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Distribution and spread of spiny-cheek crayfish *Orconectes limosus* (Rafinesque, 1817) in Belarus

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Abstract

The spiny-cheek crayfish *Orconectes limosus* was registered for the first time in the Neman River and its tributaries, in the Grodno region, Belarus in 1997. The crayfish spread upstream from Grodno over the next 14 years, migrating 177 km along the course of the Neman River. Today spiny-cheek crayfish are recorded in 8 rivers including the Neman, Narew and Western Bug basins. We never found native crayfish species together with spiny-cheek crayfish during our surveys, which may indicate replacement of native species by invasive *O. limosus* in the studied area.

Key words: Belarus; alien species; spiny-cheek crayfish; spread rate

Introduction

The spiny-cheek crayfish, *Orconectes limosus* (Rafinesque, 1817) is native to North America, and widely distributed throughout Atlantic watersheds (Hamr 2002). *O. limosus* was introduced to Europe in 1890 and is recorded now from 21 countries, including countries neighboring Belarus, such as Poland and Lithuania (Holdich et al. 2006; Holdich and Black 2007). This invasive species is currently found in all types of freshwater bodies all over Poland (Ďuriš 1999; Strużyżski and Śmietana 1999), and is also widespread in Lithuania, which lies adjacent to the third largest river in Belarus, the Neman (Arbačiauskas et al. 2011). *Orconectes limosus* was first recorded in Belarus in 1997, most likely as a canal-mediated invasion from Poland (Alekhnovich et al. 1999).

O. limosus is host to the oomycete *Aphanomyces astaci* (Schikora, 1906), i.e. the causative agent of crayfish plague. This water mold disease is probably the most significant reason for the decline of the European freshwater crayfish species *Astacus astacus* (Linnaeus, 1758), *Austropotamobius torrentium* (Shrank, 1803), *Austropotamobius pallipes* (Leroboullet, 1858) (Holdich 2002). There are two native species of crayfish in the waters of Belarus, namely the noble crayfish *A. astacus*, which has been a protected species for more than 30 years in the Republic of Belarus and listed as a "Vulnerable Species" on the IUCN Red List of Threatened species, and the more prolific and widespread, narrow-clawed crayfish *Astacus leptodactylus* (Eschscholtz, 1823), which is listed as a species of "Least Concern" on the IUCN Red List. The invasion of *O. limosus* represents a serious threat to both these native crayfish species.

The purpose of this paper is to review the invasion history of *O. limosus* in Belarus, and provide preliminary estimates of negative ecological impacts of this invasion.

Material and methods

The distribution and spread of *Orconectes limosus* in the Neman River, Narew River and the Western Bug River was analyzed during the period 1997–2011 using both unpublished and published data (Appendix 1). During most of these surveys, crayfish were collected by a hand net (30×40 cm, mesh size 5 mm) and a special

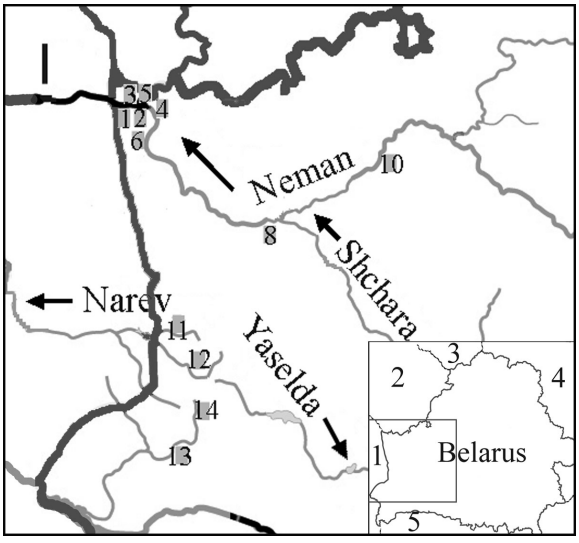

Figure 1. Distribution of *Orconectes limosus* in Belarus (Appendix 1 outlines key to sites). Numbers in the insert: 1 – Poland, 2 – Lithuania, 3 – Latvia, 4 – Russia, 5 – Ukraine. Arrows show the watercourse direction.

trap net (30×90 cm, mesh size 35 cm, inlet diameter 35 cm). To estimate crayfish abundance per m^2, a 30 m stretch along the river banks was searched for crayfish with hand nets.

Results and discussion

The first records of spiny-cheek crayfish from the Neman River and some left tributaries (Shlyamitsa, Mariha and Chernaya Gancha rivers and the Augustów Canal) were made in 1997 near Grodno city (Alekhnovich et al. 1999). It is believed that spiny-cheek crayfish appeared in these waters in the beginning of 1980s. Elevated and well established population densities near Grodno city and further downstream (up to 20 km), well as reports from officers of the Natural Resources and Environment Protection Agency confirm their long-term presence in the Neman River (Alekhnovich et al. 1999) (Figure 1, Appendix 1: Sites 1–6).

The invasion of the spiny-cheek crayfish into Belarus most likely occurred via the Biebrza River in Poland (tributary of the Narew River). This river is directly connected to the Augustów Canal by a tributary, the Rospuda River. Spiny-cheek crayfish were discovered for the first time near the confluence of the Narew and Bierbrza Rivers in Poland in 1970 (Kossacowski 1974). The crayfish used the Narew watercourse to expand its distribution from the Mazurian Lakeland. Spiny-cheek crayfish were discovered in a canal on the territory of Gizychko city in 1946, from where it spread into nearby lakes. It was observed in lakes near Mikolaika city in 1972 (Kossakowski and Orzechowski 1974). From the numerous Mazurian lakes, spiny-cheek crayfish were able to colonize the Narew River, e.g. via the Pisa River (which flows from the largest lake in Poland, namely Śniardwy Lake). The establishment of the crayfish in the Narew River system enabled further expansion into the southern regions of Poland, through the Western Bug River. These rivers merge near Warsaw. Research carried out in 1973 by the Inland Fisheries Institute (Olsztyn) showed that *O. limosus* was not observed in the southern reaches of the Narew River at that time (Kossakowski and Orzechowski 1974). The Shlyamitsa and Mariha rivers are tributaries of the larger Chernaya Gancha River which is part of the Augustów Canal (Figure 1) that flows into the Neman River. The Augustów Canal connects the Neman River, in Belarus with tributaries of the Narew River, Poland. The distance from the confluence of the Rospuda and Biebrza Rivers with part of the Augustów Canal in Belarus is approx. 90 km long. Over a period of approx. 12 years *O. limosus* conquered and colonized this distance.

Until the end of the twentieth century crayfish were not found upstream of Grodno (Figure 1, Appendix 1, Sites 1, 2, 3, 4 and 6). In 2010, spiny-cheek crayfish were found in the Neman River, 84 km upstream from Grodno (Site 8). In 2011, the species was observed a further 93 km upstream (Site 10, Figure 2). The distance from the southern site at Grodno, registered in 1997 (Site 6), to the most northerly site, (Site 10) in 2011, is 177 km. *O. limosus* overcame this distance at an average rate of 12.6 km per year.

In the early 21st century, spiny-cheek crayfish were registered in the Narew and Western Bug river basins. In 2006, *O. limosus* was found in the Narewka River (Site 11), and the Kolonna River (Site 12) in the National Park "Belavezhskiaya pushcha" in Belarus. In 1970, the crayfish was noticed in the Narew River (tributary of the Western Bug) in Polish territory (Kossakowski 1974). In 2009 some individuals were caught in the upper part of Lesnaya Levaya River (Site 13), Western Bug basin (Baitchorov and Giginiak 2009). Investigations in 2011 show that spiny-cheek crayfish were distributed throughout the Lesnaya Levaya River (Site 14).

Figure 2. Crayfish caught at Site 10 (Figure 1, Appendix 1), Neman River (Photo AV Alechnovich, VI Razlutskij).

Spiny-cheek crayfish adapt to different environmental conditions over a wide geographical range and may occur in very different types of water bodies (Hamr 2002; Holdich 2002; Holdich et al. 2006). According to our data, numerous well established populations inhabit Belarus, adapting to conditions in the Augustów Canal (Figure 1, Appendix 1, Site 4) and river conditions at Grodno (Site 6). Crayfish colonize muddy substrates with macrophyte beds (*Elodea canadensis* and *Potamogeton* spp.) where populations are abundant at the latter site, while populations of crayfish also exist on hard substrates without shelter in the Augustów Canal. However, during migration activity in autumn, crayfish colonize many different substrates types. Unlike European crayfishes, some populations of spiny-cheek crayfish mate twice a year in autumn and spring (for the review Holdich and Black 2007), but lay eggs only after the spring mating (Hamr 2002; Kozák et al. 2007). Populations mating in the autumn are recorded in Poland (Piesik 1974; Smietana, pers. com. 2006 from Holdich and Black 2007) and in the Czech Republic (P Kozák, pers. com. 2006; A Petrusek, pers. com. 2006 from Holdich and Black 2007). It is likely therefore, that the population of *O. limosus* in Belorussian Shlyamitsa River is mating twice a year.

The habitats of both spiny-cheek and narrow-clawed crayfish *A. leptodactylus* are known to overlap (Schulz and Smietana 2001), but both species were never caught at the same site during this research in Belarus. In some lakes in south-west Belarus, where *A. leptodactylus* were once very well established in large numbers, a catastrophic population decline was observed. Some years later crayfish reappeared, but populations never recovered to their original number. A similar shift in population dynamics is evident where crayfish plague exists (Harlioğlu and Harlioğlu 2006).

Native species are presumably supplanted by spiny-cheek crayfish (Schulz and Smietana 2001). *O. limosus* may outcompete native crayfish even in the absence of the crayfish plague agent because it has many features that enhance its survival, giving it an advantage over native species. It is able to endure heavy pollution and low oxygen concentrations (Holdich et al. 2006); it has a rapid population growth, which is associated with a high somatic growth rate (Kozak et al. 2007), early puberty (Holdich et al. 2006) and high fecundity (Smith 1981; Ďuriš et al. 2006). These characteristic features are associated with high nocturnal and diurnal activity (Lozan 2000; Musil et al. 2010).

This research shows that spiny-cheek crayfish is an active invader, rapidly spreading in Belarus. This invasion may result in severe adverse impact and consequences for the native crayfish species.

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Supplementary material

The following supplementary material is available for this article:

Appendix 1. Records of *Orconectes limosus* in Belarus in 1997–2011.

Appendix 1. Records of *Orconectes limosus* in Belarus in 1997–2011.

Site No. (Map Ref.)	Location	Record Coordinates		Date of Record	Biotope	Number of Collected Individuals	Collector
		Latitude, °N	Longitude, °E				
1	Shlyamitsa River (basin of Neman River)	53°55'002	23°36'508	October 1997,	Sand substrate, depth 1.0 m	300	Alekhnovich et al. 1999
2	Chernaya Gancha River (basin of Neman River)	53°54'036	23°45'363	October 1997	Silty sand substrate, aquatic vegetation, depth 1.5m	19	Alekhnovich et al. 1999
3	Mariha River (basin of Neman River)	53°56'148	23°35'148	October 1997	Sandy substrate, depth 0.6m	7	Alekhnovich et al. 1999
4	Neman River (Demidkovo village, oxbow)	53°53'473	23°45'528	October 1997	Silty sand substrate, aquatic vegetation, depth 2.5m	16	Alekhnovich et al. 1999
5	Augustów Canal	53°53'473	23°45'273	September 2011	Muddy bottom, numerous aquatic vegetation	28	Alekhnovich and Razlutskij
6	Neman River (Grodno city)	53°40'767	23°46'474	August 2010	Silty sand substrate, numerous aquatic vegetation, depth 0.6m	21	Razlutskij
7	Neman River (Grodno city)	53°40'767	23°46'474	November 2011	Silty sand substrate, numerous, aquatic vegetation, depth 0.6m	18	Alekhnovich and Razlutskij
8	Neman River (Mosti city)	53°25'811	24°41'007	July 2010	Silty sand substrate, aquatic vegetation depth 0.7m	8	Razlutskij
9	Neman River (Mosti city)	53°25'811	24°41'007	November 2011	Silty sand substrate, aquatic vegetation, depth 0.7m	12	Alekhnovich and Razlutskij
10	Neman River (Berezovka city)	53°42'440	25°27'295	September 2011	Sand and stone substrate depth 1.5m	1	Alekhnovich and Razlutskij
11	Narewka River (basin of Narew River)	52°45'012	23°48'407	July2003	Silty sand substrate, aquatic vegetation, depth 0.5m	25	Baitchorov and Giginiak, 2009
12	Kolonna River (basin of Narew River)	53°54'536	23°57'550	May 2006	Silty sand substrate, aquatic vegetation, depth 0.5m	15	Baitchorov and Giginiak, 2009
13	Lesnaya Levaya River, (basin of Western Bug River).	52°26'213	23°55'068	May 2009	Silty sand substrate, aquatic vegetation, depth 0.5m	10	Baitchorov and Giginiak, 2009
14	Lesnaya Levaya River, (basin of Western Bug River).	52°33'573	24°13'382	September 2011	Silty sand substrate, aquatic vegetation, depth 0.4m	29	Alekhnovich and Razlutskij