University of Illinois
Institute of Natural Resource Sustainability
William Shilts, Executive Director

ILLINOIS NATURAL HISTORY SURVEY
Brian D. Anderson Director
1816 South Oak Street
Champaign, IL 61820-6964
217-333-6830

# Status of Three Species of Freshwater Snails (Gastropoda: Pleuroceridae) in the Lower Ohio River Basin, Illinois

Jeremy S. Tiemann
and
Kevin S. Cummings

Illinois Natural History Survey
Institute of Natural Resource Sustainability
University of Illinois

Prepared for: Illinois Department of Natural Resources
Wildlife Preservation Fund
Contract Number: RC08L20W

ILLINOIS
NATURAL
HISTORY
SURVEY

INHS Technical Report 2009 (35)
Date of issue: 21 October 2009

# Table of Contents

# CHAPTER 1

## Status of *Lithasia* spp. in the Ohio River basin, Illinois

**Abstract** – We report on a status survey of *Lithasia* spp. (Gastropoda: Pleuroceridae) we conducted in the Ohio River basin, Illinois. Prior to our survey, only three *Lithasia* species were known to occur in Illinois; however, through our efforts, we found a fourth species (*Lithasia geniculata*). The distribution of *L. armigera* and *L. verrucosa* does not appear to have changed within Illinois, whereas the distribution of *L. obovata* appears to be declining in Illinois, which prompted us to nominate it for inclusion on the state list of endangered and threatened species for Illinois by the Illinois Endangered Species Protection Board. *Lithasia geniculata* has been recorded only in one location, and we feel it should be considered for state endangered.

### INTRODUCTION

Freshwater mollusks are a vital component of stream ecosystems. Not only does their sensitivity to stream habitats allow them to be biological indicators of stream integrity (Williams et al. 1993), but they also occupy a central position in food webs by grazing on periphyton and providing a food source for predators (Stewart 2006). Sadly, freshwater mollusks are one of the most imperiled groups of animals in North America (Williams et al. 1993; Neves et al. 1997). At least 210 (70%) of the nearly 300 freshwater mussel species and over 260 (40%) of the estimated 650 freshwater snail species are extinct, are listed federally as endangered or threatened, or are in need of conservation (Williams et al. 1993; Neves et al. 1997; Lysne et al. 2008). The primary factors responsible for the decline are anthropogenic disturbances to stream habitats (e.g., habitat destruction and environmental contamination) and invasions of exotic species. This decline of freshwater mollusks also is evident in Illinois. Two-thirds (53) of the 80 freshwater mussel species are extirpated from the state, are listed at the state-level, or have relatively unstable

populations (Cummings and Mayer 1997); however, little is known about the status of the state's 76 freshwater snail species (Cummings 1991).

One group of freshwater mollusks that has suffered significant losses is the gastropod family Pleuroceridae. Of the approximate 150 currently recognized species in the family in North America, 32 (20%) are extinct and five (3%) are federally–listed as endangered or threatened (Minton and Lydeard 2003). The current conservation status of members of the pleurocerid genus *Lithasia* varies from imperiled to apparently secure, with one species unknown and another species possibly extinct (Minton and Lydeard 2003). Illinois was thought to be on the northwestern range for three *Lithasia* species: *L. armigera*, *L. obovata*, and *L. verrucosa* (Table 1) (Baker 1906; Burch 1989; Cummings 1991). All three species were historically present in the Ohio River basin, but little was known of their current status. Survey data are needed to accurately assess their status and provide evidence of changes in assemblage structure, including population declines and shrinking distributions (Stewart 2006).

*Lithasia* spp. are prosobranch (gill breathing) snails that are restricted to eastern North America (Burch 1989). Pleurocerids have solid, dextral (right facing) shells with the mantle openings facing anterior; their spiral opercula are usually not circular (Burch 1989). Their colors vary from pale yellow to dark brown or black. *Lithasia* spp. are dioecious (separate sexes) with females often being larger than males (Richardson and Scheiring 1994). Males lack verges (external sex organs) and females lay eggs via the egg-laying sinus on the right side of the foot (Burch 1989). Their eyes are on outward sides of the bases of the tentacles (Burch 1989).

Members of the genus *Lithasia* are typically found in perennial streams (Houp 1970; Johnson and Brown 1997; Greenwood and Thorp 2001). They most often can be found in rocky areas at various depths, but also can be present in the shallow areas near shore on firm sand or slightly silted areas. Some species occupy swift currents, whereas others are found in slow moving or still water habitats. Pleurocerids in general can be the dominant grazers in stream ecosystems and constitute 90% of the total invertebrate

biomass (Newbold et al. 1983, Richardson et al. 1988; Huryn et al. 1994). They are feeding generalists, capable of scraping organic material (e.g., periphyton and detritus) from various benthic substrates, and, in turn, are consumed by many organisms, including fishes (Dazo 1965; Greenwood and Thorp 2001; Krist 2002; Haag and Warren 2006). In addition, they can affect nutrient dynamics and energy flow, and can be an important substratum for algal attachment (Richardson et al. 1988; Richardson and Scheiring 1994). However, pleurocerids exhibit relatively low rates of secondary production, especially when compared with other mollusks (Dazo 1965; Richardson et al. 1988). Pleurocerids are iteroparous organisms that have life spans to about 10 years (Dazo 1965; Houp 1970). Age classes can be difficult to distinguish because pleurocerid growth can be continuous throughout the year but become asymptotic after about 2 years (Dazo 1965).

No comprehensive survey for *Lithasia* spp. has been conducted in Illinois, nor has a diagnostic key been created for this group in the state. Surveys are needed by natural resource agencies to determine the state and federal statuses of organisms and to make predictions regarding management decisions, and diagnostic keys are needed to aid in the identification of this fauna. Our objectives were to 1) determine the distribution of *Lithasia* spp. in Illinois, and 2) create a key to the *Lithasia* found in Illinois. This report is the first part of a series of papers on the distribution of Illinois freshwater snails.

## METHODS

Data were collected from three sources to determine the status and distribution of *Lithasia* spp. in Illinois:

1) *Field surveys*: Snails were qualitatively sampled at over 70 sites throughout the Ohio River basin. Live individuals and shells of dead specimens were collected by hand-picking in habitats that appeared likely to support snails. Shells also were randomly picked-up during surveys for other taxa (e.g., amphibians/reptiles, fishes, or freshwater mussels).

2) *Museum records*: Beginning on 15 May 2007, we inspected museum collection holdings known to house pleurocerid specimens from Illinois and border waters. Nearly 1,600 lots were examined, representing about 20,000

specimens. Museum collections examined included Chicago Academy of Sciences; Field Museum of Natural History, Chicago; Illinois Natural History Survey (including the University of Illinois Museum of Natural History), Champaign; Ohio State University Museum of Biological Diversity, Columbus; and the University of Michigan Museum of Zoology, Ann Arbor. Data from the Florida Museum of Natural History, Gainesville, were obtained on-line but specimens were not examined.

3) *Peer-reviewed literature*: We conducted literature reviews on freshwater snails and a total of 171 publications were examined, but only about 20 contained distributional data on Illinois pleurocerids (e.g., Baker 1906; Goodrich 1939; Goodrich 1940; Burch 1989) or border waters (e.g., Goodrich and van der Schalie 1944; Wu et al. 1997; Stewart 2006).

Scientific names and their authorities are based on Turgeon et al. (1998). Species accounts are given for each taxa and include 1) summary statements on their distribution and status in Illinois; 2) figures of specimens; and 3) a distribution map denoting historic (black dots) and current (red dots) distributions within Illinois. Based on the fact that very few alcohol-preserved Illinois pleurocerid specimens are known prior to 1985, a cutoff date of 1985 was chosen to compare the current status with historical records. Therefore, a species was considered extant in the state if it was collect in 1985 or later.

Pleurocerids are often highly variable in shell morphology both among and within populations, which can make identification difficult (Goodrich 1945; Krist 2002). Variability in shell morphology can be attributed to several factors, including environmental conditions and predator-prey interactions. Physicochemical parameters have been shown to change snail morphology. Taxonomy of pleurocerids historically has been based nearly solely on shell morphology. However, because of the environmental plasticity of the group, the present classification is problematic and debatable. Researchers are currently using a combination of reproductive anatomy and molecular data to resolve some of the taxonomic issues. We modified available snail keys in the

literature (e.g., Goodrich and van der Schalie 1944, Branson 1987; Burch 1989) to create a diagnostic key for Illinois *Lithasia* (Appendix 1).

## RESULTS

Field surveys, examination of museum collections, and literature reviews revealed that at least four species of *Lithasia* historically occurred in Illinois, all of which are still extant in the state. New to the state list is *Lithasia geniculata* (Tiemann and Cummings *in press*, which is Chapter 2 of this report). Based upon our surveys and historical data, *L. obovata* has experienced a substantial range reduction, and was therefore proposed as state endangered and was formally listed as such on 30 October 2009. Although spotty in distribution, *L. armigera* and *L. verrucosa* appear to be relatively common where found and the overall range of these two species is similar to what it was in historical times. Lastly, because *L. geniculata* was recorded only from one location, we feel it should be considered for state endangered. Species accounts are as follows:

***Lithasia armigera* (Say, 1821) – Armored Rocksnail:** The lower Ohio River basin in Illinois is on the northwestern range for *L. armigera*. The snail was historically known from the lower Wabash (downstream of its confluence with the White River, near Mt. Carmel) and Ohio rivers (Baker 1906; Goodrich 1940; Goodrich and van der Schalie 1944; Burch 1989) and still can be found in these areas (Fig. 1). Although we cannot compare historical to present day densities, the distribution of *L. armigera* does not appear to have changed within Illinois. *Lithasia armigera* is believed to be globally vulnerable, which means it is at moderate risk of extinction partially due to a restricted range and relatively few populations (Minton and Lydeard 2003). Threats to the species include colonization of zebra mussels and restricted distributions by impoundments.

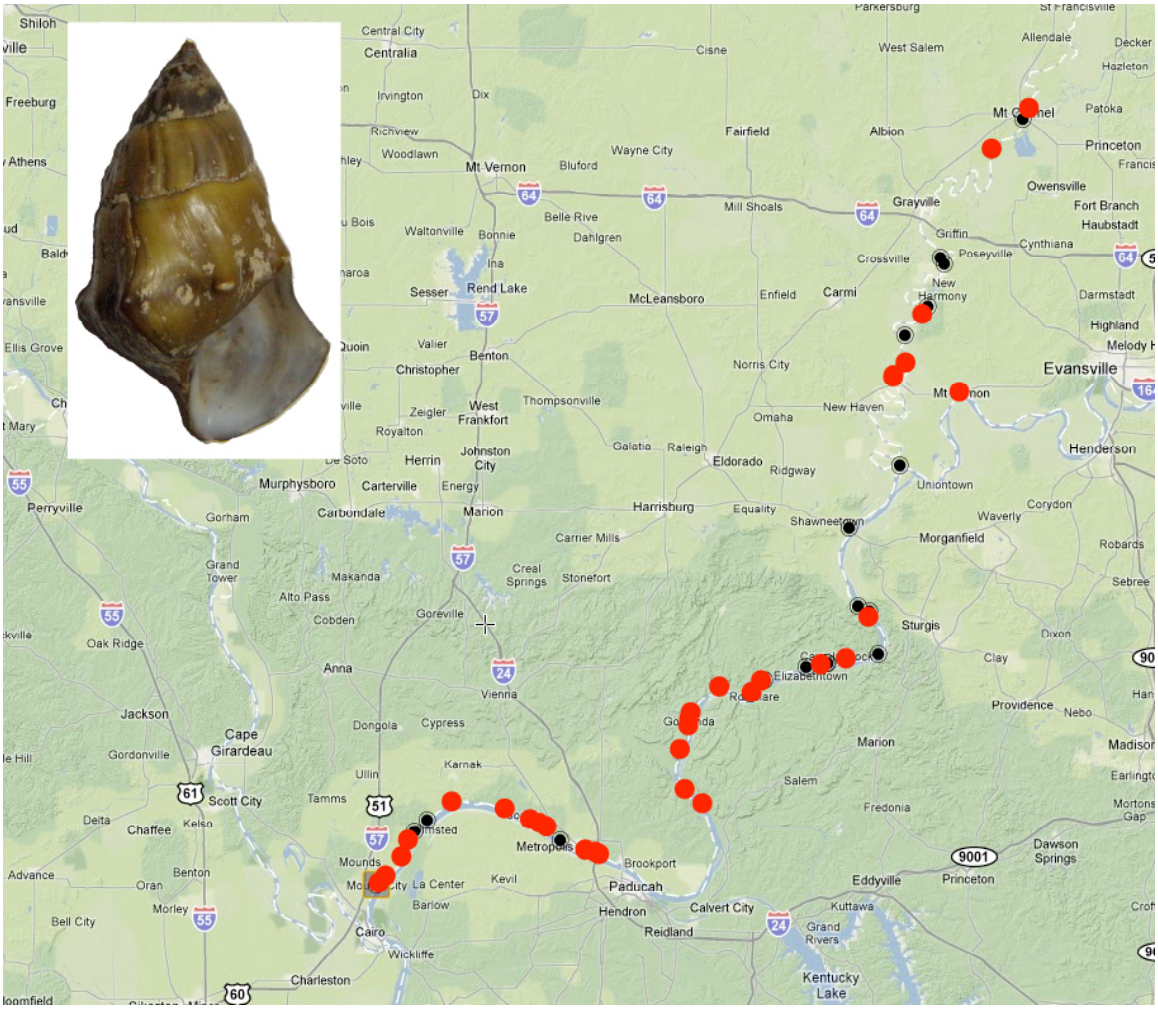


**Figure 1**. Photograph and distribution map of *Lithasia armigera.* Black dots are historic sites and red dots are where species was found alive during our survey.

***Lithasia geniculata* Haldeman, 1840 – Ornate Rocksnail:** Historically found in the Tennessee and Cumberland river basins, our study was the first to document *L. geniculata* in the Ohio River (Tiemann and Cummings *in press*). Given the global conservation status of G3 (vulnerable to extirpation or extinction) assigned to *L. geniculata* by Minton and Lydeard (2003) and the distance to the populations upstream of Kentucky Lake and Lake Barkley, efforts (e.g., listing at the state level) should be taken to protect the Ohio River population. Threats to the species include colonization of zebra mussels, loss of habitat pertaining to water demand, and restricted distributions by impoundments. Future studies

could include additional sampling methods (e.g., trawling and diving) to assess the full range and habitat preference of the species, and genetic analysis to determine if the Ohio River population is unique.

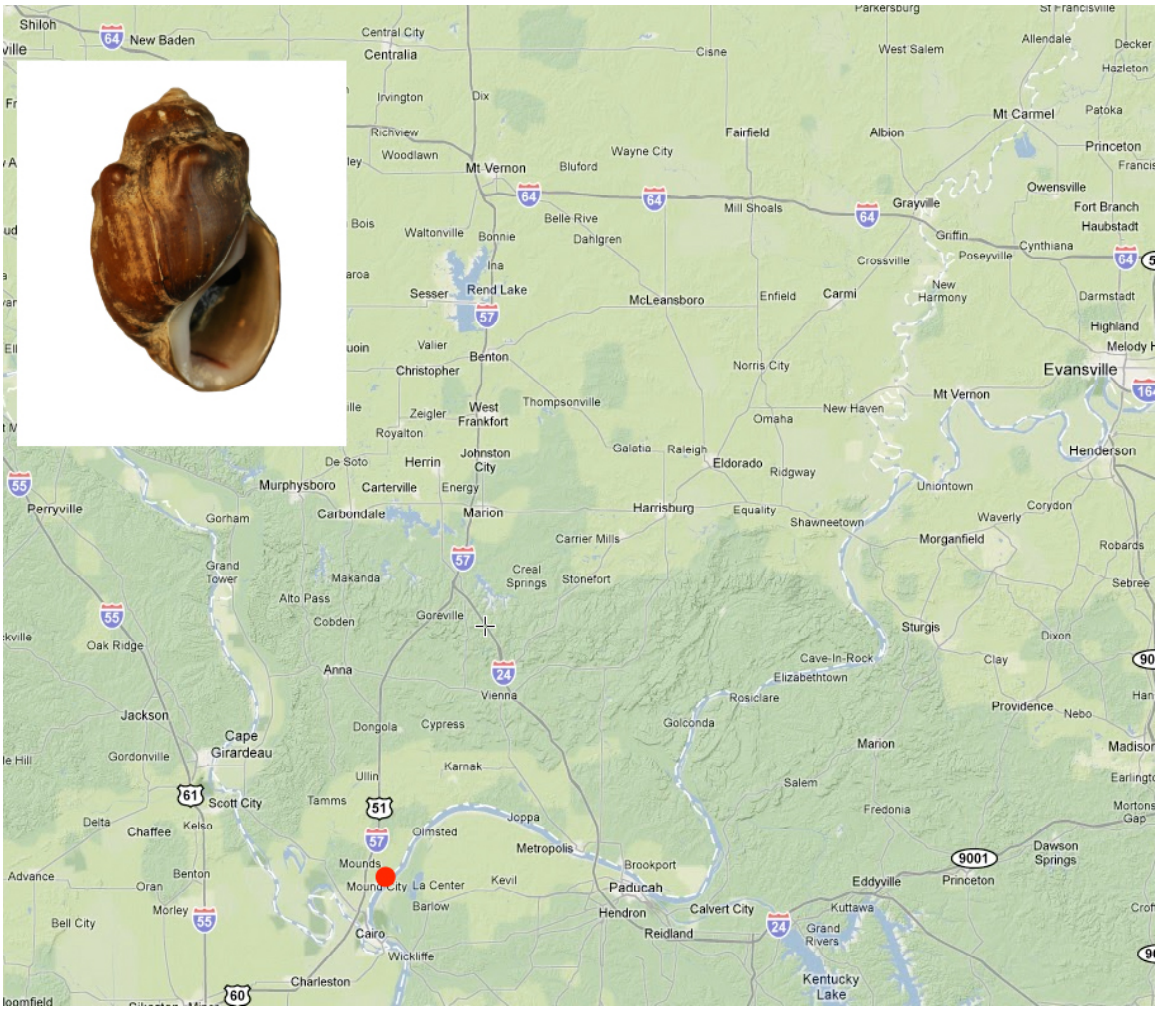


**Figure 2.** Photograph and distribution map of *Lithasia geniculata.*

***Lithasia obovata* (Say, 1829) – Shawnee Rocksnail:** Illinois is on the northwestern range for *L. obovata*. The snail was known from the lower Wabash (downstream of its confluence with the Embarras River, near Vincennes) and Ohio rivers, in addition to the lower portions in a few of their tributaries such as the Embarras, Little Wabash, and Saline rivers (Baker 1906; Goodrich 1940; Goodrich and van der Schalie 1944; Burch 1989). It still can be found in the

Little Wabash and Ohio rivers. *Lithasia obovata* appears to be declining in Illinois, and it is becoming more rare. The species affinity to isolated, shallow habitats and its inability to reach deep-water dispersal pathways make it vulnerable to extirpation (Greenwood and Thorp 2001). Given the rarity of *L. obovata*, we nominated the species as endangered for inclusion on the state list of endangered and threatened species for Illinois by the Illinois Endangered Species Protection Board. Threats to the species include colonization of zebra mussels and restricted distributions by impoundments.

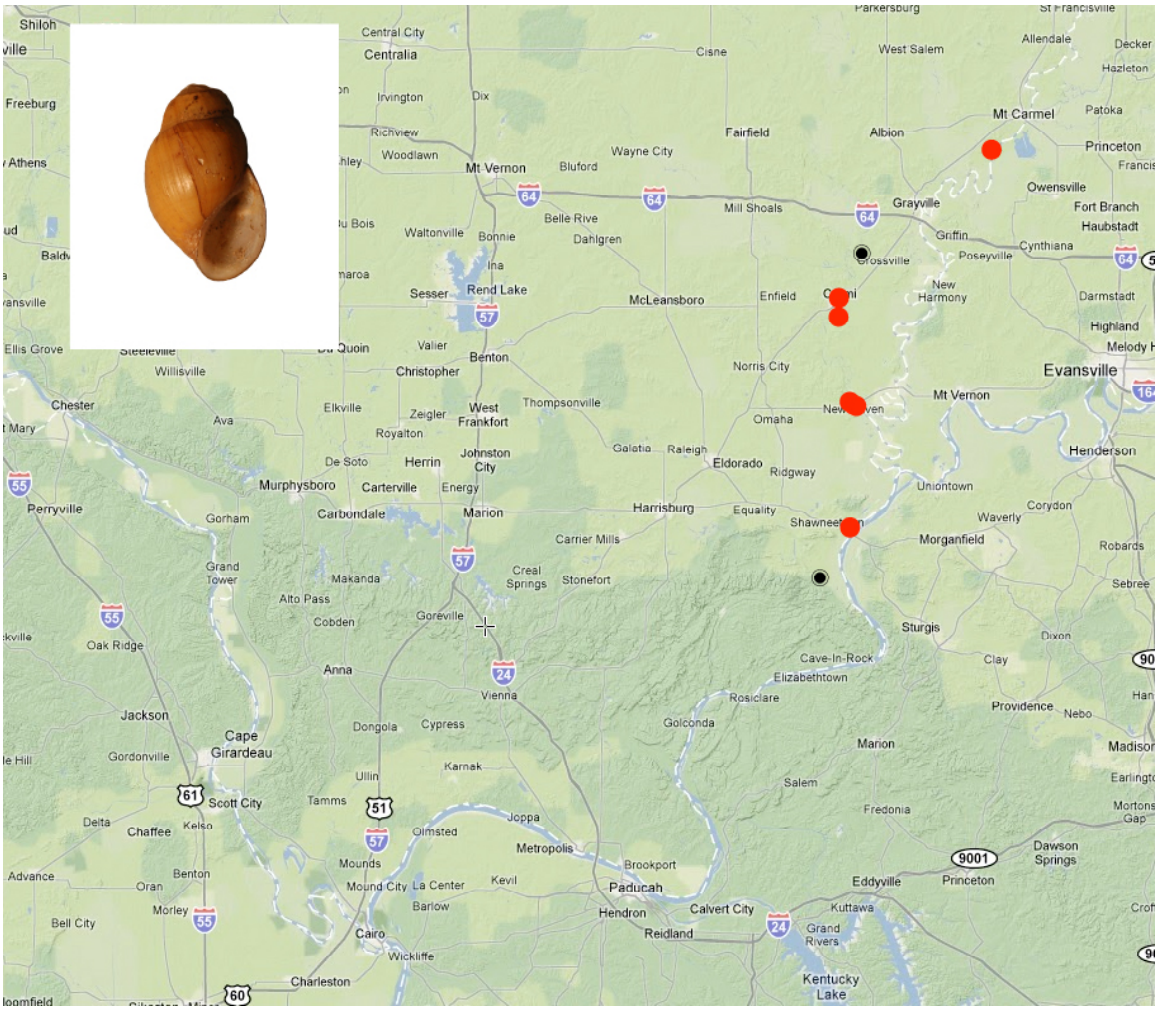


**Figure 3.** Photograph and distribution map of *Lithasia obovata.* Black dots are historic sites and red dots are where species was found alive during our survey.

***Lithasia verrucosa* (Rafinesque, 1820) – Vericose Rocksnail:** The lower Ohio River basin in Illinois is on the northwestern range for *L. verrucosa*. The snail was historically known from the lower Wabash (downstream of New Harmony) and Ohio rivers (Baker 1906; Goodrich 1940; Goodrich and van der Schalie 1944; Burch 1989) and still can be found in these areas. Again, although we cannot compare historical to present day densities, the distribution of *L. armigera* does not appear to have changed within Illinois. As with *L. armigera*, *L. verrucosa* is believed to be globally vulnerable (Minton and Lydeard 2003), and the threats to the species are the same as *L. armigera*.

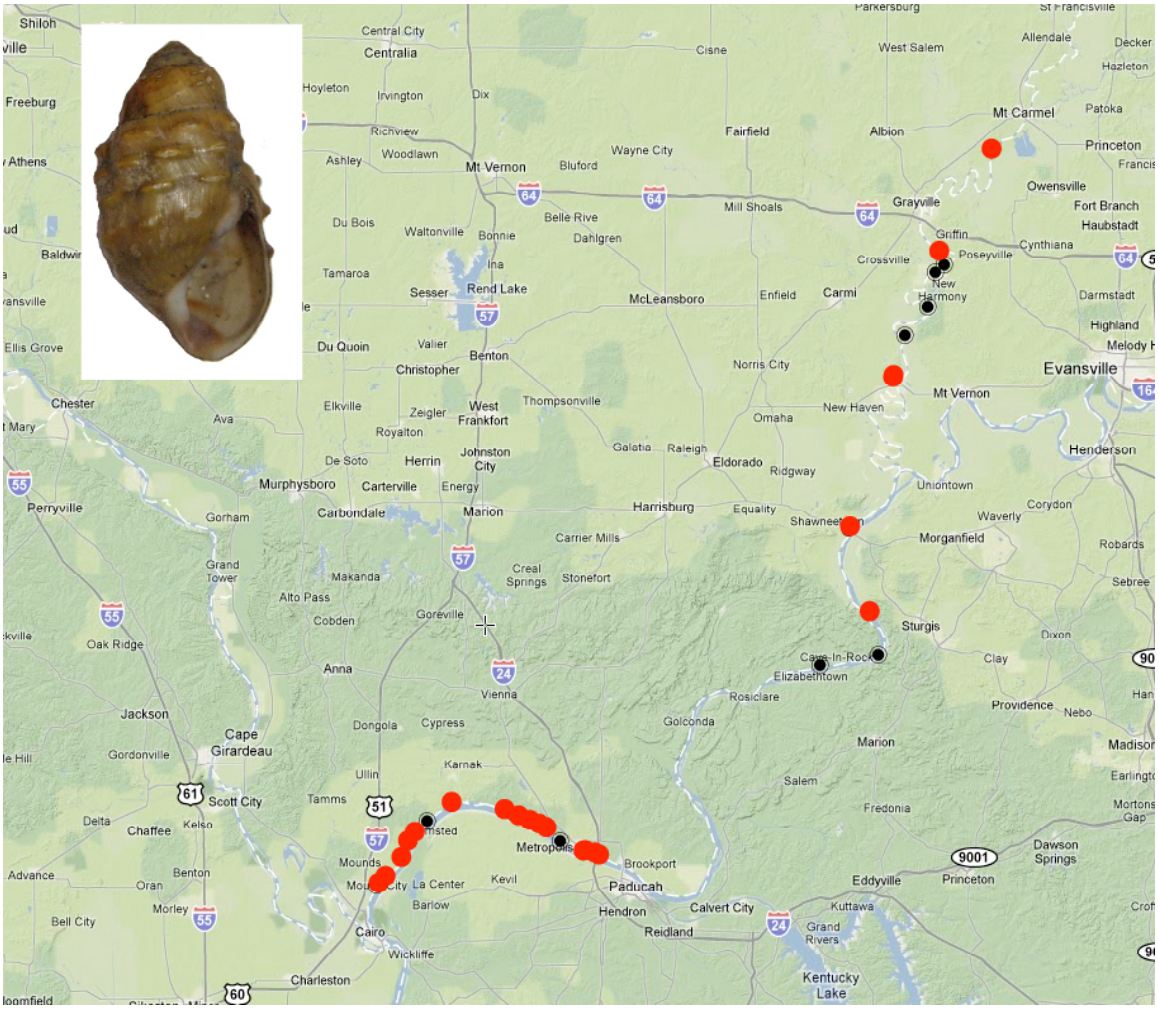


**Figure 4.** Photograph and distribution map of *Lithasia verrucosa*. Black dots are historic sites and red dots are where species was found alive during our survey.

## DISCUSSION

The Ohio – Mississippi confluence appears to form a barrier for pleurocerids (Burch 1989). As with freshwater mussels (Cummings and Mayer 1997), historical and present-day pleurocerid diversity in Illinois is greatest in the Wabash and Ohio river basins. All pleurocerids known to occur in Illinois can found in this area. The Wabash and/or Ohio river mainstems contained the only known populations of four pleurocerid species: *Lithasia armigera, Lithasia geniculata*, *Lithasia verrucosa,* and *Leptoxis praerosa* (Baker 1906; Burch 1989; Tiemann and Cummings *in press*). Five other pleurocerids (*Elimia livescens*, *Lithasia obovata*, *Pleurocera acuta*, *Pleurocera alveare*, and *Pleurocera canaliculata*) are known to occur in the Wabash / Ohio basin, and *Elimia semicarinata* is known to occur only in direct tributaries of the Ohio River (Baker 1906; Burch 1989). Although not recently reported (e.g., Pyron et al. 2008) a similar distribution pattern for these species also was reported for Indiana (Goodrich and van der Schalie 1944). In comparison, the Mississippi River basin (exclusive of the Ohio River basin) in Illinois, historically support only two pleurocerids: *Elimia livescens* and *Pleurocera acuta*.

Few conservation and monitoring programs have explicitly incorporated gastropods. Data on the historical distribution of freshwater snails should be collected to ascertain species trajectories (Lydeard et al. 2004). This information can guide not only the geographic focus of conservation efforts but also appropriate management efforts. Threats to pleurocerids are the same as those affecting all riverine faunas. Pleurocerids are not only affected by environmental degradation (e.g., siltation, chemical pollution, impoundments, instream construction, gravel mining, dredging, channelization, etc.), but also by sporadic shifts in natural phenomena, including shifts in climate and evolving stream drainage patterns (Ahlstedt 1991; Goudreau et al. 1993; Neves et al. 1997; Angelo et al. 2002; Lydeard et al. 2004). Both the Wabash and Ohio rivers have experienced significant physical and biological changes during the past century as the result of anthropogenic disturbances (Taylor and Spurlock 1982; Simon 2006). Competition and predation from exotic species also is a threat (Tucker 1994; Greenwood and Thorp 2001). Several live specimens encountered were colonized and covered by zebra mussels *Dreissena polymorpha*. Not only do pleurocerids have restricted, discontinuous

distributions and are confined to fragmented, isolated populations, but they also have slow and restricted dispersal capabilities (Dazo 1965; Angelo et al. 2002; Brown and Johnson 2004). Therefore, if a species experiences a drastic range reduction or becomes extirpated, natural recovery processes will be slow. One conservation technique used successfully for a number of organisms, including pleurocerids, is transplantations / reintroductions (Ahlstedt 1991).

Brown and Johnson (2004) outlined a conservation plan for imperiled gastropods and suggested a two-prong approach: 1) obtaining detailed information on distributions and habitat requirements, including determining the necessary diet and physicochemical parameters needed for reproduction, and 2) developing adequate propagation methods, including not jeopardizing the source population. Gastropod conservation and recovery efforts will face many challenges in the future. The continued survival of snails will require landowners and natural resource agencies to work together to protect the remaining populations while striving toward further improvements in restoration and preservation of aquatic ecosystems (Neves et al. 1997; Angelo et al. 2002; Brown and Johnson 2004; Lydeard et al. 2004).

## ACKNOWLEDGMENTS

This study was funded in partial by the Illinois Department of Natural Resources' (IDNR) Wildlife Preservation Fund (RC08-L20W), the Illinois Endangered Species Protection Board (RC09-E05W), and the Illinois Department of Transportation. Many people, including C.A. Phillips (INHS), A.R. Kuhns (INHS), J.E. Schwegman (IDNR), and L. Frankland (IDNR), collected snails for or with us. Drs. R.T. Dillon, Jr. (College of Charleston), T.W. Stewart (Iowa State University), and G.T. Watters (Ohio State University) aided in snail identification. D. Roberts (Chicago Academy of Science), R. Bieler and J. Gerber (Field Museum of Natural History), G.T. Watters (Ohio State University), and D. Foighil (University of Michigan Museum of Zoology) generously provided access to specimens under their care.

## LITERATURE CITED


Ahlstedt, S.A. 1991. Reintroduction of the spiny riversnail *Io fluvialis* (Say, 1825) (Gastropoda: Pleuroceridae) into the North Fork Holston River, southwest Virginia and Northeast Tennessee. American Malacological Bulletin 8:139-142.

Angelo, R.T., M.S. Cringan, and J.E. Fry. 2002. Distributional revisions and new and amended occurrence records for prosobranch snails in Kansas. Transactions of the Kansas Academy of Sciences 105:246-257.

Baker, F.C. 1906. A catalogue of the Mollusca of Illinois. Bulletin of the Illinois State Laboratory of Natural History 7:53-136.

Branson, B.A. 1987. Keys to the aquatic Gastropoda known from Kentucky. Transactions of the Kentucky Academy of Science 48:11-19.

Brown, K.M. and P.D. Johnson. 2004. Comparative conservation ecology of pleurocerid and pulmonate gastropods the United States. American Malacological Bulletin 19:57-62.

Burch, J.B. 1989. North American freshwater snails. Malacological Publications, Hamburg, Michigan. viii + 365 p.

Cummings, K.S. 1991. The aquatic Mollusca of Illinois. p. 429-439 *in* L.M. Page and M.R. Jeffords (eds.). Our living heritage: The biological resources of Illinois. Illinois Natural History Survey Bulletin 34:357-477.

Cummings, K.S. and C.A. Mayer. 1997. Distributional checklist and status of Illinois freshwater mussels (Mollusca: Unionacea). p 129-145 *in* K.S. Cummings, A.C. Buchanan, C.A. Mayer, and T.J. Naimo, (eds.). Conservation and management of freshwater mussels II: initiatives for the future. Proceedings of a UMRCC Symposium, 16-18 October 1995, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois. 293 p.

Dazo, B.C. 1965. The morphology and natural history of *Pleurocera acuta* and *Goniobasis livescens* (Gastropoda: Cerithiacea: Pleuroceridae). Malacologia 3:1-80.

Goodrich, C. 1939. Pleuroceridae of the Mississippi River basin exclusive of the Ohio River system. Occasional Papers of the Museum of Zoology, Univeristy of Michigan 406:1-4.

Goodrich, C. 1940. The Pleuroceridae of the Ohio River drainage system. Occasional Papers of the Museum of Zoology, Univeristy of Michigan 417:1-21.

Goodrich, C. and H. van der Schalie. 1944. A revision of the Mollusca of Indiana. American Midland Naturalist 32:257-326.

Goodrich C 1945. *Goniobasis livescens* of Michigan. Miscellaneous Papers, Museum of Zoology, University of Michigan 64: 1-36.

Goudreau, S.E., R.J. Neves, and R.J. Sheehan. 1993. Effects of wastewater treatment plant effluents on freshwater mollusks in the upper Clinch River, Virginia, USA. Hydrobiologia 252:211-230.

Greenwood, K.S. and J.H. Thorp. 2001. Aspects of ecology and conservation of sympatric, prosobranch snails in a large river. Hydrobiologia 455:229-236.

Haag, W.R. and M.L. Warren, Jr. 2006. Seasonal feeding specialization on snails by river darters (*Percina shumardi*) with a review of snail feeding by other darter species. Copeia 2006:604-612.

Houp, K.H. 1970. Population dynamics of *Pleurocera acuta* in a central Kentucky limestone stream. American Midland Naturalist 83:81-88.

Huryn, A.D., J.W. Koebel, and A.C. Benke. 1994. Life history and longevity of the pleurocerid snail *Elimia*: a comparative study of eight populations. Journal of the North American Benthological Society 13: 540–556.

Johnson, P.D. and K.M. Brown. 1997. The role of current and light in explaining the habitat distribution of the lotic snail *Elimia smicarinata* (Say). Journal of the North American Benthological Society 16:545-561.

Krist, A.C. 2002. Crayfish induce a defensive shell shape in a freshwater snail. Invertebrate Biology 121:235–242.

Lydeard, C., R.H. Cowie, W.F. Ponder, A.E. Bogan, P. Bouchet, S.A. Clark, K.S. Cummings, T.J. Frest, O. Gargominy, D.G. Herbert, R. Hershler, K.E. Perez, B. Roth, M. Seddon, E.E. Strong, and F.G. Thompson. 2004. The global decline of nonmarine mollusks. Bioscience 54:321-330.

Lysne, S.J., K.E. Perez, K.M. Brown, R.L. Minton, and J.D. Sides. 2008. A review of freshwater gastropod conservation: challenges and opportunities. Journal of the North American Benthological Society 27:463-470.

Minton, R.L. and C. Lydeard. 2003. Phylogeny, taxonomy, genetics and global ranks of an imperilled, freshwater snail genus *Lithasia* (Pleuroceridae). Molecular Ecology 12:75-87.

NatureServe. 2008. An online encyclopedia of life. Accessed 14 February 2008. http://www.natureserve.org/explorer/

Neves, R.J., A.E. Bogan, J.D. Williams, S.A. Ahlstedt, and P.W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: a downward spiral of diversity. p 43-85 *in* G.W. Benz and D.E. Collins (eds.). Aquatic fauna in peril: the southeastern perspective. Southeast Aquatic Research Institute Special Publication 1, Lenz Design and Communications, Decatur, Georgia. 554 p.

Newbold, J.D., J.W. Elwood, R.V. O'Neill, and A.L. Sheldon. 1983. Phosphorous dynamics in a woodland stream ecosystem: a study of nutrient spiraling. Ecology 64:1249–1265.

Pyron M., J. Beugly, E. Martin, and M. Spielman. 2008. Conservation of the freshwater gastropods of Indiana: Historic and current distributions. American Malacological Bulletin 26:137-151.

Richardson, T.D., and J.F. Scheiring. 1994. Ecological observations of two pleurocerid gastropods: *Elimia clara* (Lea) and *E. cawhawbensis* (Say). Veliger 37:284-289.

Richardson, T.D., J.F. Scheiring, and K.M. Brown. 1988. Secondary production of two lotic snails (Pleuroceridae: *Elimia*). Journal of the North American Benthological Society 7:234–245.

Simon, T.P. 2006. Biodiversity of fishes in the Wabash River: status, indicators, and threats. Proceedings of the Indiana Academy of Science 115:136-148.

Stewart, T.W. 2006. The freshwater gastropods of Iowa (1821-1998): Species composition, geographic distributions, and conservation concerns. American Malacological Bulletin 21:59-75.

Taylor, R.W. and B.D. Spurlock. 1982. The changing Ohio River naiad fauna: A comparison of early Indian middens with today. Nautilus 96:49-51.

Tiemann, J.S. and K.S. Cummings. *In press*. New record for the freshwater snail *Lithasia geniculata* (Gastropoda: Pleuroceridae) in the Ohio River, Illinois, with comments on potential threats to the population. Southeastern Naturalist.

Tucker, J.K. 1994. Windrow formation of two snails (Families Viviparidae and Pleuroceridae) colonized by the exotic zebra mussel, *Dreissena polymorpha*. Journal of Freshwater Ecology 9:85-86.

Turgeon, D.D., Quinn, Jr., J.F., Bogan, A.E., Coan, E.V., Hochberg, F.G., Lyons, W.G., Mikkelsen, P.M., Neves, R.J., Roper, C.F.E., Rosenberg, G., Roth, B., Scheltema, A., Thompson, F.G., Vecchione, M., and Williams, J.D. 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. 526 p.

Williams, J.D., M.L. Warren, Jr., K.S. Cummings, J.L. Harris, and R.J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. Fisheries 18(9):6-22.

Wu, S.K., R.D. Oesch, and M.E. Gordon. 1997. Missouri Aquatic Snails. Missouri Department of Conservation, Natural History Series, Number 5, Jefferson City, Missouri. 97 p.

**Appendix 1.** Diagnostic key to the *Lithasia* of Illinois (Aperture forms an obvious canal; columella twisted and thickened above and below, shell ovoid (egg-shaped), turban-shaped, or fusiform). Key modified from Goodrich and van der Schalie (1944), Branson (1987), and Burch (1989). Juveniles can be difficult to identify because characteristics used to distinguish among species are not always present/developed. Therefore, it is best to use adults (typically ≥15 mm in length).

# Key to the species of *Lithasia* (Pleuroceridae) in Illinois

1a. Shell with row of nodules on periphery of body whorl; columellar margin of the aperture usually thickened, meeting the anterior lip with a channel; a calloused thickening usually occurs on the parietal wall at the posterior end of the aperture ..... 2

1b. Shell without nodules on the periphery of body whorl; compactly ovoid; without plicae (ridges); parietal wall not callus thickened; found in larger streams in the Wabash and Ohio river basins .....*Lithasia obovata* (Fig. 3)

2a. Adults have a central row of tubercles or numerous small tubercles in parallel rows on body whorl..... 3

2b. Adults have a crown-like row of tubercles on body whorl; found in the Ohio River .....*Lithasia geniculata* (Fig. 2)

3a. Adults have a central row of tubercles on body whorl; found in the Wabash and Ohio rivers.....*Lithasia armigera* (Fig. 1)

3b. Adults have numerous small tubercles in parallel rows on body whorl; found in the Wabash and Ohio rivers .....*Lithasia verrucosa* (Fig. 4)

# CHAPTER 2

## New Record for the Freshwater Snail *Lithasia geniculata* (Gastropoda: Pleuroceridae) in the Ohio River, Illinois, with Comments on Potential Threats to the Population

*This chapter was submitted and accepted as a note to the Southeastern Naturalist.*

**Abstract** – We report on a recently discovered population of the freshwater snail *Lithasia geniculata* Haldeman (Gastropoda: Pleuroceridae) from the Ohio River, Illinois, the first documented occurrence for this species outside the Tennessee and Cumberland river basins. We collected 14 individuals on 26–27 August 2008 from the Ohio River, near Mound City, Pulaski County, Illinois. All of the specimens collected were discovered on an exposed shoal after the river dropped ~0.5 m in a 24 hr period and contained several (7–33) *Dreissena polymorpha* (Pallas) attached to their shells.

Freshwater snails (Gastropoda) are a vital component of many stream ecosystems. Not only does their sensitivity to perturbations allow them to be used as biological indicators of stream integrity, but they also occupy a central position in food webs by grazing on periphyton and providing a food source for predators (Brown et al. 2008). The family Pleuroceridae, a group of gill-breathing, operculate snails, reaches its greatest diversity in streams of the southeastern United States (Burch 1989; Minton and Lydeard 2003; Brown et al. 2008). Within North America, the group is composed of 7 genera and approximately 156 species but has experienced a severe decline in diversity during the past century (Burch 1989; Turgeon et al. 1998; Graf 2001; Minton and Lydeard 2003; Brown et al. 2008). The entire genus *Gyrotoma* (6 species), endemic to the shoals of the Coosa River, Alabama-Georgia, and approximately 26 other species in the family are now presumed globally extinct due to inundation of riffle areas by impoundments and habitat degradation from poor land-use practices (Burch 1989; Brown et al. 2008; Lysne

et al. 2008). The 32 extinct species, plus the 5 that are on the federal endangered species list, comprise roughly 20% of the known North American pleurocerid fauna. Freshwater gastropods remain an understudied fauna, and disseminating research findings (e.g., distribution and status records) so that all parties have access to the most up-to-date information is an important factor in snail conservation (Brown et al. 2008; Lysne et al. 2008; Perez and Milton 2008).

Illinois is on the northwestern edge of the range of pleurocerids, but little is known about the group in the state (Cummings 1991). The last to compile information on the distribution and status of the family in Illinois was Baker (1906). In Illinois, 8 of the 11 pleurocerid species are found only in the Wabash/Ohio river basin (Baker 1906; Burch 1989; Cummings 1991). We have begun investigating the status of pleurocerids of Illinois by conducting literature reviews (e.g., Goodrich 1940; Goodrich 1941; Burch 1989), examining museum specimens and data (e.g., Carnegie Museum of Natural History, Pittsburgh [CM]; Chicago Academy of Science [CA]; Field Museum of Natural History, Chicago [FMNH]; Florida Museum of Natural History, Gainesville [UF]; the now combined Illinois Natural History Survey [INHS] and University of Illinois Museum of Natural History [UIMNH], Champaign; Ohio State University Museum, Columbus [OSUM]; and University of Michigan Museum of Zoology, Ann Arbor [UMMZ]; acronyms follow Leviton et al. 1985, except for Ohio State), and qualitatively collecting snails throughout the state. While conducting surveys of the Ohio River, we found an undocumented population of *Lithasia geniculata* Haldeman (Ornate Rocksnail) (Fig. 1) and herein report about it and potential threats to the population.

We conducted turtle and qualitative snail surveys in the Ohio River downstream of Metropolis, Illinois, on 25–27 August 2008. While checking turtle traps near Mound City, Pulaski County, on the 26$^{th}$, we noticed the river had dropped approximately 0.5 m from the previous day. This drop in water level exposed a shoal that was not sampled on the 25$^{th}$. We sampled the shoal for 0.5 person-hours on the 26$^{th}$ and 0.75 person-hours on the 27$^{th}$. Fourteen live individuals of *L. geniculata* were collected during the 2-d period and were found in sandy areas with small amounts of gravel. The exposed pools on the

shoals were large and numerous individuals were observed but not collected; in addition, not all of the exposed pools were sampled. Individuals collected were preserved in 95% EtOH and deposited into the Illinois Natural History Survey Mollusk Collection, Champaign (INHS 32740). The 14 vouchered individuals varied in height from 17-25 mm (mean 21.1 $\pm$ 2.3 mm SD). Although *L. geniculata* can be phenotypically variable (Minton et al. 2008), the specimens we collected were distinctly shouldered with a single crown-like row of nodules on the upper portion of the body whorl (Fig. 1), typical of *L. geniculata* (Goodrich 1941; Branson 1987).

Prior to our survey, the only published records of *L. geniculata* (= *L. geniculata geniculata* and *L. geniculata fuliginosa*) were from the Tennessee River drainage (e.g., mainstem Tennessee River and Duck River basin) in Kentucky, Tennessee, and Alabama, and the Cumberland River drainage (e.g. mainstem Cumberland River and Red River basin) in Kentucky and Tennessee (Goodrich 1940; Gooch et al. 1979; Burch 1989; Minton 2002; Minton and Lydeard 2003). The closest populations of *L. geniculata* to the one we discovered appears to be in the Tennessee River downstream of Kentucky Lake at river mile 5.3 (Gooch et al. 1979), and in the Cumberland River downstream of Lake Barkley near river mile 9 (J. Sickel, Murray State University, pers. comm.; INHS 33096). Our discovery expands the known range of *L. geniculata* into a new basin (Ohio River), a new state (Illinois), and documents its occurrence in the lower Tennessee and Cumberland rivers (Fig. 2).

We did, however, encounter additional specimens in our museum search referable to *L. geniculata* from the Falls of the Ohio River, near Louisville, Kentucky, collected in 1904 (FMNH 80314). OSUM has two lots from the Ohio River that are referable to *L. geniculata*: 22 miles upstream of Louisville collected by C. Stein in 1961 (OSUM 14378), and 10 river miles upstream of Louisville collected by Greenwood and Thorp in 1989 (OSUM 19823). Although the OSUM specimens were initially identified as *Lithasia obovata* (Say) (Shawnee Rocksnail), they were distinctly shouldered but lacked a definite row of nodules. Minton et al. (2008) suggested that *Lithasia* spp. can contain

substantial intraspecific variation in shell form. We believe that such ecophenotypic plasticity might help to explain the morphological form found in the upper Ohio River.

It seems doubtful that the Ohio River individuals were deliberately discarded though human activity. We know of no published studies documenting snail transport on barges or boats, nor do we know of any aquatic organisms (e.g., macrophytes) transported from Tennessee to the Ohio River. Also, pleurocerids are not a component of the pet or bait trade. We also think it is improbable that the snails washed or moved downstream from extant populations upstream in the Tennessee River because of the lack of habitat in the intervening impoundments (Isom 1971) and the limited dispersal capabilities of freshwater snails (Brown et al. 2008). Greenwood and Thorp (2001) suggested that *Lithasia* spp. are vulnerable because of their affinity to specialized habitats (e.g., clean rocky substrates in larger streams) and their inability to disperse due to impoundments. Almost the entire area separating the Ohio River population from those upstream in Tennessee and Cumberland rivers has changed from lotic to lentic habitat through the creation of two large impoundments (Lake Barkley and Kentucky Lake). In addition, two locks and dams are present on the Ohio River and between the population we discovered in Illinois and those in the nearby lower Tennessee and Cumberland rivers. It seems probable that the impounding of the lower Tennessee and Cumberland rivers eliminated historical intervening populations of *L. geniculata* in those rivers. Isom (1971) stated that the decline of pleurocerids throughout the Tennessee River Valley was associated with habitat alteration as a result of impoundments, but offered no substantiating data. Neves et al. (1997) stated that impoundments have had a detrimental effect on freshwater gastropods "although poorly documented." We have found no studies specifically documenting the effects of impoundments on gastropods. While speculation that impoundments have negative effects on riverine gastropods seems intuitive, data supporting such claims await further studies.

It is beyond the scope of our study to determine if the Ohio River population is native or introduced; however, based upon the FMNH and OSUM specimens, records from Gooch et al. (1979) in Kentucky Lake (river mile 145) and Pickwick Reservoir (River mile 257)

and the fact that snails are an understudied group (Lysne et al. 2008), it seems likely that the populations upstream of Kentucky Lake and Lake Barkley were contiguous with the Ohio River population before the Tennessee and Cumberland rivers were impounded. We suspect that the native range of *L. geniculata* included the lower Ohio River from Louisville, Kentucky, to the confluence with the Mississippi River at Cairo, Illinois, and that the Ohio River populations went undetected until our survey. Additional fieldwork is necessary to further elucidate the range of *L. geniculata* in the Ohio River.

Lysne et al. (2008) listed four conservation challenges that freshwater gastropods face, including negative effects from invasive species. The *L. geniculata* collected contained numerous (7–33) *Dreissena polymorpha* (Pallas) (Zebra Mussel) attached, as did other live snails present, including *Lithasia armigera* (Say) (Armored Rocksnail), *Lithasia verrucosa* (Rafinesque) (Verrucose Rocksnail), and *Pleurocera canaliculata* (Say) (Silty Hornsnail). In addition, we saw hundreds of dead snails (all species listed above) infested with *D. polymorpha*. We can only speculate the Zebra Mussels caused the snails' demise. *Dreissena polymorpha* has been known to colonize pleurocerids and pose a threat to their survival (Tucker 1994; Greenwood and Thorp 2001). Greenwood and Thorp (2001) suggested that *D. polymorpha* might negatively affect gastropods by biofouling (e.g., impeding feeding, growth, movement, respiration, and reproduction), as has been reported for freshwater mussels (Hebert et al. 1991; Strayer and Malcom 2007). Greenwood and Thorp (2001) also suggested that Zebra Mussel infestations increase with water depth, and reported that very few *Lithasia* found were polluted with *D. polymorpha*. However, we noticed that all *Lithasia* spp. we encountered were fouled with *D. polymorpha* in the shallows of the river. Some individuals resembled "golf balls" as reported by Greenwood and Thorp (2001) for *P. canaliculata* from the deeper portions of the Ohio River.

Another conservation challenge for aquatic gastropod is loss of habitat pertaining to water demand (Lysne et al. 2008). We observed several thousand pleurocerids (all species listed above) and other mollusks (both bivalves and gastropods) marooned at the Mound City site due to the drastic drop in water levels. The Ohio River is a highly

regulated stream with over 20 locks and dams from the origin at Pittsburgh, Pennsylvania, to the confluence with the Mississippi River. The fluctuation in water levels to regulate the navigation channel can leave shoals exposed, causing mollusks to be stranded and at risk of desiccation. As seen with freshwater mussels (Metcalf 1983; Golladay et al. 2004), it is assumed that drought-like conditions can cause movement restrictions, physiological stress, and even death.

Given the global conservation status of G3 (vulnerable to extirpation or extinction) assigned to *L. geniculata* by Minton and Lydeard (2003) and the distance to the populations upstream of Kentucky Lake and Lake Barkley, efforts (e.g., listing at the state level) should be taken to protect the Ohio River population. Future studies could include additional sampling methods (e.g., trawling and diving) to assess the full range and habitat preference of the species, and genetic analysis to determine if the Ohio River population is unique.

## Acknowledgments

Funds were provided in part by a grant from the Illinois Department of Natural Resources' Wildlife Preservation Fund and the Illinois Department of Transportation. C. Phillips assisted in collecting. D. Foighil (UMMZ), J. Gerber (FMNH), T. Pearce (CM), D. Roberts (CA), J. Slapcinsky (UF), and T. Watters (OSUM) generously provided access to specimens and data under their care.H. Dunn and L. Koch shared their specimens from the lower Cumberland River. S. Chance, G. Levin, R. Minton, J. Sickel, and B. Tiemann offered comments and constructive criticism.

## Literature Cited

Baker, F.C. 1906. A catalogue of the Mollusca of Illinois. Bulletin of the Illinois State Laboratory of Natural History 7:53-136.

Branson, B.A. 1987. Keys to the aquatic Gastropoda known from Kentucky. Transactions of the Kentucky Academy of Science 48:11-19.

Brown, K.M., B. Lang, and K.E. Perez. 2008. The conservation ecology of North American pleurocerid and hydrobiid gastropods. Journal of the North American Benthological Society 27:484-495.

Burch, J.B. 1989. North American freshwater snails. Malacological Publications, Hamburg, Michigan. viii + 365 pp.

Cummings, K.S. 1991. The aquatic Mollusca of Illinois. Pp. 429-439 *in* L.M. Page and M.R. Jeffords (editors). Our living heritage: The biological resources of Illinois. Illinois Natural History Survey Bulletin 34:357-477.

Golladay, S.W., P. Gagnon, M. Kearns, J.M. Battle, and D.W. Hicks. 2004. Response of freshwater mussel assemblages (Bivalvia: Unionidae) to a record drought in the Gulf Coastal Plain of southwestern Georgia. Journal of the North American Benthological Society 23:494-506.

Gooch, C.H., W.J. Pardue, and D.C. Wade. 1979. Recent mollusk investigations on the Tennessee River, 1978. Draft Report. Tennessee Valley Authority, Division of Environmental Planning, Muscle Shoals, Alabama and Chattanooga, Tennessee. 126 pp.

Goodrich, C. 1940. The Pleuroceridae of the Ohio River drainage system. Occasional Papers of the Museum of Zoology, University of Michigan 417:1-21.

Goodrich, C. 1941. Studies on the gastropod family Pleuroceridae – VIII. Occasional Papers of the Museum of Zoology, University of Michigan 447:1-13.

Graf, D.L. 2001. The cleansing of the Augean Stables, or a lexicon of the nominal species of the Pleuroceridae (Gastropoda: Prosobranchia) of recent North America, North of Mexico. Walkerana 12:1-124.

Greenwood, K.S. and J.H. Thorp. 2001. Aspects of ecology and conservation of sympatric, prosobranch snails in a large river. Hydrobiologia 455:229-236.

Hebert, P.D.N., C.C. Wilson, M.H. Murdoch, and R. Lazer. 1991. Demography and ecological impacts of the invading mollusk *Dreissena polymorpha*. Canadian Journal of Fisheries and Aquatic Sciences 69:405-409.

Isom, B.G. 1971. Effects of storage and mainstream reservoirs on benthic macroinvertebrates in the Tennessee valley. Pp. 179-191 *in* G.E. Hall (editor).

Reservoir fisheries and limnology. American Fisheries Society Special Publication 8. 511 pp.

Leviton, A.E., R.H. Gibbs, Jr., E. Heal, and C.E. Dawson. 1985. Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia 1985:802-832.

Lysne, S.J., K.E. Perez, K.M. Brown, R.L. Minton, and J.D. Sides. 2008. A review of freshwater gastropod conservation: Challenges and opportunities. Journal of the North American Benthological Society 27:463-470.

Metcalf, A.L. 1983. Mortality in unionacean mussels in a year of drought. Transactions of the Kansas Academy of Science 86:89-92.

Minton, R.L. 2002. A cladistic analysis of *Lithasia* (Gastropoda: Pleuroceridae) using morphological characters. Nautilus 116:39-49.

Minton, R.L. and C. Lydeard. 2003. Phylogeny, taxonomy, genetics and global ranks of an imperilled, freshwater snail genus *Lithasia* (Pleuroceridae). Molecular Ecology 12:75-87.

Minton, R.L, A.P. Norwood, and D.M. Hayes. 2008. Quantifying phenotypic gradients in freshwater snails: A cases study in *Lithasia* (Gastropoda: Pleuroceridae). Hydrobiologia 605:173-182.

Neves, R.J., A.E. Bogan, J.D. Williams, S.A. Ahlstedt, and P.W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: A downward spiral of diversity. Pp. 43-85 *in* G.W. Benz and D.E. Collins (editors). Aquatic fauna in peril: The southeastern perspective. Southeast Aquatic Research Institute Special Publication 1, Lenz Design and Communications, Decatur, Georgia. 554 pp.

Perez, K.E. and R.L. Milton. 2008. Practical applications for systematics and taxonomy in North American freshwater gastropod conservation. Journal of the North American Benthological Society 27:471-483.

Strayer, D.L. and H.M. Malcom. 2007. Effects of zebra mussels (*Dreissena polymorpha*) on native bivalves: The beginning of the end or the end of the beginning? Journal of the North American Benthological Society 26:111-122.

Tucker, J.K. 1994. Windrow formation of two snails (families Viviparidae and Pleuroceridae) colonized by the exotic zebra mussel, *Dreissena polymorpha*. Journal of Freshwater Ecology 9:85-86.

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. 526 pp.

Figure 1. *Lithasia geniculata* Haldeman from the Ohio River, Mound City, Pulaski County, Illinois (INHS 32740). The specimen (24 mm in height) had 32 Zebra Mussels removed for identification purposes.

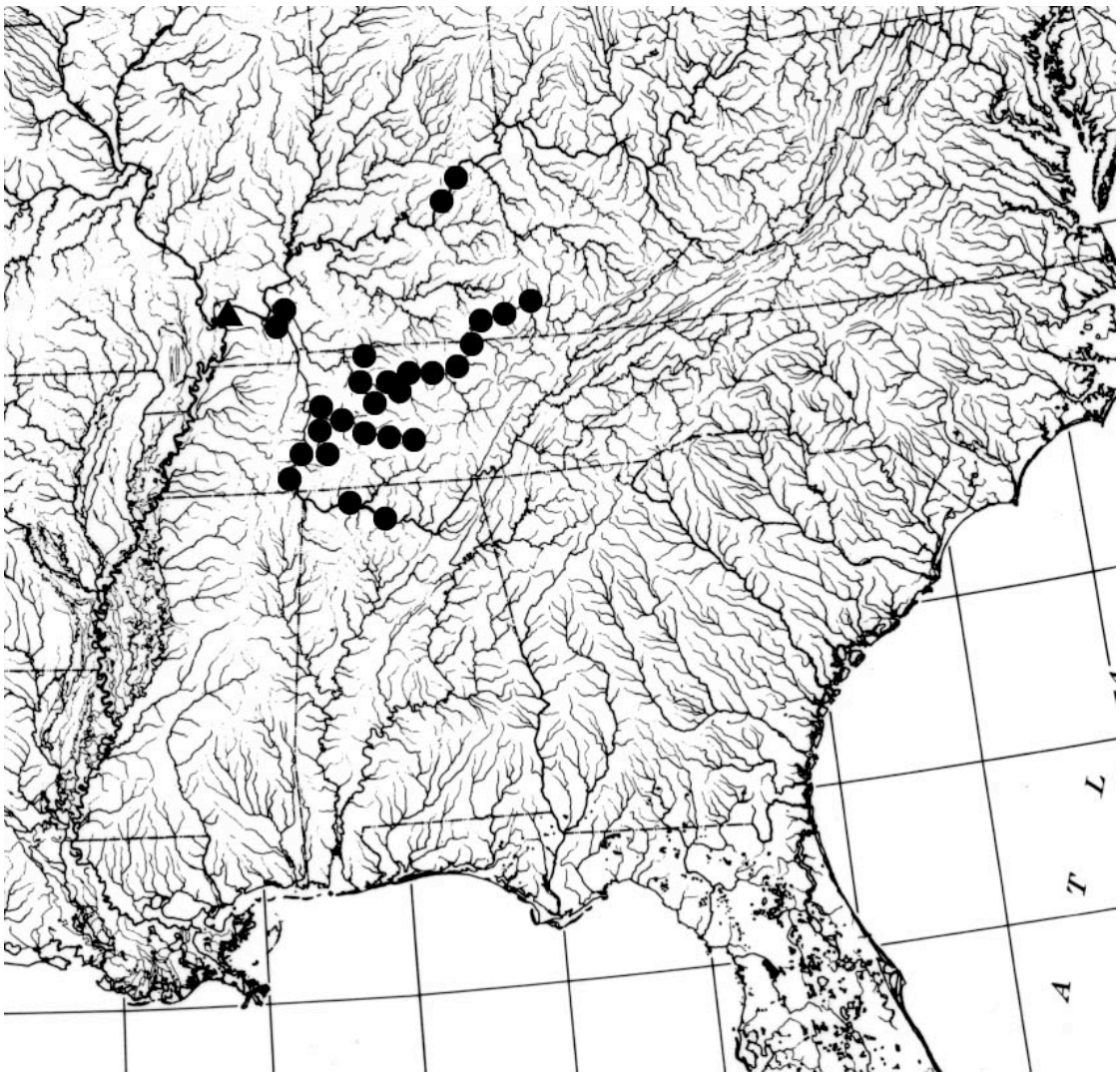

Figure 2. Distribution of *Lithasia geniculata* Haldeman. Triangle indicates where the Ohio River, Illinois, specimen was found, and circles indicate where the species was known prior to our survey. Historical information (= *L. geniculata geniculata* and *L. geniculata fuliginosa*) obtained through Gooch et al. (1979) and specimens located at CA, CM, FMNH, INHS (including UIMNH), OSUM, UF, and UMMZ.