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Short Communication

The distribution of the invasive New Zealand mud snail (*Potamopyrgus antipodarum*) in streams in the Lake Ontario and Lake Erie watersheds

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Abstract

The invasive New Zealand mudsnail, *Potamopyrgus antipodarum*, is a small freshwater hydrobiid snail with populations in western US rivers and streams and in the Laurentian Great Lakes. The snail has had established populations in the Great Lakes since at least 1991 and in one stream emptying into Lake Ontario since at least 2007. This study's purpose was to broadly survey streams and rivers emptying into Lakes Ontario and Erie to determine the extent of the species' lotic invasion in the Eastern US. In the summer of 2011, over 100 sites were sampled from the Niagara River, NY to Oswego, NY along Lake Ontario and over 80 sites from Buffalo, NY to the Pennsylvania-Ohio State line along Lake Erie. At each site, general observations of the stream were made and the organisms living in the stream were surveyed for the presence of New Zealand mud snails. *Potamopyrgus* was found at the site of original discovery and at one additional location along Lake Ontario. In addition an unusual snail was discovered that was a hybrid between a native species (*Pleurocera livescens*) and an invasive (*Pleurocera virginica*). This hybrid was extremely abundant in several locations and may be invasive.

Key words: *Potamopyrgus antipodarum*; *Pleurocera livescens; Pleurocera virginica*; hybrid; invasive; Great Lakes

Introduction

The New Zealand mudsnail, *Potampyrgus antipodarum* (J.E. Gray, 1843) (Figure 1), is a small freshwater hydrobiid snail with introduced populations in western US and far western Canadian rivers and streams and in the Laurentian Great Lakes (Proctor et al. 2007; Davidson et al. 2008). The snail is invasive in that it has established self-sustaining populations and its geographic distribution is expanding. In its invaded range, the snail is composed of asexual clones with at least three different clones in the western U.S. and at least one in the Laurentian Great Lakes (Proctor et al. 2007; Dybdahl and Drown 2011). The dominant clone in the Great Lakes is the same as one of the three clones found in Europe, suggesting that it was introduced via international shipping, likely through ballast water (Zaranko et al. 1997; Proctor et al. 2007).

In the Great Lakes region the snail had only been found in the Great Lakes themselves usually in relatively deep water (> 4 m) in Lakes Ontario (Zaranko et al. 1997; Levri et al. 2008) and Erie (Levri et al. 2007) as well as in Lakes Superior and Michigan. In 2007, however, one population of the snail was discovered in a small stream in upstate NY near Lake Ontario (Levri and Jacoby 2008). While it is unclear what the ecological consequences are of the presence of the snail in the Laurentian Great Lakes (Levri et al. 2008), the spread of this species into streams and rivers could result in substantial ecological problems including altering the nitrogen and carbon cycles (Hall et al. 2003), outcompeting native grazers (Kerans et al. 2005; Riley et al. 2008), dominating secondary production (Hall et al. 2006), and negatively influencing higher trophic levels (Vinson and Baker 2008; Bruce and Moffitt 2010). In this study we report on surveys of streams emptying into Lakes Ontario and Erie from 2008 and 2011 to determine if the snail has expanded its invaded range since its discovery in a New York stream in 2007.

Material and methods

Streams were sampled wherever accessible along Lake Ontario from the Niagara River to Oswego, NY and from Buffalo, NY to the Ohio-Pennsylvania border along Lake Erie. We attempted to sample each stream at two different locations, usually where roadways crossed the stream. Along Lake Ontario, we sampled 106 sites (Figure 2), and along Lake Erie, 80 sites were sampled (Figure 3). Samples were taken using dip nets and hand sampling for fifteen minutes at each site during June and July of 2008 and 2011. Samples were taken of any gastropod found. At each site, conductivity, pH, temperature, flow, and an estimate of tree cover were measured.

Results

Potamopyrgus antipodarum was found at two sites during the 2011 survey (O1 and O29). The O29 site represents a new location for *P. antipodarum* as it was not found there in 2008. The finding of the snail at this new location indicates that it may be slowly expanding its range (Figure 2). In addition, an unknown type of snail was found at several sites along Lake Ontario (Figure 4). After sending a sample of the unknown snails to Dr. Robert Dillon of the College of Charleston, the unknown snail was determined by morphological analysis to be a hybrid between the native *Pleurocera livescens* (Menke, 1830) (previously *Elimia livescens*) and the invasive *Pleurocera virginica* (Say, 1817) (previously *Elimia virginica*) (Bianchi et al. 1994). The hybrid is similar in appearance to *Potamopyrgus* when a juvenile (Figure 1). Neither *P. antipodarum* nor the hybrid was found in Lake Erie streams (Figure 3).

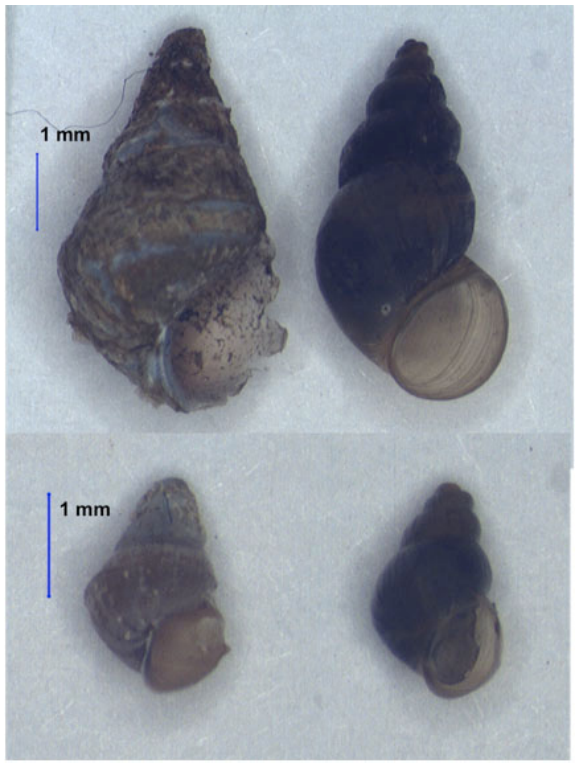

Figure 1. The *Pleurocera livescens* × *Pleurocera virginica* hybrid snails (left) are similar in appearance to *Potamopyrgus antipodarum* (right). The *P. antipodarum* on top is an adult and is next to a juvenile hybrid; on the bottom are juveniles of both species. The. hybrid can attain adult lengths of greater than 10 mm. Photograph by Ed Levri.

Discussion

Potamopyrgus antipodarum was originally found in New York streams in a small, unnamed stream near the Niagara River in Niagara County in far western New York state (Levri and Jacoby 2008). The second location reported here is from Fish Creek at 43°21'37.26"N; 78°33'21.30"W also in Niagara County. Since the new location is some distance (approximately 39 km) from the original stream, it is very possible that the snail came from Lake Ontario rather than being dispersed from the stream where it was first found. It is possible that sampling was not thorough enough at other sites and that *P. antipodarum* is spreading into Lake Ontario's and Erie's tributaries more than we detected, as low density populations would be difficult to detect. In the one new stream where *P. antipodarum* was found, we did not detect it at a downstream site or a site further upstream.

The hybrid that was discovered has been found before in streams associated with the Erie Canal (Bianchi et al 1994), and our sites represent new locations for the snail. Since the hybrid looks similar to *P. antipodarum* when it is small (Figure 4), it could cause confusion about the distribution of both. The hybrid is a genetic mixture of the native *Pleurocera livescens* and the invasive *Pleurocera virginica* (Bianchi et al 1994). *P. virginica* was able to spread into the region due to the connection of the Hudson River

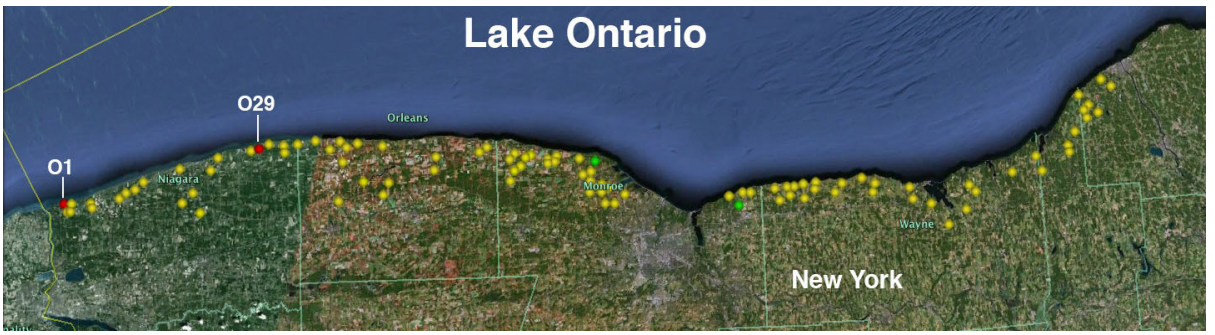

Figure 2. The known distribution of the New Zealand mud snail in streams along Lake Ontario. Red dots indicate sites where *Potamopyrgus antipodarum* was found, yellow dots indicate locations where *P. antipodarum* was not found, and green dots indicate sites where the snail was not found in 2008 but were not able to be sampled in 2011.

Figure 3. Sampled sites along Lake Erie. Neither *Potamopyrgus antipodarum* nor the *Pleurocera livescens* × *Pleurocera virginica* hybrid was found at any of the Lake Erie stream sites.

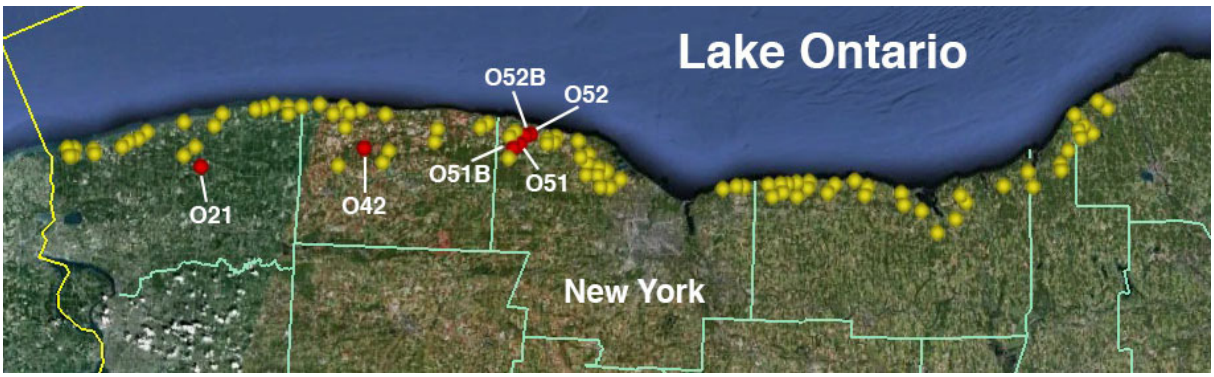

Figure 4. The known distribution of the *Pleurocera livescens* × *Pleurocera virginica* hybrid in streams along Lake Ontario. Red dots indicate sites where the hybrid was found, and yellow dots indicate locations where the hybrid was not found.

watershed to the Great Lakes watershed by the Erie Canal. All sites where the hybrid has been noticed previously, have been in waterways connected to the Erie Canal. The locations where the hybrid was discovered in this study are also in streams that have connections to the canal, but the hybrid has spread to regions very close to Lake Ontario. Thus it appears that the hybrid zone between these two species is widening. It is very possible that the hybrid itself is invasive, and it should be monitored.

The expansion of the geographic range of *P. antipodarum* in lotic systems is, so far, much slower in the Great Lake region than in the western US, where the snail expanded from one location in the Snake River in Idaho to all western US states (except for New Mexico) within 20 years (Proctor et al. 2007). However, the relative slow rate of expansion in Great Lakes watershed streams may be due to the characteristics of the stream where it was first found. The original small stream is not easily accessible and is not one that would attract recreational water users. The detection of the New Zealand mud snail in this new location in Fish Creek is significant because, this stream, unlike the stream where the snail was first discovered, is easily accessible by the public and may be used by recreational fishermen. The dispersal of the snail in the western US from one watershed to another was largely facilitated by recreational water users (Proctor et al. 2007). *P. antipodarum* can withstand being out of water for days at a time if kept moist, and, due to its small size, is likely to get caught in clothing, footwear, or gear and not be noticed. This coupled with the fact that the snail is parthenogenetic in its invaded ranges means that only one snail is required to start a new population. Because of its substantial influence on the ecology of streams in the western US and Australia, it is important that the spread and impact of this species be monitored in the Great Lakes region.

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Appendix 1. Records of the presence of *Potamopyrgus antipodarum* in streams emptying into Lake Ontario. Numbers refer to sites shown in Figure 2.

Record No. (map ref.)	Location	Record coordinates		Record date	Other Gastropod Species Found	Reference
		Latitude	Longitude			
O1	Unnamed Stream, Site O1	43°16'16.14"N	79° 1'15.06"W	June 2007	*Fossaria modicella* *Physa gyrina*	Levri and Jacoby 2008 and present study
O29	Fish Creek, Site O29	43°21'37.26"N	78°33'21.30"W	July 2011	*Helisoma trivolvis* *Gyraulus parvus* *Fossaria modicella*	Present study

Appendix 2. Records of the presence of the *Pleurocera livescens* × *Pleurocera virginica* hybrid in streams emptying into Lake Ontario. Numbers refer to sites shown in Figure 4.

Record No. (map ref.)	Location	Record coordinates		Record date	Other Gastropod Species Found	Reference
		Latitude	Longitude			
O21	Eighteen Mile Creek	43°15'9.48"N	78°41'52.98"W	July 2011	*Physa gyrina*	Present study
O42	Orchard River	43°18'2.10"N	78°18'38.34"W	July 2011	*Physa gyrina* *Pleurocera livescens*	Present study
O51	Sandy Creek	43°19'15.72"N	77°56'22.56"W	July 2011	*Physa gyrina* *Fossaria modicella* *Pleurocera livescens*	Present study
O51B	Sandy Creek	43°18'49.02"N	77°57'17.04"W	July 2011	*Pleurocera livescens*	Present study
O52	Sandy Creek	43°20'20.88"N	77°54'54.78"W	July 2011	*Physa gyrina* *Pleurocera livescens* *Fossaria modicella* *Valvata* sp.	Present study
O52B	Sandy Creek	43°20'8.40"N	77°55'40.20"W	July 2011	*Physa gyrina* *Pleurocera livescens* *Valvata* sp.	Present study