Aquatic Invasions (2008) Volume 3, Issue 3: 335-340
doi: 10.3391/ai.2008.3.3.9 (Open Access)

Special issue "Invasive Aquatic Molluscs – ICAIS 2007 Conference Papers and Additional Records"
Frances E. Lucy and Thaddeus K. Graczyk (Guest Editors)

Short communication

Rapid expansion of the New Zealand mud snail *Potamopyrgus antipodarum* (Gray, 1843) in the Azov-Black Sea Region

Mikhail O. Son

Odessa Branch Institute of Biology of the Southern Seas, National Academy of Sciences of Ukraine, Odessa, Ukraine
E-mail: michail.son@gmail.com

Received: 18 July 2008 / Accepted: 12 August 2008 / Published online: 5 October 2008

Abstract

This is a brief review of present invasion history of the New Zealand mud snail (*Potamopyrgus antipodarum*) within the Azov-Black Sea Region. The most recent locations of *P. antipodarum* expansion within the Azov-Black Sea Region (lower parts of the Danube, Dniester, and Don basins, small steppe rivers and streams) are described.

Key words: alien species, *Potamopyrgus antipodarum*, molluscs, Azov-Black Sea Region

Potamopyrgus antipodarum (Gray, 1843) was introduced into Europe from New Zealand at the end of the 19th century. It is the most widespread non-indigenous mollusc in the world; its invasive range includes many countries of Europe, Asia, North America, and Australia: in Europe, only Iceland and some eastern countries (Albania, Bulgaria, and former Yugoslavia) have escaped invasion (Ponder 1988; Cianfanelli et al. 2007; Levri et al. 2007).

The first *Potamopyrgus antipodarum* in the Azov-Black Sea Region was found in 1951, simultaneously in two estuarian systems: Razim Lagoon (Grossu 1951) and the Dnieper-Bug Liman (Markovskij 1954). Later, in the twentieth century it was found in some marine and mesohaline localities: the Bug and Berezan estuaries, lagoonal Budakskij Liman (Anistratenko 1998; Chukhchin 1984); however, there was no rapid spread or formation of large colonies until recently. Currently, it is expanding extremely rapidly in both fresh and oligohaline waters. Between 2003 and 2007, *P. antipodarum* was found in many new sites along the coastal line of the Black Sea and Sea of Azov.

Molecular genetic studies on *Potamopyrgus* from some Western European habitats, demonstrated the existence of two strains, both genetically and morphologically different to each other (Jacobsen and Forbes 1997; Städler et al. 2005). They are assumed to have invaded from isolated habitats on the North Island of New Zealand at different periods of time. We reported two distinct lines of *Potamopyrgus* (Figure 1) from the Azov-Black Sea Region (Son 2007a; Son et al. 2008).

A revision of the genus *Potamopyrgus* (Stimpson, 1865) in the native range resulted in the description of four new species out of a total of eight and showed otherwise cryptic species of *Potamopyrgus*, which occur in rivers, lakes and estuaries (Haase 2008).

As conformity between New Zealand *Potamopyrgus* spp. and European clones descripted as *P. jenkinsi* (Smith, 1889), *P. alexenkoae* (Anistra-tenko in Anistratenko and Stadnichenko

Figure 1. Two distinct lines of *Potamopyrgus* from the Azov-Black Sea Region, scale bar = 1 mm (Photo: MO Son).

Table 1. New records of the of the New Zealand mud snail *Potamopyrgus antipodarum* within Azov-Black Sea Region.

Year	Place of record	Region
2003	Stentsovsko-Zhebriyanski Plavni wetland of the Danube Delta and Yalpug Lake	Odessa Region (Ukraine)
2004	Upper part of estuarian reservoir Sukhoj Liman	Odessa Region (Ukraine)
2005	Streams flowing into the Dniester estuary and the shoal of the Dniester estuary, near the mouths of these streams	Odessa Region (Ukraine)
2006	Dalnik River and Akkarzha Stream (basin of estuarian reservoir Sukhoj Liman)	Odessa Region (Ukraine)
2007	Spring stream flowing into the Don River and the shoal in the Don itself near the mouth of this stream, stream in the Botanic Garden of Southern Federal University (Rostov-on-Don)	Rostov Region (Russia)
	Stream flowing into the Sosyk River (basin of estuarian reservoir Sukhoj Liman); steppe stream	Nikolaev Region (Ukraine)
	Kuchurgan Reservoir (estuarian lake near the Dniester Delta used as reservoir-cooler of the Kuchurgan Hydroelectric Power Station)	State border between Odessa Region (Ukraine) and Republic of Moldova (area of unrecognised Pridnestrovian Moldavian Republic)
2008	Baraboj River; small river entering Budakskij Liman, Fontanka River (Sasyk Lake Basin), drainage system of the Odessa City	Odessa Region (Ukraine)

1995), and *P. polistchuki* (Anistratenko 1991) is not yet established, we use *P. antipodarum* as the temporary name.

This paper is based on material collected by the author. Original material is deposited in the mollusk collection of the Odessa Branch Institute of Biology of the Southern Seas (OB IBSS). All collected material was fixed in 70% ethanol. River basins of the Azov and Black sea coasts were investigated annually from 1999 to 2008. Molluscs were sampled using a net or quadrat frame (25x25 cm) on sand and mud and by hand from hard substrates.

From 2003 to 2008, *P. antipodarum* were found in new sites within the Azov-Black Sea Region (Table 1).

Studies on biotopical distribution of *P. antipodarum* in the Azov-Black Sea Region demonstrate that this species prefers ecotones or human-made habitats with low native species richness, where it occurs in high abundance. Records of *P. antipodarum* in non-disturbed streams demonstrate difference in a number of the species in streams and in reservoirs and river channel itself near the mouth of these streams. So, the numbers in the channels of the Don River and Dniester Estuary are lower than those in the streams running into them. Only in the Fontanka River was the species found in high abundance in the main channel. In other non-disturbed habitats, where *P. antipodarum* was found, it was present in low abundance with the exception of the Stentsovsko-Zhebriyanski Plavni wetland, where a number of the snails were observed in marshes and spring pools alternately connected with the sea and with the floodplain (Son 2007b).

In all basins of steep rivers, prone to drought, *P. antipodarum* was found in common man-made habitats in which there is an acceleration of current: aqueducts, artificial rapids, support of bridges, etc. These rheophilic biotopes in small stream were also noted as refugia for other alien species (Son 2007c; Son 2007a), but for *P. antipodarum* these biotopes are the most peculiar. As a rule, stream flow is artificially sped up in these habitats because upstream of the sampling site, the limnic reservoir, which feeds water to the stream via pipework or a river channel is diverted by hydrotechnic constructions (Figure 2). Figure 3 demonstrates various natural (A, C) and man-made (B, D) habitats where *P. antipodarum* occurs in high abundance.

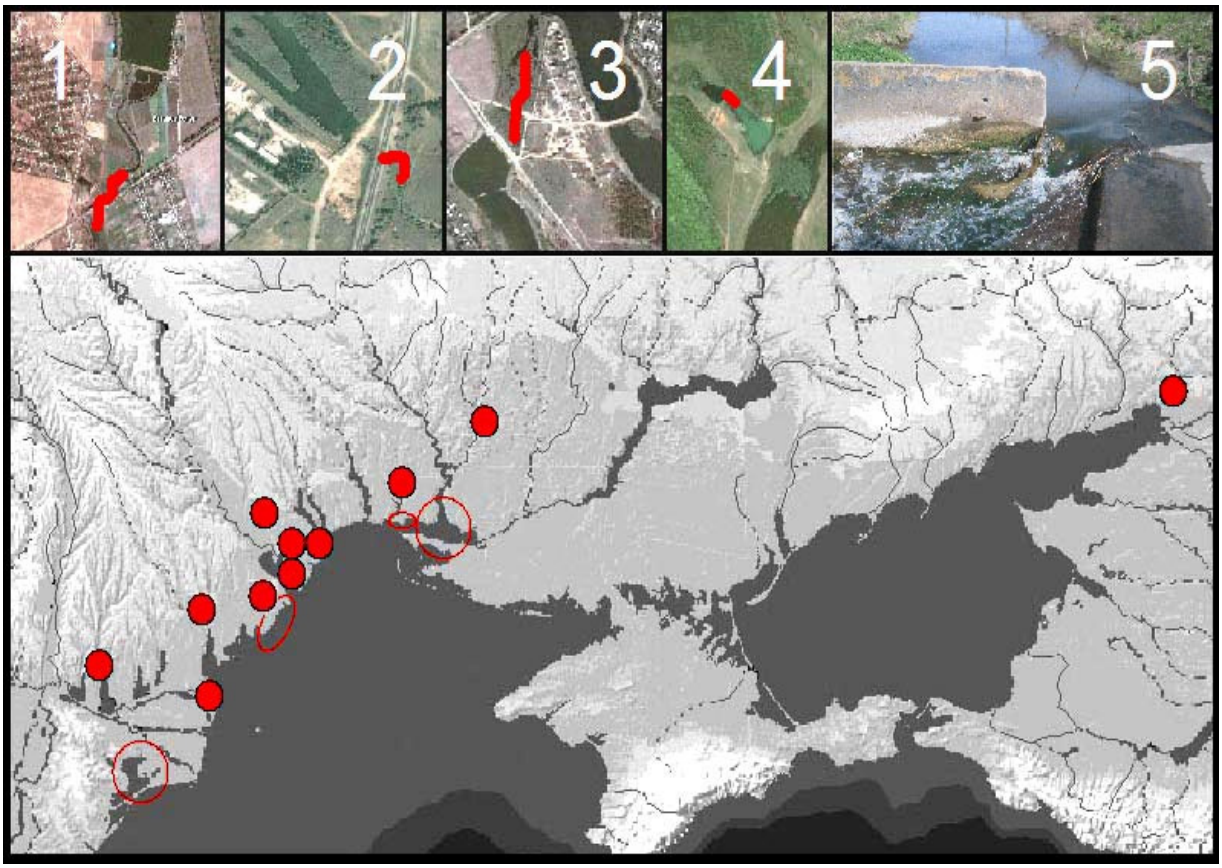

Figure 2. Records of *Potamopyrgus antipodarum* in the Azov-Black Sea Region (circles – in the XX and rings – in the XXI century) and satellite shots of human-made rheophilic biotopes – refugia for species in steep drought rivers: Baraboj River (1); Sukhoj Liman Basin (2, 3); Sosyk River Basin (4); example of the human-made construction on the Baraboj River (5) (Photo: M.O. Son).

As the region considered in this study contains many aquatic habitats isolated from the sea and large waterways and since it is within a range of active animal migration, it is likely that a biotic pathway is involved in the spread of this species. In Northern Europe, it has been shown, that birds mostly transport this snail (Lassen 1978). Significant concurrence of its spread in the Azov-Black Sea Region with a corridor of birds' migrations "Via Pontica" allows us to assume this pathway is the basic one operating here again. The transfer of this parthenogenetic species by birds is usually successful because only one female is required to start a population in an isolated water body.

Taking into account the rapid expansion of the species and its wide ecological tolerance, it is expected that in the near future it will occupy the majority of small rivers and streams in the region. In this regard it is necessary to discuss the possible ecological consequences of its invasion.

Effects of *P. antipodarum* can include indirect effects on the trophic dynamics of an ecosystem. In experiments investigating the relationship between *P. antipodarum* and benthic fauna, invader densities were positively correlated with the total number of native taxa, as well as with total densities (Schreiber et al. 2002). On the other hand, local aquatic ecosystems of streams and little rivers usually have not got native species similar to *P.antipodarum*, so that effects caused by consequent changes in community structure can have unpredictable ecological consequences. In addition, *P. antipodarum* can play a role in the transmission of

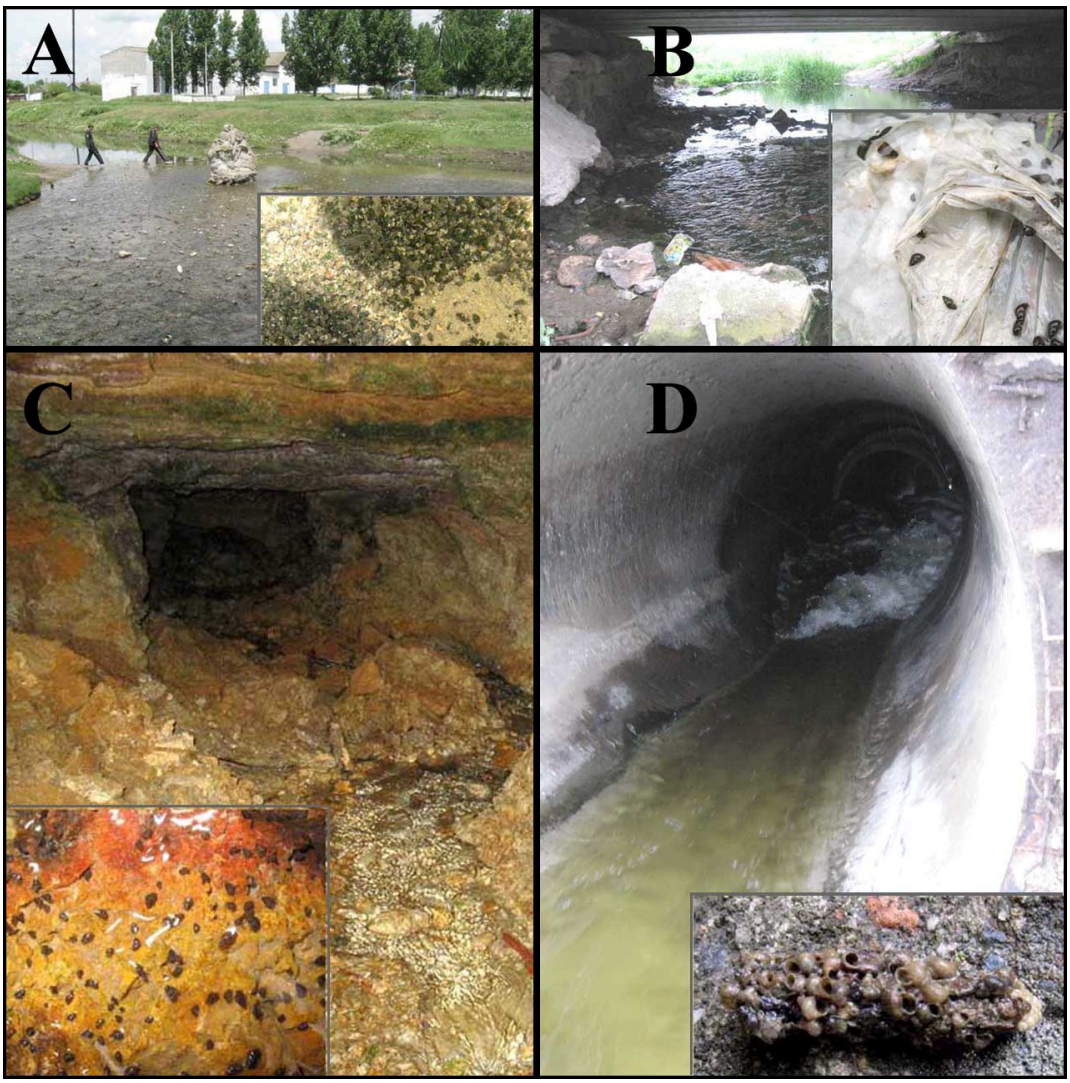

Figure 3. Various habitats of *Potamopyrgus antipodarum* (see Annex 1) (Photo: M.O. Son).

trematode parasites (Morley 2008), which indicates the necessesity for parasitology research of this species and further accounts of its expansion for the purpose of parasitological monitoring.

Acknowledgements

We are grateful to Frances Lucy (Institute of Technology Sligo, Ireland) for English editing and valuable comments that improved the manuscript. This work was partly supported by the European Commission 6th Framework Program Integrated Project ALARM (contract GOCE-CT-2003-506675).

References

Anistratenko VV (1998) Handbook for identification of Pectinibranch gastropods of the Ukrainian fauna Part 1 Marine and brackishwater. *Vestnik Zoologii* Suppl 8: 3-65

Chukhchin VD (1984) Ecology of gastropods of the Black Sea. Naukova Dumka, Kiev, 176 pp

Cianfanelli S, Lori E, Bodon M (2007) Alien freshwater molluscs in Italy and their distribution. In: Gherardi F (ed), Biological invaders in inland waters: profiles, distribution, and threats. Springer, Dordrecht, The Netherlands, pp 103-121, http://dx.doi.org/10.1007/978-1-4020-6029-8_5

Grossu AV (1951) *Potamopyrgus jenkinsi*, gastropod nou pentru apele continentale ale Republicii Populare Romine. *Communculare Academii Republicii Populare Romîne* 1(7): 593-596

Haase M (2008) The radiation of hydrobiid gastropods in New Zealand: a revision including the description of new species based on morphology and mtDNA sequence information. *Systematics and Biodiversity* 6(1): 99-159, http://dx.doi.org/10.1017/S1477200007002630

Jacobsen R, Forbes VE (1997) Clonal variation in life-history traits and feeding rates in the gastropod, *Potamopyrgus antipodarum*: performance across a salinity gradient. *Functional Ecology* 11: 260-267, http://dx.doi.org/10.1046/j.1365-2435.1997.00082.x

Lassen HH (1978) *Potamopyrgus jenkinsi* in Jutland. Distribution, dispersal, and colonization. *Fauna og Flora* 84: 73-79

Levri EP, Kelly AA, Love E (2007) The invasive New Zealand mud snail (*Potamopyrgus antipodarum*) in Lake Erie. *Journal of Great Lakes Research* 33: 1-6, http://dx.doi.org/10.3394/0380-1330(2007)33[1:TINZMS]2.0.CO;2

Markovskij YuM (1954) Invertebrate fauna of the lower reaches of Ukrainian rivers, its environmental conditions and possibilities of its use, part 2: The Dnieper–Bug Estuary. Akad. Nauk USSR, Kiev, 207 pp

Morley NJ (2008) The role of the invasive snail *Potamopyrgus antipodarum* in the transmission of trematode parasites in Europe and its implications for ecotoxicological studies. *Aquatic Sciences – Research Across Boundaries* 70: 107-114

Ponder WF (1988) *Potamopyrgus antipodarum* – a molluscan coloniser of Europe and Australia. *Journal of Molluscan Studies* 54: 271-285, http://dx.doi.org/10.1093/mollus/54.3.271

Schreiber ESG, Lake PS, Quinn GP (2002) Facilitation of native stream fauna by an invading species? Experimental investigations of the interaction of the snail, *Potamopyrgus antipodarum* (Hydrobiidae) with native benthic fauna. *Biological Invasions* 4: 317-325, http://dx.doi.org/10.1023/A:1020925022843

Son MO (2007a) Invasive molluscs in fresh and brackish waters of the Northern Black Sea Region. Druk Press, Odessa, 132 pp

Son MO (2007b) Invasive mollusks (Mollusca, Bivalvia, Gastropoda) in the Danube Delta. *Vestnik zoologii* 41(3): 213-218

Son MO (2007c) Native range of the zebra mussel and quagga mussel and new data on their invasions within the Ponto-Caspian Region. *Aquatic Invasions* 2: 174-184, http://dx.doi.org/10.3391/ai.2007.2.3.4

Son MO, Nabozhenko MV, Shokhin IV (2008) The Don River Basin is a new stage of expansion of *Potamopyrgus jenkinsi* (Smith, 1889) (Gastropoda, Hydrobioidea) in Europe. *Doklady Biological Sciences* 419: 129-130, http://dx.doi.org/10.1134/S0012496608020178

Städler T, Frye M, Neiman M, Lively CM (2005) Mitochondrial haplotypes and the New Zealand origin of clonal European *Potamopyrgus*, an invasive aquatic snail. *Molecular Ecology* 14: 2465-2473, http://dx.doi.org/10.1111/j.1365-294X.2005.02603.x

Annex 1. New records of *Potamopyrgus antipodarum* (Gray, 1843) in the Azov-Black Sea Region.

Location	Record coordinates		Date of record	Abundance	Collector
	Latitude,°N	Longitude,°E			
Yalpug Lake	45°29'59"	28°39'19"	05.05.2003	5 snails	M. O. Son
Kuchurgan Reservoir. Site 1	46°35'27"	29°59'19"	10.05.2007	11 empty shells was found	M. O. Son
Kuchurgan Reservoir. Site 2	46°39'08"	29°57'33"	17.05.2008	1 living snail and many empty shells was found	M. O. Son
Steppe stream in the Nikolaev Region (including underground site of a channel)	47°11'14"	32°16'41"	08.07.2007	not estimated	M. O. Son
Baraboj River	46°17'42"	30°30'09"	22.03.2008	not estimated	M. O. Son
Stream flowing into the Sosyk River	46°49'39"	31°25'27"	14.07.2007	2 living snail and many empty shells was found	M. O. Son
Stentsovsko-Zhebriyanski Plavni wetland of the Danube Delta	45°30'02"	29°37'24"	29.04.2003	not estimated	M. O. Son
Dniester estuary	46°15'34"	30°25'00"	27.10.2005, 26.04.06*, 29.03.07, 16.03.2008	80 ind. m^2**	M. O. Son
Don River	47°12'22"	39°41'42"	07.06.2007	20 ind. m^2	M. O. Son
Stream flowing into the Dniester estuary (including underground sites of the channels) (Figure 3-C)	46°15'34"	30°25'00"	16.04.2005, 27.04.05, 27.10.05, 26.04.06*, 29.03.07, 16.03.2008	6300 ind. m^2	M. O. Son
Stream flowing into the Don River	47°12'23"	39°41'35"	07.06.2007	2000 ind. m^2** (Son et al. 2008)	M. O. Son
Small river entering to Budakskij Liman	46°03'59"	30°21'21"	06.05.2008	1 snail found	M. O. Son
Fontanka River (Sasyk Lake Basin) (Figure 3-A)	45°49'57"	29°36'55"	06.05.2008	550000 ind. m^2**	M. O. Son
Upper part of estuarian reservoir Sukhoj Liman	46°23'19"	30°38'31"	31.05.05, 06.07.06, 06.05.08*	not estimated	M. O. Son
Dalnik River	46°24'11"	30°35'33"	29.04.06, 08.05.06, 06.05.2008*	278 ind. m^2	M. O. Son
Akkarzha Stream. Site 1 (Figure 3-B)	46°20'48"	30°34'51"	03.05.2008	4600 ind. m^2**	M. O. Son
Akkarzha Stream. Site 2 (Figure 3-D)	46°20'51"	30°35'43"	03.05.2008, 18.07.2006	not estimated	M. O. Son
Akkarzha Stream. Site 3	46°20'53"	30°35'43"	03.05.2008	40 ind. m^2	M. O. Son
Akkarzha Stream. Site 4	46°21'07"	30°35'52"	03.05.2008	not estimated	M. O. Son
Drainage canal entering into the Odessa Buy	46°27'05"	30°46'07"	14.07.2008	114 ind. m^2	M. O. Son

* data of estimated sample.
** places of a congestion of the species in cases of the mosaic distribution (connected with aggregation of the snails on the hard substrate).