antipa»	Vol. XLIX	pp. 7–12	© Octobre 2006
---	-----------	----------	-------------------

***SINANODONTA WOODIANA* (LEA, 1834), *CORBICULA FLUMINEA* (O. F. MÜLLER, 1774), *DREISSENA BUGENSIS* (ANDRUSOV, 1897) (MOLLUSCA: BIVALVIA): ALIEN INVASIVE SPECIES IN ROMANIAN FAUNA**

OANA-PAULA POPA, LUIS OVIDIU POPA

Abstract. This paper is a synthesis of the faunistic data present in the specialized literature on the invasive freshwater bivalve species identified in the Romanian fauna for the time being.

Résumé. Ce travail est une synthèse des données faunistiques actuelles dans la littérature spécialisée sur les espèces bivalves d'eau douce invasives identifiées dans la faune roumaine pour l'instant.

Key words: freshwater bivalves, invasive species.

Any kind of species introduced in a new territory can be considered invasive if it spreads uncontrollingly, disturbing the habitats, affecting the native species and even transforming the ecosystems. According to this definition, we can include in the category of the invasive species both alien species (the most frequent case), and native species which spread as we mentioned above. In the first case, the used terminology is *invasive alien species*, and, in the second one, we can use the name of *invasive native species*. All alien species from a specific territory were defined as forming the so-called "xeno-diversity" (gr. *xenos* = alien). It has to be mentioned that it is not necessary that an alien species introduced in a new habitat to become invasive. To talk about an invasive species we have to identify the uncontrolled distribution character, with its above-mentioned subsequent effects.

As regards the invasive native species, in Romania an example is a freshwater bivalve species, *Dreissena polymorpha*, native from the Ponto-Caspic basin and Aral Lake. In Romania, the species withdrew in the lagoons of the Black Sea during the last glacial period. Later, it recovered the lost territories, and now an extension of species range can be observed. Grossu (1962) considered that the species did not occur in all aquatic basins. Colonizing character of this species was recognized, the invading of the Snagov and Buftea lakes, near Bucharest, being reported. During the last 20 years *Dreissena polymorpha* extended more and more its range, generating negative effects in the activity of the hydro-power plants from the basins of the rivers Siret and Olt (Tatole et al., 2003).

First of all, biological invasion phenomenon is associated to human activities. Most of the natural barriers present both in the terrestrial environment and in the aquatic ones were removed by human activities and thus the number of the potential invaders increased as well as of the source areas for invasion (Leppäkoski et al., 2002).

The changes generated by man in environment and in climate make the habitats to allow easier the invasion. Another negative aspect of the invasion is the

lost of the uniqueness of the ecosystems, which become similar, even if they are in advantage from the specific diversity point of view.

One of the main possibilities by which a wide range of aquatic organisms, both marine and freshwater, succeeded in spreading in new territories is the ballast water. Also canal construction (for trade, irrigations, etc.) are added, which removed the natural obstacles in front of these species distribution.

Worldwide systematical study of the invasive species started in 1997, together with the implementation of the Global Invasive Species Programme, whose purpose is the approach of the global threatening represented by the invasive alien species and the drawing up of the documents for the implementation of the Article 8 (h) of the Convention on Biological Diversity. Romania has signed the Convention on Biological Diversity since 1992, ratifying it in 1994.

In Romania, the study on invasive mollusc species began with the marine ones. The invasive freshwater bivalve species were studied from faunistical point of view, the aspects regarding the genetic variability of the population these species developed in the newly colonized habitats not being approached, yet.

Sinanodonta woodiana (Lea, 1834)

Sinanodonta woodiana (Lea, 1834) is a large sized representative of family Unionidae, from the East and South-East Asia. Native distributional area of this species includes the basin of Amur River, Hanka Lake, China, Hong Kong, Taiwan, Kampuchea, Thailand and Japan. Within this range two subspecies were reported, namely: *S. woodiana woodiana* Lea, 1834, from China and *S. woodiana japonica* Martens, 1874, from Japan.

In Europe, *S. woodiana woodiana* Lea, 1834 penetrated accidentally, the first report dating in 1984, from Hungary, with a material collected since 1980 from the fish pond of the castle from Gyula (Sárkány-Kiss, 1986). In 1985, the species reached accidentally the fish farms from Szarvas (in eastern Hungary), with the alevin transport from Krasnodar (Russia) and from Amur River basin, parts of his native distribution area.

In France, in the fish farms from L'Etang des Gravieres à Fonvieille (Arles) it penetrated in 1982, together with the fish imported from Hungary and Russia (Amur Basin). In 1998, it was also reported from Italy. In 1997, Thomas Watters published a history of this species distribution in Europe, Central America and some of the Indonesian islands.

According to Frank et al (1990), in the Danube River basin, the species was reported by Reichutz from Austria, in 1998, from Czech Republic by Beran, from Dyje River, near Breclav, in 1997, from Serbia, at Zenta in 1990, from Slovakia, from the Danube floodplain, in 1995.

In Romania, the first three specimens of *S. woodiana* were collected from the fish farms from Cefa – Oradea, in 1979, identified and published in 1986 (Sárkány-Kiss, 1986). In fact, these specimens represent the first collecting of this species in Europe.

Within Romanian territory the species spread from Criş-Tisa system back in the Danube, some of its tributaries reaching the Black Sea coast (it was collected from the Sahalin Island by Ioan Sirbu, in 1999).

In Romania, *S. woodiana* was reported from: Caraş River, in 1998 (Sárkány-Kiss et al., 2000); Dobrogea, at Isaccea, Hârşova and Măcin, in 1997 (Skolka & Gomoiu, 2001); the Danube Delta, in 1998 (Sárkány-Kiss et al., 2000); Zavideni dam lake, on the Olt River flow; Timiş River, in 2000 (Sárkány-Kiss et al., 2000);

Cerna River, but also from Cerna Valley, at the confluence of this river with the Danube (Sîrbu, 2004); upstream and downstream Giurgiu (the Danube, km 480) – mature and juvenile shells, but also living specimens from a population from the km 514, in the Danube (Andrei & Popa, 2004); mature living specimens of *S. woodiana*, in 2005, from Drobeta Turnu Severin (personal data). All these reports, which were made from important aquatic basins, confirm that this species developed stable populations within the Romanian sector of the Danube.

Physiological, ecological and biological particularities of the species can explain this success, which offer it some advantages against the native unionid species. So, *S. woodiana* has a much higher increasing rate and faces better the pollution and hypoxia in comparison with the autochthonous ones (Sîrbu et al., 2005). Glochidia are discharged within the period May – August (mainly in June and July), and this species can develop 2 – 3 larval stages per year, being in contrast with the native species which reproduce once a year. Parasitic period lasts between 5 and 15 days, depending on the water temperature. The individuals can live between 12 – 14 years. According to our observations, glochidium might not be specific to a host and therefore any fish species can have the parasite (Dudgeon & Morton, 1983).

Considering the faunistic studies made up to now, the distribution of *S. woodiana* started with the invasion of the lower flow of the Criş River, both in the Romanian and Hungarian sides. In 1990, as a result of his studies on the Criş River, Andrei Sárkány-Kiss asserted that *S. woodiana* represented 75 % of the unionid bivalve community biomass occurred in this river. Also it became prevalent species in the Unionidae communities of some rivers, especially in their lower flow. Data from literature refer mainly to the aquatic basins from the western and central parts of Romania (Sîrbu et al., 2005).

From the analysis of the present data on the history of these species penetration in Romania, it seems that *S. woodiana* invaded the Romanian sector of the Danube from this river entrance in our country to the Danube Delta along 10 years at the most (Sárkány-Kiss et al., 2000).

Corbicula fluminea (O. F. Müller, 1774)

Native distributional area of *Corbicula fluminea* (O. F. Müller, 1774) is South-East Asia. *Corbicula fluminea* is an opportunist species which develops mainly in sandy areas. Many times we can occur individuals of this species at depths of 8 cm, that meaning that this species can survive some hours without water. It often occurs at depths of 5 – 6 m, on sandy substratum but it also prefers the muddy substratum with vegetation. Flora of the areas colonized by *Corbicula* consists of *Elodea canadensis*, *Potamogeton* sp., *Ranunculus* sp., *Ceratophyllum* sp. (Araujo et al., 1993).

At the beginning of the 20th century, the species was introduced in North America and, recently it succeeded in colonizing the European continent. In North America, where it developed important populations, this species generates negative effects which we can compare with those generate by another invasive species, namely *Dreissena polymorpha*. When *Corbicula fluminea* populations develop expansively, water feed pipes of the localities can be obturated, problems of the feeding systems of the hydro-power plants can appear, as well as dumps of the water pipes of the industrial and irrigation systems.

In North America, the first report of *Corbicula fluminea* was made by Buch, in 1938, according to Araujo et al. (1993). Counts (1981, 1985) mentioned *Corbicula fluminea* as present since 1924 and 1937 in Nanaimo, Vancouver Island, British Columbia, Canada, Washington. From these reports, the species spread rapidly, colonizing almost all aquatic, lotic and lentic systems, becoming an invading species which created problems economically and ecologically.

After 1980, *Corbicula fluminea* was introduced in South America and in Europe. It is reported by Mouthon from France and Portugal, in 1981. From Portugal, it was reported by Nagel, in 1989, from Duero River (Araujo et al., 1993). In Europe, *C. fluminea* distributed from West to East, and in the Danube it penetrated after the opening of the canal Rin – Main – Danube, which offers the possibility of mixing the faunas of the Rin and the Danube basins (Müller et al., 2002).

The first living specimens collected from the Romanian sector of the Danube were juveniles (3-4 mm), taken from the Iron Gates area, at Berzeasca, by Skolka and Gomoiu, in the winter of 1997 (Skolka & Gomoiu, 2001). Later, in 1999, living specimens were collected from the Danube, at Vadu Oii (Bij De Vaate & Hulea, 2000).

Corbicula fluminea spread rapidly in the Danube. In 2002, Bănărescu & Sîrbu reported the species from the Danube, from the sector which runs through Banat, including it in the category of the ubiquitous eurybiont species, which populate any kind of water, mainly the eutrophic waters.

According to the specialized literature, reports of this species for the main tributaries of the Danube on the Romanian territory were not given, but probably, next years, *Corbicula fluminea* will be reported from these new habitats, too. Popa (2005) reported the species from the confluence of the Jiu River with the Danube, then downstream, from four stations placed between km 510-480. The authors' subsequent collecting (2004 from the Danube, at Galați, 2005 from the Danube, km 929 – unpublished data) confirms the presence of some stable populations of this species, at least in the Romanian sector of the Danube (Sîrbu, 2004).

Dreissena bugensis (Andrusov, 1897)

Dreissena bugensis was described by Andrusov, at the end of the 19th century, from a limited area of the Bug River. Later, the species was reported from the lower area of the Bug River (Zhulidov et al., 2004).

According to Therriault et al. (2004), in 1897 Andrusov made also the first important classification of the species of the genus *Dreissena*. He declared valid the following species, among others:

- *Dreissena polymorpha* (Pallas)
- *Dreissena rostriformis* (Deshayes)
- *Dreissena bugensis* (Andrusov)

Zhadin (1952) considered valid species only *Dreissena polymorpha* and *Dreissena bugensis*. Later, Mordukhai – Boltovskoi (1960) classified *Dreissena bugensis* a subspecies of *Dreissena rostriformis*, so the valid species was *Dreissena rostriformis bugensis*. Starobogatov (1994) reclassified the species *Dreissena bugensis* and *Dreissena rostriformis* in the subgenus *Pontodreissena* (Therriault et al., 2004).

Distribution area of *Dreissena bugensis* remained the same, i.e. the basins of Bug and Nipru rivers, till 1940, when the species had the access to the basin of the Black Sea because of the construction of a canal system (Zhulidov et al., 2005).

After 1990, it was found in the middle basin of Volga River. At present, it is also reported from Nipru River as well as from the brackish waters of the Caspian Sea (Zhulidov et al., 2004).

The species is absent in West Europe but it succeeded in penetrating the Danube and colonized North America. In Romania, *Dreissena bugensis* is reported from the Danube, at Cernavodă, in 2004 (Micu & Telembici, 2004). The species report from 2005 (Popa & Popa, 2006) represents the westernmost collecting place of Europe for *D. bugensis*.

Since its penetration in the Danube, practically the entire western side of Europe is accessible to it, because of the canal Danube - Main - Rin, which removed the natural barriers in front of this species.

SINANODONTA WOODIANA (LEA, 1834), *CORBICULA FLUMINEA*
(O. F. MÜLLER, 1774), *DREISSENA BUGENSIS* (ANDRUSOV, 1897)
(MOLLUSCA: BIVALVIA): SPECII STRĂINE INVAZIVE ÎN FAUNA ROMÂNIEI

REZUMAT

Această lucrare oferă o sinteză a datelor faunistice existente în literatura de specialitate referitoare la speciile de bivalve dulcicole invazive identificate până în prezent în fauna României.

LITERATURE CITED

- ANDREI, G., O.-P. POPA, 2004 - Noi date privind răspândirea speciei *Sinanodonta woodiana* (Lea, 1834) (Mollusca, Bivalvia, Unionoidea) în România. Muzeul Olteniei Craiova. Studii și comunicări, Științele naturii, 20: 99-104. (in Romanian)
- ARAUJO, R., D. MORENO, M. A. RAMOS, 1993 - The Asiatic clam *Corbicula fluminea* (Müller, 1774) (Bivalvia: Corbiculidae) in Europe. American Malacological Bulletin, 10 (1): 39-49.
- BĂNĂRESCU, P. M., I. SÎRBU, 2002 - Contribution to the knowledge of the Banat aquatic fauna. Proceedings of the Symposium - Studies of Biodiversity - West Romania Protected Areas: 108-115.
- BIJ DE VAATE, A., O. HULEA, 2000 - Range extension of the Asiatic clam *Corbicula fluminea* (Müller, 1774) in the River Danube: first record from Romania. Lauterbornia, 38: 23-26.
- COUNTS, C. L. III, 1981 - *Corbicula fluminea* (Bivalvia: Sphaeriacea) in British Columbia. Nautilus, 96 (1): 12-13.
- COUNTS, C. L. III, 1985 - *Corbicula fluminea* (Bivalvia: Corbiculidae) in the state of Washington in 1937, and in Utah in 1975. Nautilus, 99 (1): 18-19.
- DUDGEON, D., B. MORTON, 1983 - The population dynamics and sexual strategy of *Anodonta woodiana* (Bivalvia: Unionacea) in Plover Cove Reservoir, Hong Kong. Journal of Zoology, London, 201: 161-183.
- FRANK, C., J. JUNGBLUTH, A. RICHNOVSZKY, 1990 - Die Mollusken der Donau vom Schwarzwald bis zum Schwarzen Meer - Eine monographische Darstellung. 135 pp.
- GROSSU, A. V., 1962 - Mollusca - Bivalvia. In: Fauna Republicii Populare Române. Edit. Academiei Române, București, 3 (3): 5-407. (in Romanian)
- LEPPÄKOSKI, E., S. GOLLASCH, S. OLENIN, 2002 - Alien species in European waters. Invasive Aquatic Species of Europe. Distribution, Impacts and Management: 1-6.
- MICU, D., A. TELEMBICI, 2004 - First record of *Dreissena bugensis* (Andrussov, 1897) from the Romanian stretch of River Danube. Abstracts: International Symposium of Malacology, August 19-22nd 2004.
- MORDUKHAI-BOLTOVSKOI, F. D., 1960 - Caspian Fauna in the Azov and Black Seas basins. Academy of Sciences of USSR, Moscow. 286 pp.
- MÜLLER, J. C., D. HIDDE, A. SEITZ, 2002 - Canal construction destroys the barrier between major European invasion lineages of the zebra mussel. Proceedings of The Royal Society B: 1139-1142.
- POPA, O.-P., 2005 - Contributions to the knowledge of the mollusks from the Romanian Sector of the Danube between Calafat and Oltenita. Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa", 48: 7-19.

- POPA, O.-P., L. O. POPA, 2006 - The most westward European occurrence point for *Dreissena bugensis* (Andrusov, 1897). *Malacologica Bohemoslovaca*, 5: 3-5.
- SÁRKÁNY-KISS, A., 1986 - *Anodonta woodiana* (Lea, 1834) a new species in Romania (Bivalvia, Unionacea). *Travaux du Muséum d'Histoire Naturelle "Grigore Antipa"*, 28: 15-17.
- SÁRKÁNY-KISS, A., I. SÎRBU, O. HULEA, 2000 - Expansion of the adventive species *Anodonta woodiana* (Lea, 1834) (Mollusca, Bivalvia, Unionoidea) in central and eastern Europe. *Acta oecologica*, 7 (1-2): 49-57.
- SÎRBU, I., 2004 - Comunitățile de moluște acvatice din Dunăre sectorul Baziaș - Orșova (Banat). Muzeul Brukenthal - Studii și Comunicări - Științele Naturii, 29: 107-134. (in Romanian)
- SÎRBU, I., A. SÁRKÁNY-KISS, M. SÎRBU, A. M. BENEDEK, 2005 - The Unionidae from Transylvania and neighbouring regions (Romania). *Heldia*, 6 (3/4): 183-192.
- SKOLKA, M., M.-T. GOMOIU, 2001 - Alien invertebrates species in Romanian waters. Ovidius University, *Annals of Natural Sciences, Biology - Ecology Series*, 5: 51-55.
- STAROBOGATOV, Y. I. (Ed.), 1994 - Freshwater Zebra Mussel, *Dreissena polymorpha* (Pall.) (Bivalvia, Dreissenidae): Systematics, Ecology, Practical Meaning. Species of the Fauna of Russia and Adjacent Countries, Moscow. 240 pp. (in Russian)
- TATOLE, V., V. ZINEVICI, N. NICOLESCU, A. IFTIME, 2003 - Structural analysis of the biotic component of hydropower harnessed ecosystems from the Basins of Olt and Siret rivers (Romania). *Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa"*, 45: 499-526.
- THERRIAULT, T. W., M. F. DOCKER, M. I. ORLOVA, D. D. HEATH, H. J. MACISAAC, 2004 - Molecular resolution of the family Dreissenidae (Mollusca: Bivalvia) with emphasis on Ponto-Caspian species, including first record of *Mytilopsis leucophaeata* in the Black Sea basin. *Molecular Phylogenetics and Evolution*, 30: 479-489.
- WATTERS, T. G., 1997 - A synthesis and review of the expanding range of the asian freshwater mussel *Anodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae). *The Veliger*, 40 (2): 152-156.
- ZHADIN, V. I., 1952 - Mollusks of fresh and brackish waters of URSS. Israeli Program for Scientific Translations, Jerusalem. 318 pp.
- ZHULIDOV, A. V., D. F. PAVLOV, T. F. NALEPA, G. H. SCHERBINA, D. A. ZHULIDOV, T. Y. GURTOVAYA, 2004 - Relative distributions of *Dreissena bugensis* and *Dreissena polymorpha* in the lower Don River system, Russia. *International Review of Hydrobiology*, 89 (3): 326-333.
- ZHULIDOV, A. V., D. A. ZHULIDOV, D. F. PAVLOV, T. F. NALEPA, T. Y. GURTOVAYA, 2005 - Expansion of the invasive bivalve mollusk *Dreissena bugensis* (quagga mussel) in the Don and Volga River Basins: revisions based on archived specimens. *Ecology & Hydrobiology*, 5 (2): 127-133.
- *** 1993 - Multilateral Convention on biological diversity (with anexes). Concluded at Rio de Janeiro on 5 June 1992, United Nations - Treaty Series, Vol. 1760, I-30619, 143-382.

Received: April 7, 2006

Accepted: June 15, 2006

Muzeul Național de Istorie Naturală „Grigore Antipa”

Șos. Kiseleff nr. 1, 011341 București 2, România

e-mail: oppopa@antipa.ro

popaluis@idilis.ro