

## The Invasive New Zealand Mud Snail (*Potamopyrgus antipodarum*) in Lake Erie

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**ABSTRACT.** *The New Zealand mud snail (Potamopyrgus antipodarum) is an invasive species in Europe, Japan, Australia, and North America. In the western United States it is a species of special concern where population densities in some rivers and streams are very large (~300,000 per m<sup>2</sup>) and considerable ecological effects of its presence have been reported. Much less about the effects of this species is known in the Great Lakes, where the snail was found in Lake Ontario and the St. Lawrence River in 1991. Here we report the occurrence of the snail in Lake Erie. Two P. antipodarum were collected in 18 m deep water (sampling range 5–18 m) in Lake Erie off shore of Presque Isle State Park near Erie, Pennsylvania in the summer of 2005 and others were collected off of Sturgeon Point in Lake Erie (sampling range 5–20 m) south of Buffalo, NY and in the central basin of Lake Erie (18 m) in 2006. This finding demonstrates that this species continues to expand its range in the Great Lakes. The range expansion increases the likelihood that it may become established in rivers and streams emptying into the Great Lakes where higher densities and greater ecological damage may result.*

**INDEX WORDS:** *Potamopyrgus antipodarum, Lake Erie, invasive, exotic, New Zealand mud snail, Hydrobiidae.*

### INTRODUCTION

The New Zealand mud snail, *Potamopyrgus antipodarum*, Gray, is a freshwater hydrobiid common to lakes and streams throughout New Zealand where it is endemic (Winterbourn 1970). In the past 150 years, *P. antipodarum* has become widespread with invasive populations established in Great Britain (Wallace 1985), mainland Europe, Australia (Ponder 1988), and Japan (e.g., Shimada and Urabe 2003). At least two separate populations have become established in North America. A population was discovered in the Snake River in Idaho and Wyoming in 1987 and has since spread rapidly into many watersheds in the western United States (Taylor 1987, Bowler 1991, Richards 2002). A second population was discovered in Lake Ontario and the St. Lawrence River in 1991 (Zaranko *et al.* 1997). The most likely mechanism of introduction in the Laurentian Great Lakes is via international shipping. In the western U.S. it has been hypothesized

that introduction occurred by stocking fish from overseas (Bowler 1991).

In Lake Ontario, the population seemed to be confined initially to the northeast and southwest portions of the lake (Zaranko *et al.* 1997). Since the study by Zaranko *et al.* (1997), the snail has been found in other locations in Lake Ontario (D. Zaranko, pers. comm., R. Dermott, pers. comm., Levri in prep.) and in two locations in Lake Superior (Grigorovich *et al.* 2003, Grigorovich pers. comm.). The ecological and economic effects of *Potamopyrgus* in the Great Lakes are not known. Densities in Lake Ontario have been reported to be as high as 5,600 individuals m<sup>-2</sup> (Zaranko *et al.* 1997); however these densities appear to be at least an order of magnitude lower compared to those in the native range and in other introduced populations. For example, in the western United States, where *Potamopyrgus* has established itself in several major river systems and is spreading rapidly, densities have been found to exceed 299,000 individuals m<sup>-2</sup> (Kerans *et al.* 2005). In Yellowstone National Park, the snail has been demonstrated to

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**TABLE 1.** Location of sampling sites in Lake Erie and number of *Potamopyrgus* collected. Sites in east central basin (near Erie, PA) were sampled in June 2005, while sites in the eastern basin (near Sturgeon Point, NY) and west central basin (near Put-in-Bay, OH) were sampled in June 2006. Samples could not be obtained at four sites in the eastern basin because of a hard bottom. EB = eastern basin, ECB = eastern central basin, WCB = west central basin.

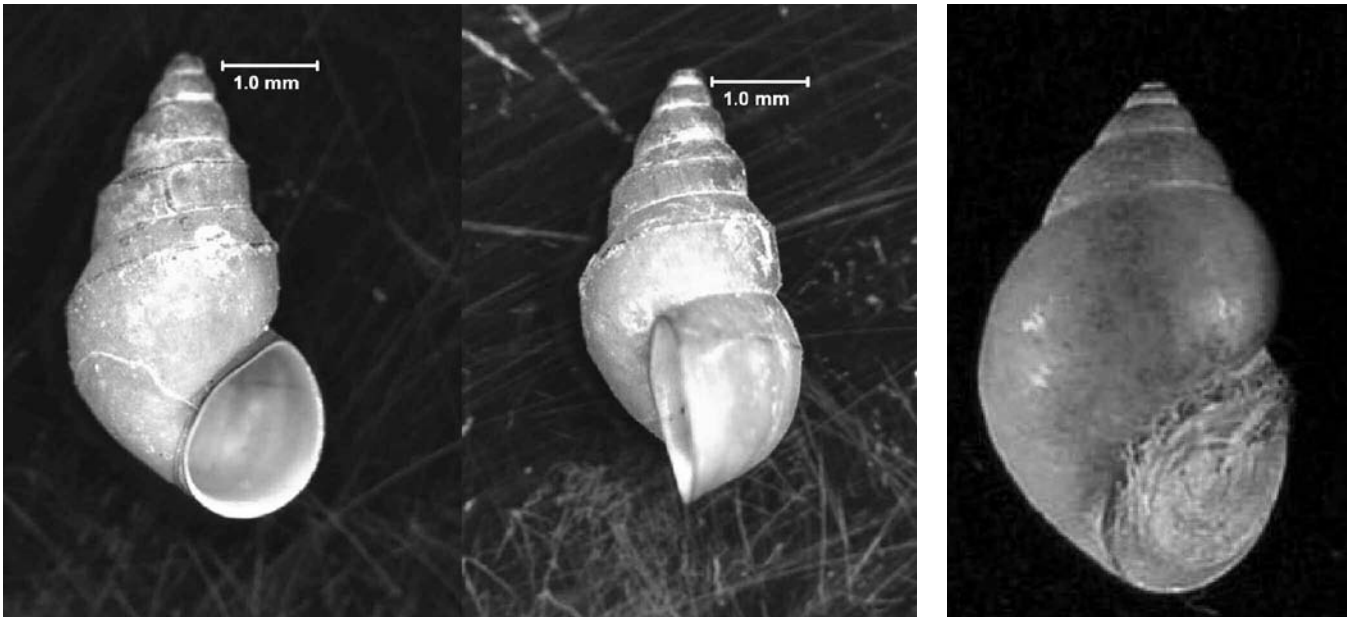
Site Number	Depth (m)	Location	Latitude	Longitude	# <i>Potamopyrgus</i> found
SPTI-15	15	EB	42° 37.88'	79° 07.32'	3
SPT1-20	20	EB	42° 40.86'	79° 11.79'	2
SPT2-10	10	EB	42° 38.28'	79° 05.80'	0
SPT2-15	15	EB	42° 38.62'	79° 06.40'	0
SPT2-20	20	EB	42° 41.14'	79° 10.52'	5
SPT3-10	10	EB	42° 39.80'	79° 05.40'	0
SPT3-15	15	EB	42° 39.99'	79° 05.67'	0
SPT3-20	20	EB	42° 43.14'	79° 10.59'	2
PI-1	5	ECB	42° 10.21'	80° 03.74'	0
PI-2	10	ECB	42° 10.67'	80° 03.71'	0
PI-3	15	ECB	42° 11.97'	80° 03.90'	0
PI-4	18	ECB	42° 13.22'	80° 03.95'	0
PI-5	18	ECB	42° 13.20'	80° 04.18'	2
PI-6	15	ECB	42° 11.94'	80° 03.96'	0
PI-7	10	ECB	42° 10.65'	80° 03.85'	0
PI-8	5	ECB	42° 10.39'	80° 03.90'	0
PI-9	18	ECB	42° 13.17'	80° 04.61'	0
PI-10	8	ECB	42° 08.56'	80° 05.14'	0
SLT1-5	5	WCB	41° 38.30'	82° 49.33'	0
SLT1-15	15	WCB	41° 40.30'	82° 19.37'	0
SLT1-18	18	WCB	41° 42.80'	82° 14.11'	0
SLT2-5	5	WCB	41° 40.01'	82° 47.16'	0
SLT2-15	15	WCB	41° 41.35'	82° 19.04'	1
SLT2-18	18	WCB	41° 43.84'	82° 14.65'	2
SLT3-5	5	WCB	41° 41.61'	82° 46.99'	0
SLT3-10	10	WCB	41° 37.52'	82° 40.07'	0
SLT3-15	15	WCB	41° 42.35'	82° 19.17'	0
SLT3-18	18	WCB	41° 44.87'	82° 15.25'	0
SLT4-10	10	WCB	41° 37.24'	82° 34.59'	0

alter nutrient cycling (especially nitrogen and carbon) (Hall *et al.* 2003), and it may outcompete native grazers and reduce rates of colonization of native invertebrates (Kerans *et al.* 2005). Its presence is likely to have important effects on higher and lower trophic levels (Kerans *et al.* 2005). Because of the significant detrimental ecological effects associated with this species in the western U.S. and elsewhere it is essential that this species be monitored in the Great Lakes. Here we document the presence of *P. antipodarum* in Lake Erie.

## METHODS

Because *P. antipodarum* has substantially expanded its range in Lake Ontario in the past 15 years, we decided to look for the snail in Lake Erie.

Samples were taken at depths ranging from 5 m to 18 m. These depths were chosen because depths where the snail is found in Lake Ontario range from 4 to 45 m (Zaranko *et al.* 1997, Levri in prep.). Samples were not taken beyond 18 m for logistical reasons related to the relatively shallow depths of Lake Erie. Benthic samples were taken using a Ponar grab (area = 0.052 m<sup>2</sup>) at 37 sites in Lake Erie in June 2005 and June 2006. The sites were clustered off of Sturgeon Point, NY (8 sites), Erie, PA (10 sites), and Put-in-Bay, OH (11 sites) (Table 1). These three clusters were in the eastern basin, east central basin, and west central basin of the lake, respectively. Samples were washed through a screen with 2.0 mm openings and organisms preserved in 70% ethanol. All mollusks in the samples



**FIG. 1.** Photographs of *Potamopyrgus antipodarum* (a) collected near Sturgeon Point, NY at 20 m. This specimen possesses a small keel. The majority of Great Lakes *Potamopyrgus* do not possess a keel however. Photograph of *Bithynia tentaculata* (b) (photo from U. S. Geological Survey).

(except for a few archived individuals) were dissected to assess if they were captured alive. Proper identification was confirmed by Robert Dillon, College of Charleston.

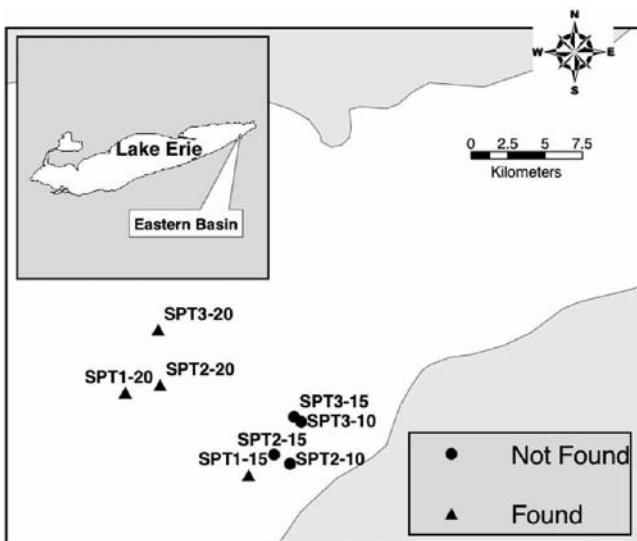
## RESULTS AND DISCUSSION

*Potamopyrgus antipodarum* (Fig. 1a) is a prosobranch hydrobiid snail common to most freshwater habitats in its native range in New Zealand. Adults range in length from about 3 mm to 12 mm in its native range (Winterbourn 1970). Adult lengths in invasive populations usually range from 3.5 to 6 mm (Ponder 1988, Zaranko *et al.* 1997, Levri unpublished data). The shell shape is dextral ranging from ovateconical to cylindrical with up to eight whorls. The aperture is elliptical, and the aperture height is less than the length of the spire. The concave attenuate spire with a protruding apical whorl is a defining characteristic of the snail (Zaranko *et al.* 1997). The operculum is thin and ovate. In the Laurentian Great Lakes individuals have been found to be smooth or keeled (Zaranko *et al.* 1997). The species is described in detail in Winterbourn (1970) and Zaranko *et al.* (1997).

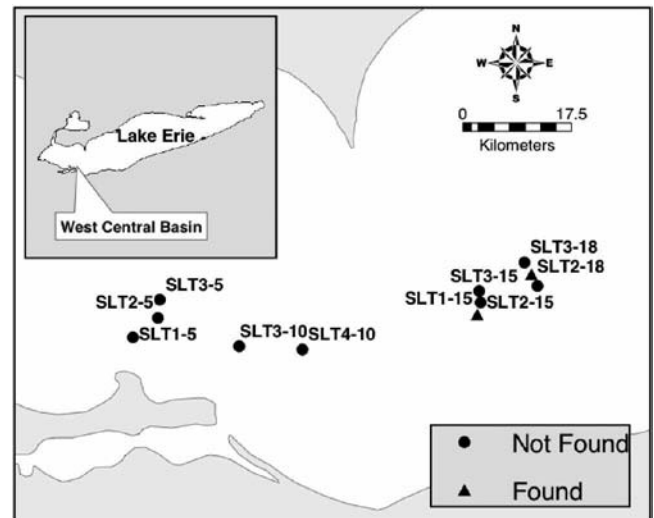
*Potamopyrgus antipodarum* is an ecological generalist able to tolerate moderate salinities (0–26 ppt) (Winterbourn 1970), oligotrophic and eu-

trophic waters (Dorgelo 1987), and a wide range of water temperatures (Hylleberg and Siegismund 1987). The diet of the snail is also variable as it feeds on green algae and diatoms as well as detritus (Haynes and Taylor 1984).

In the present study, *P. antipodarum* was found at 4 of 8 sites in the eastern basin, 1 of 10 sites in the east central basin, and 2 of 11 sites in the west central basin of Lake Erie (Table 1, Figs. 2–4). The maximum number of individuals found at a single site was 5 (= 32 per m<sup>2</sup>). All individuals were found at sites between 15–20 m water depth, which is consistent with depth distributions found in Lakes Ontario and Superior (Zaranko *et al.* 1997, Grigorovich *et al.* 2003). Overall, this species appears to have a depth range of 4 to 45 m in the Great Lakes (Zaranko *et al.* 1997, Grigorovich *et al.* 2003, Levri in prep.). Since this is the initial discovery of the snail in Lake Erie, it is not clear how fast the population is spreading. Greatest numbers were found in the eastern basin but few were found in the central basin, which likely indicates it is spreading from east to west. The expansion and distribution of this species in Lake Erie may be influenced by the large area in the central basin subject to summer hypoxia. Prosobranch gastropods such as *Potamopyrgus* are sensitive to low oxygen concentrations (Brown *et al.* 1998). However, two indi-



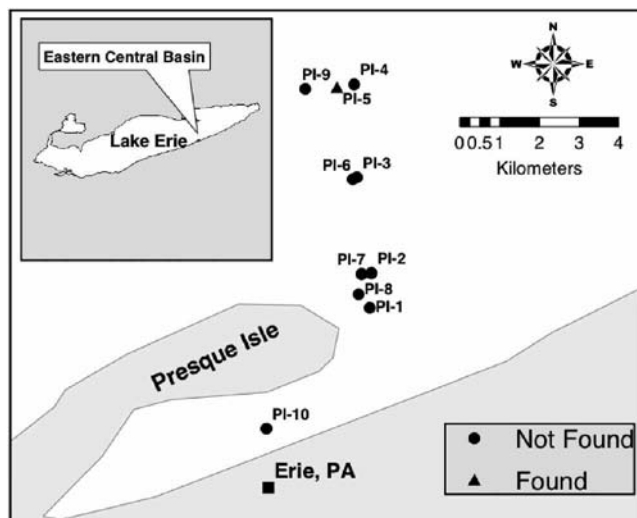
**FIG. 2.** The sites sampled in the eastern basin near Sturgeon Point, NY. The solid triangles represent the locations where *Potamopyrgus* was found. Numbers on the figure correspond with sites in Table 1.



**FIG. 4.** The sites sampled studying the West Central Basin in the central basin of Lake Erie. The solid triangles represent the location where *Potamopyrgus* was found. Numbers on the figure correspond with sites in Table 1.

viduals in the east central basin were collected at a site in the summer hypoxic region.

The finding of *Potamopyrgus* in Lake Erie likely demonstrates that the range of this exotic is expand-



**FIG. 3.** The sites sampled in the eastern central basin near Erie, PA. The solid triangle represents the location where *Potamopyrgus* was found. Numbers on the figure correspond with sites in Table 1.

ing in the Great Lakes. Since the snail was found in three different distant locations in Lake Erie, it is likely that *Potamopyrgus* has been established in the lake for some time. Over 40 stations in Lake Erie and five in Lake Huron were assessed in the early and mid 1990s for the presence of *Potamopyrgus*, and none were found in either lake ([Farara and Burt 1993, Farara 1995; Dahl *et al.* 1995] as cited in Zaranko *et al.* 1997). Thus, the snail probably did not inhabit the lake or it was living in isolated populations in the mid 1990s. Since its establishment it is likely that the snail has avoided detection in Lake Erie due to its small size and the depths where it is usually found (usually greater than 10 m in depth in other Great Lakes) (Zaranko *et al.* 1997, Levri in prep.). Individuals have also been found recently in Lake Superior (Grigorovich *et al.* 2003). Within Lake Ontario there have been recent discoveries of the snail in places where they were not found to be in Zaranko *et al.*'s (1997) study (Levri in prep., Zaranko pers. comm.).

The most similar species to *Potamopyrgus* in the Great Lakes is *Bithynia tentaculata* (Fig. 1b), which is widely distributed in the Great Lakes. *B. tentaculata* reaches a larger size than *Potamopyrgus* (12–15 mm compared to 4–6 mm of *Potamopyrgus* in the Great Lakes). In *Bithynia* the umbilicus is imperforate while the umbilicus of *Potamopyrgus* is

narrowly perforate. *Bithynia* tends to have 5–6 whorls compared to the 7–8 of *Potamopyrgus*.

The densities of *P. antipodarum* at the sites sampled in this study in Lake Erie are low compared to the densities found in Lake Ontario (up to 5,600/m<sup>2</sup>) and western U.S. rivers (in some places over 300,000/m<sup>2</sup>). The differences between the densities in Lakes Erie and Ontario could be due to year-to-year variation in densities, which can be substantial in Lake Ontario (Zaranko *et al.* 1997, Levri in prep.) or due to the limited number of sites that were sampled in Lake Erie.

Even though densities of the snail in the Great Lakes are modest, it is important that this species be monitored. To date no *P. antipodarum* have been reported from rivers and streams in the eastern U.S. It is not clear why populations of the snail have not moved into rivers and streams emptying into the Great Lakes. If it were to colonize rivers and streams, similar devastating ecological effects to those that have been observed in the western U.S. may occur. Since *Potamopyrgus* has only been found in deeper water in the Great Lakes, it is relatively less likely that the snail will be spread easily by fishers and recreational users as it has been in Europe and the western U.S. The main mechanisms of range expansion by the snail are likely to be natural movement, transport due to dredging and dumping of sediments, and further introductions from Europe.

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