Journal of Freshwater Ecology

ISSN: 0270-5060 (Print) 2156-6941 (Online) Journal homepage: https://www.tandfonline.com/loi/tjfe20

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To cite this article: Jennifer A. Bury , Bernard E. Sietman & Byron N. Karns (2007) Distribution of the Non-Native Viviparid Snails, *Bellamya chinensis* and *Viviparus georgianus*, in Minnesota and the First Record of *Bellamya japonica* from Wisconsin, Journal of Freshwater Ecology, 22:4, 697-703, DOI: 10.1080/02705060.2007.9664830

To link to this article: https://doi.org/10.1080/02705060.2007.9664830

Distribution of the Non-Native Viviparid Snails, *Bellamya chinensis* and *Viviparus georgianus*, in Minnesota and the First Record of *Bellamya japonica* from Wisconsin

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ABSTRACT

We documented the currently known distribution of the Asian snail *Bellamya (=Cipangopaludina) chinensis* in Minnesota, along with another viviparid snail, *Viviparus georgianus*, a North American native whose range has expanded. We also recorded the first known occurrence of *Bellamya japonica* in Wisconsin. *Bellamya chinensis* and *V. georgianus* occurred predominately in lakes within the Minneapolis/St. Paul metropolitan area and the lakes region of northcentral Minnesota. Both species are now established in the three major watersheds that drain Minnesota. We collected *Bellamya japonica* at six sites in the Namekagon River, part of St. Croix River system in Wisconsin.

INTRODUCTION

Non-native species are considered serious threats to global biodiversity (Wilcove et al. 1998, Mack et al. 2000). Among these, freshwater mollusks such as the zebra mussel (*Dreissena polymorpha*) have received much attention due to their potential to alter aquatic communities and ecosystem processes and to cause extinctions (Ricciardi et al. 1998, Strayer et al. 1999). However, most non-native species, including some mollusks, have received relatively little attention even though their impact on aquatic communities is unknown (Strayer 1999). This includes the Asian freshwater snails *Bellamya* (=*Cipangopaludina*) *chinensis* and *Bellamya japonica*, which are now established in North America, and *Viviparus georgianus*, a North American native, which has expanded beyond its historic range (Clench 1962).

Bellamya chinensis is a large olive-brown, edible mollusk native to eastern and southeastern Asian regions (Pace 1973, Chung and Jung 1999). Wood (1892) first documented *B. chinensis* in the United States in Chinese markets of San Francisco, California, and Johnson (1915) subsequently found it in Massachusetts. It has since been documented in a number of areas in the contiguous United States (Jokinen 1982). The only Minnesota record of *B. chinensis* was from 1939 in the Mississippi River at St. Cloud (Dawley 1944). In states bordering Minnesota, there are five county records from Wisconsin (Dundee 1974, Jass 2004), although the species has been observed recently in several northern Wisconsin lakes (pers. comm., D. Heath[b]). Barnhart (1978) reported an established population from central Iowa. Michigan is a mid-continental state with *B. chinensis* records dating back to 1947 (Clench and Fuller 1965).

Historically, *V. georgianus* occurred in the southeastern United States, mainly in the Mississippi River system, from Florida, Georgia, and Alabama, and north to Illinois and Indiana (Clench 1962, Burch and Jung 1988). Its range has expanded to include

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parts of several eastern and upper midwestern states and Canada (Clench 1962, Clench and Fuller 1965). The first Minnesota record for *V. georgianus* was a single specimen found at Lake of the Isles in Minneapolis in 1930 (Dawley 1944). Jass (2004) recorded this species from four Wisconsin counties, the earliest of which was a dead shell from the Milwaukee area in 1906 (Chadwick 1906). *Viviparus georgianus* was also documented in Michigan (Clench 1962) where it was considered rare (Pace and Szuch 1985).

Bellamya japonica, a native to Japan and Southeast Asia (Clench and Fuller 1965), was first reported in the United States in California in 1911(Hannibal 1911). North American records of this species are limited. The closest documented occurrence to Minnesota was a 1937 record from Michigan (Clench and Fuller 1965).

During a statewide survey of freshwater mussels in Minnesota, we collected specimens of *B. chinensis* and *V. georgianus* from several drainages, which prompted us to do a more thorough analysis of their distribution in Minnesota. Thus, we documented the currently known distribution of *B. chinensis* and *V. georgianus* in Minnesota and observed for the first time *B. japonica* in Wisconsin.

MATERIALS AND METHODS

We sampled 894 river and lake sites in Minnesota from 2002 to 2006 (Fig. 1). Freshwater mussels were the focus of this survey, but we collected and vouchered aquatic snails when they were encountered. In 2004, we sampled 64 sites on the main stem of the St. Croix River (Wisconsin-Minnesota) and the Namekagon River (Wisconsin), where snails were the survey focus. Snails were collected mostly by sight and hand picking while wading, snorkeling, or using SCUBA gear. We did not quantify abundance of snails, but noted instances where snails appeared abundant or where windrows of snails were washed on shore. In addition to our survey, we contacted all Minnesota Department of Natural Resources (DNR) district fisheries managers and fisheries research biologists about possible sightings of large snails. We either sampled areas where they thought snails were present, or we were given specimens and locality data. We also searched for records in the University of Minnesota James Ford Bell Museum of Natural History (JFBM), Science Museum of Minnesota (SMM), Harvard University Museum of Comparative Zoology, and the Milwaukee Public Museum. Nomenclature and identifying characteristics for *B. chinensis* and *B. japonica* followed Smith (2000). *Viviparus georgianus* nomenclature followed Turgeon et al. (1998). We deposited voucher specimens at JFBM and the Illinois Natural History Survey Mollusk Collection, Champaign, Illinois.

RESULTS

We collected live or dead specimens of *B. chinensis* and *V. georgianus* at 82 and 45 Minnesota sites, respectively (Fig. 1). Of these, both species were found at 9% of the sites. *Bellamya japonica* was collected at six sites in the Namekagon River in the St. Croix River Drainage, Wisconsin. These represent the first records of *B. japonica* from Wisconsin. Of the 117 Minnesota sites where we recorded non-native snails, 50% resulted from our informal survey of Minnesota DNR personnel. Also, we found two Minnesota records for *B. chinensis* from our museum searches; a 1967 record from White Bear Lake, Ramsey County, at SMM, and a 2003 record from the Sunrise River, Chisago County, at JFBM.

Both *B. chinensis* (79%) and *V. georgianus* (82%) were found mostly in lakes or lake outflows. The majority of occurrences were in the Minneapolis/St. Paul metropolitan area and the lakes region of northcentral Minnesota (Fig. 1). Both species occurred in the three major basins that drain Minnesota–the Mississippi River, Laurentian Great Lakes, and Hudson Bay. By drainage, most *B. chinensis* records were from the

Mississippi River headwaters (60%) and the St. Croix River system (21%). Occurrences within these watersheds were concentrated in the Prairie River (11%) and Kettle River (12%) systems. Of the *B. chinensis* records from the Mississippi River headwaters, 16% were from the Minneapolis/St. Paul metropolitan area. Most *V. georgianus* records were from the Mississippi River headwaters (69%), with areas of concentration in the Pine River (16 %), Crow Wing River (11%), Leech Lake River (11%), and Long Prairie River (9%) systems. Prevalence of *V. georgianus* was similar in the Big Fork River (9%) and Kettle River (9%) systems.

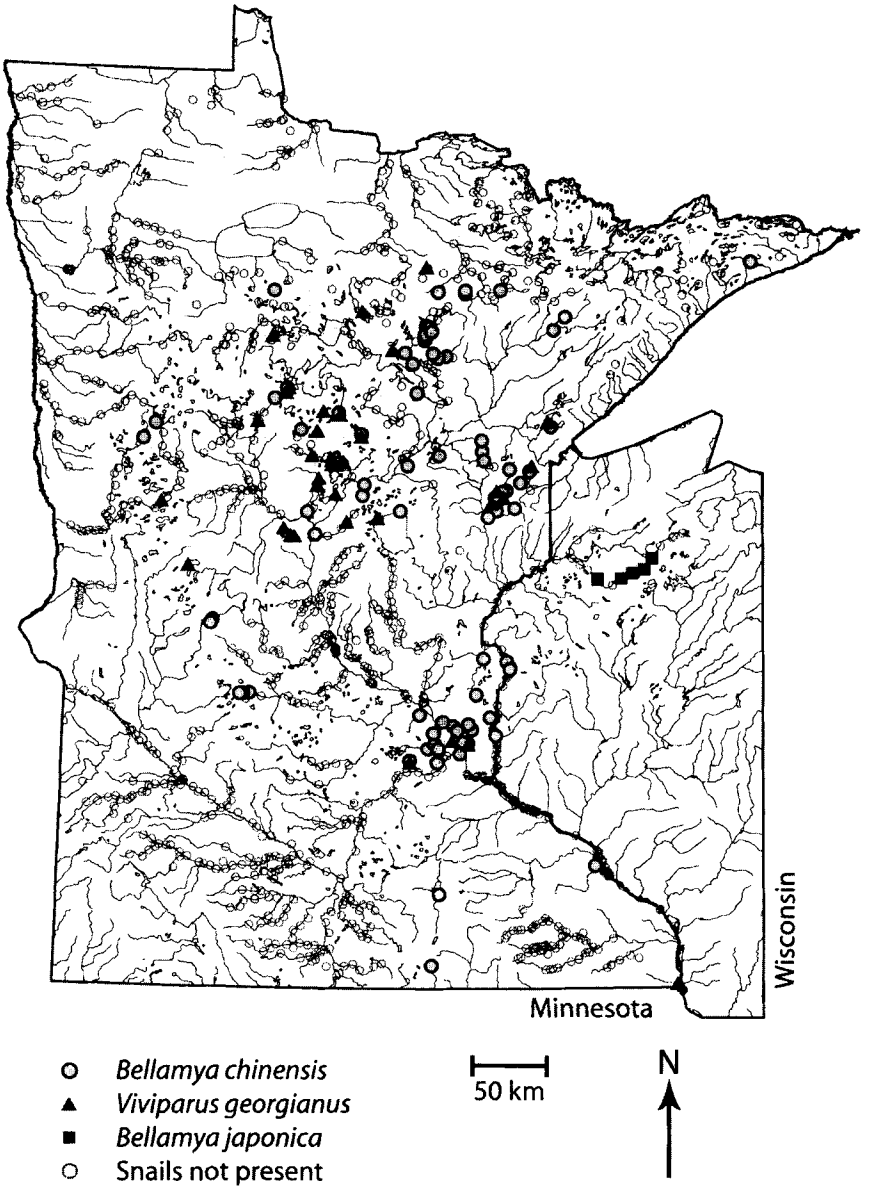

Figure 1. Recorded distribution of *B. chinensis* and *V. georgianus* in Minnesota and *B. japonica* in Wisconsin.

DISCUSSION

We found both *B. chinensis* and *V. georgianus* to be broadly distributed in Minnesota, although most records were clustered around the Minneapolis/St. Paul metropolitan area and the lakes region of northcentral Minnesota. *Bellamya japonica* was found only in the Namekagon River, Wisconsin. This species could be more widespread in Wisconsin, and its close proximity suggests it could also occur in other parts of the St. Croix River drainage or in nearby Minnesota. The 1967 record of *B. chinensis* from White Bear Lake indicates this species might have been present in the Minneapolis/St. Paul metropolitan area for several decades.

Previous studies have found these species typically living in lakes and in portions of rivers with slow to moderate current (Clench and Fuller 1965, Clarke 1981, Jokinen 1982), in irrigation canals (Pace 1973), and in roadside ditches (Hanna 1966, Pace 1973). In a laboratory experiment, Hutchison (1947) found that activity of *B. chinensis* decreased by 50% in high flow areas compared to standing water. Our observations generally concur with these studies. We suspect populations in flowing river reaches in Minnesota occur in part because upstream lake populations serve as sources for downstream colonization.

Although these species have received modest attention as non-native faunal elements in parts of North America, they generally have not been viewed as problem invasive species (Mackie 2000). We think this view is flawed with respect to these species in Minnesota and Wisconsin for two reasons. There is abundant aquatic habitat favorable to these snails (such as lakes and marshes), and in such habitat, they can reach high densities. Knowledge of the effects of these snails on aquatic ecosystems and invertebrate communities is limited, particularly in respect to other snails and invertebrate grazers. One negative interaction reported by Eckblad and Shealy (1972) showed that *V. georgianus* can cause significant mortality of largemouth bass (*Micropterus salmoides*) embryos when they invade nests. Additionally, *B. chinensis* is known to carry and transmit parasites to humans (Ingles 1930, Chung and Jung 1999) and unionid clams (Huehner and Etges 1977), although to our knowledge, cases involving human intestinal fluke transmitted by *B. chinensis* have not been reported in the mainland United States.

Several studies have cited anthropogenic causes for the continued spread of these species (Hannibal 1911, Johnson 1915, Wolfert and Hiltunen 1968). In Minnesota, we suspect humans are dispersing these snails as well. Both *B. chinensis* and *V. georgianus* have crossed major drainage divides in Minnesota and some populations appear disjunct, suggesting human-mediated dispersal. *Bellamya chinensis* has been used in water gardens and aquariums (Dawley 1944, Clench 1962, Mackie 2000). This could be one reason for the prevalence of this snail in the Minneapolis/St. Paul area. Alternatively, recreational boaters and anglers could be contributing to the spread of these species among lakes, particularly in northcentral Minnesota. It is also possible that *B. chinensis* is being spread in certain areas to establish colonies for use as a human food source (Mackie 2000).

All three species can reach extremely high densities (Wolfert and Hiltunen 1968, Jokinen et al. 1982). For instance, a population of *V. georgianus* in Michigan was reported as possibly "...the largest standing crop biomass records among freshwater gastropods" (Pace and Szuch 1985). Commercial fishermen in Lake Erie reported retrieving over two tons of *B. japonica* in just one seine haul (Wolfert and Hiltunen 1968). In certain Minnesota lakes, we observed high densities of *B. chinensis* and *V. georgianus* during summer months. We also observed high densities of *B. japonica* at an impounded site in the Namekagon River. Cyclical die offs in these species are well documented (Wolfert and Hiltunen 1968, Stanczykowska et al. 1971, Stanczykowska and Magnin 1973, Jokinen et al. 1982). Lake residents in Minnesota with whom we spoke viewed them as a nuisance because dead and decaying snails formed large windrows on

shore. Stanczykowska and Magnin (1973) and Jokinen (1982) suggested there was a correlation between high densities of *B. chinensis* and decreasing densities of other snails. Unfortunately, we know few details concerning potential competitive interactions with native species. More work is needed to determine their impacts on native snails, other aquatic invertebrates, and fish.

ACKNOWLEDGEMENTS

Funds for this study were provided in part by the U. S. Fish and Wildlife Service through Minnesota's State Wildlife Grants Program. We thank Gary Montz, Jody Hirsch, Nick Proulx, Tom Jones, Mike Loss, Wayne Mueller, David Friedl, Jeff Tillma, Jon Meerbeek, Becky Marty, John Sandberg, Doug Thompson, Jeff Mueller, Dennis Johnson, Jerry Poser, Scott Muhm, Jerry Wagner, Gerry Albert, Doug Kingsley, Donna Dustin, Kris Koski, Jerry Younk, Daniel Dexter, Heather Baird, Dexter Lindgren, Deserae Hendrickson, Dave Olfelt, David Weitzel, Ann Geisen, Todd Call, Mike Duval, and Edie Evarts for sending us snail specimens or directing us to sample sites. We thank Adam Baldinger (Harvard Museum of Comparative Zoology), Joan Jass (Milwaukee Public Museum), Richard Oehlenschlager (Science Museum of Minnesota), and Jon Slaght (University of Minnesota James Ford Bell Museum) for their assistance in our search for snail records and the loan of specimens, and Ellen Strong, Alison Welin, Gina Malizio, and Mark Hove for their various contributions to the study. Jan Wolff and two anonymous reviewers provided helpful comments on the manuscript.

LITERATURE CITED

Barnhart, M.C. 1978. Three introduced gastropods in Iowa. Nautilus 92:106-107.

Burch, J.B. and Y. Jung. 1988. A review of the classification, distribution and habitats of the freshwater gastropods of the North American Great Lakes. Walkerana 2:233-292.

Chadwick, G.H. 1906. Notes on the Wisconsin Mollusca. Bulletin of the Wisconsin Natural History Society 4:67-99.

Chung, P.R. and Y. Jung. 1999. *Cipangopaludina chinensis malleata* (Gastropoda: Viviparidae): A new second molluscan host of a human intestinal fluke *Echinostoma cinetorchis* (Trematoda: Echinostomatidae) in Korea. Journal of Parasitology 85:963-964.

Clarke, A.H. 1981. The freshwater molluscs of Canada. National Museum of Natural Sciences, National Museums of Canada, Ottawa. 446pp.

Clench, W.J. 1962. A catalogue of the Viviparidae of North America with notes on the distribution of *Viviparus georgianus* Lea. Occasional Papers on Mollusks 2:261-287.

Clench, W.J. and S.L.H. Fuller. 1965. The genus *Viviparus* (Viviparidae) in North America. Occasional Papers on Mollusks 2:385-412.

Dawley, C.W. 1944. Distribution and growth studies of the Unionidae and aquatic Gastropoda found in Minnesota. PhD thesis. University of Minnesota, Minneapolis, Minnesota.

Dundee, D.S. 1974. Catalog of introduced molluscs of eastern North America (North of Mexico). Sterkiana 55:1-36.

Eckblad, J.W. and M.H. Shealy. 1972. Predation of largemouth bass embryos by the pond snail *Viviparus georgianus*. Transactions of the American Fisheries Society 101:734- 738.

Hanna, G.D. 1966. Introduced mollusks of western North America. Occasional Papers of the California Academy of Sciences 48:1-108.

Hannibal, H. 1911. Further notes on Asiatic *Viviparus* in California. Nautilus 25:31-32.

Huehner, M.K. and F.J. Etges. 1977. The life cycle and development of *Aspidogaster*

conchicola in the snails, *Viviparus malleatus* and *Goniobasis livescens*. Journal of Parasitology 63:669-674.
Hutchison, L. 1947. Analysis of the activity of the fresh-water snail, *Viviparus malleatus* (Reeve). Ecology 28:335-345.
Ingles, L.G. 1930. Molluscan hosts in North America for human flukes. Science 72:527.
Jass, J.P. 2004. Distributions of gastropods in Wisconsin. Milwaukee Public Museum Contributions in Biology and Geology 99:1-28.
Johnson, C.W. 1915. *Viviparus malleatus* Reeve in Massachusetts. Nautilus 29:35-36.
Jokinen, E.H. 1982. *Cipangopaludina chinensis* (Gastropoda: Viviparidae) in North America, review and update. Nautilus 96:89-95.
Jokinen, E.H., J. Guerette, and R.W. Kortmann. 1982. The natural history of an ovoviviparous snail, *Viviparus georgianus* (Lea), in a soft-water eutrophic lake. Freshwater Invertebrate Biology 4:2-17.
Mack, R.N., D. Simberloff, W.M. Lonsdale, H. Evans, M. Clout, and F.A. Bazzaz. 2000. Biotic invasions: causes, epidemiology, global consequences, and control. Ecological Applications 10:689-710.
Mackie, G.L. 2000. Introduction of molluscs through the import for live food. Pages 305-313 *In*: Claudi, R. and J.H. Leach (eds.), Nonindigenous freshwater organisms: vectors, biology, and impacts. Lewis Publishers, Boca Raton, Florida.
Pace, G.L. 1973. The freshwater snails of Taiwan (Formosa). Malacological Review Supplement 1:1-118.
Pace, G.L. and E.J. Szuch. 1985. An exceptional stream population of the banded applesnail, *Viviparus georgianus*, in Michigan. Nautilus 99:48-53.
Ricciardi, A., R.J. Neves, and J.B. Rasmussen. 1998. Impending extinctions of North American freshwater mussels (Unionoida) following the zebra mussel (*Dreissena polymorpha*) invasion. Journal of Animal Ecology 67:613-619.
Smith, D.G. 2000. Notes on the taxonomy of introduced *Bellamya* (Gastropoda: Viviparidae) species in northeastern North America. Nautilus 114:31-37.
Stanczykowska, A., E. Magnin, and A. Dumouchel. 1971. Etude de trois populations de *Viviparus malleatus* (Reeve) (Gastropoda: Prosobranchia) de la region de Montreal. I. Croissance, fecondite, biomasse, et production annuelle. Canadian Journal of Zoology 49:1431-1441.
Stanczykowska, A. and E. Magnin. 1973. Quelques donnees bio-ecologiques sur trois especes de Viviparidae (Gastropoda, Prosobranchia) de Pologne et du Canada. Verhandlungen Internationale Vereinigung fur theoretische und angewandte Limnologie 18:1586-1593.
Strayer, D.L. 1999. Effects of alien species on freshwater mollusks in North America. Journal of North American Benthological Society 18:74-98.
Strayer, D.L., N.F. Caraco, J.J. Cole, S. Findlay, and M.L. Pace. 1999. Transformation of freshwater ecosystems by bivalves: a case study of zebra mussels in the Hudson River. BioScience 49:19-27.
Turgeon, D.D., J.F. Quinn, Jr., A.E. Bogan, E.V. Coan, F.G. Hochberg, W.G. Lyons, P.M. Mikkelsen, R.J. Neves, C.F.E. Roper, G. Rosenberg, B. Roth, A. Scheltema, F.G. Thompson, M. Vecchione, and J.D. Williams. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks, 2nd edition. American Fisheries Society, Special Publication 26, Bethesda, Maryland. 509 pp.
Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. BioScience 48:607-615.
Wolfert, D.R. and J.K. Hiltunen. 1968. Distribution and abundance of the Japanese snail, *Viviparus japonicus*, and associated macrobenthos in Sandusky Bay, Ohio. Ohio Journal of Science 68:32-40.

Wood, W.M. 1892. *Paludina japonica* Mart. for sale in the San Francisco Chinese markets. Nautilus 5:114-115.

Received: 26 December 2006 Accepted: 6 March 2007