Study finds 'Goldilocks' effect in snail populations

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The snail species *Potamopyrgus antipodarum* is native to New Zealand, but has established itself in many other locations. Credit: Bart Zjilstra

A University of Iowa researcher has discovered that a "Goldilocks" effect applies to the reproductive output of a tiny New Zealand snail—considered a troublesome species in many countries—that may one day help environmentalists control their spread.

Known in the United States as the "New Zealand mud snail," the freshwater snail (*Potamopyrgus antipodarum*) grows to a length of about one-quarter inch in U.S. rivers and lakes, and up to one-half inch in its native New Zealand.

The snails were first discovered in the Pacific Northwest in the 1980s and have since spread widely throughout the West, including Yellowstone National Park, as well as east to the Great Lakes. Parts of the Snake River in Idaho have been reported to contain more than 100,000 snails per square meter.

The snail study, conducted by Maurine Neiman, assistant professor in the University of Iowa Department of Biology, appears in the Nov. 21 issue of the journal *PLOS ONE*. Her co-author, Nicholas Zachar, received his undergraduate degree from the UI in 2013 and currently is studying documentary filmmaking at American University, Washington, D.C. You can view the paper online, titled "Profound Effects of Population Density on Fitness-Related Traits in Invasive Freshwater Snail."

Neiman says her research has shown that although the species is resilient and prolific, certain boundaries may restrict its ability to grow and reproduce.

"The snails are incredibly sensitive to their environment," she says. "For example, we discovered that increasing population size from seven to eight snails results in a striking drop in reproductive output, with the snails in the eight-snail populations producing only half as many embryos as snails in the seven-cup populations. Altogether, we showed that population density had a major influence on individual growth rate and embryo production, effects that were often apparent even when comparing treatments that differed in population density by only one individual."

For purposes of the study, the snail populations were grown, fed, and maintained in laboratory conditions in order to eliminate the effects of other variables.

Neiman and Zachar also detected a so-called "Goldilocks" effect, in which too few or too many snails living together could adversely affect reproduction. This possibility is especially intriguing in light of another 2013 study by Neiman's group, which showed that the reproductive output of these snails can be controlled by simply exposing the snails to water conditioned by other snails, suggesting that reproduction in these invasive snails is affected by waterborne, snail-produced chemicals.

"While individual growth rate generally decreased as population density increased, we detected a hump-shaped relationship between embryo production and density, with females from intermediate-density treatments producing the most embryos and females from low- and high-density treatments producing the fewest embryos," Neiman says.

"These results indicate that there are profound and complex relationships between population density, growth rate, and embryo production in at least two lineages of this important model system, with potential implications for the study of invasive populations, research on the maintenance of sex, and approaches used in ecotoxicology," she says.

In 2011, Neiman, together with UI colleagues John M. Logsdon Jr., UI associate professor of biology, and collaborator Jeffrey Boore of the University of California, Berkeley, received a four-year, $876,752 grant from the National Science Foundation. That research, which uses both sexual and asexually reproducing representatives of the snail species, tests ideas of why sexual reproduction persists, including the hypothesis that sex is needed to prevent the buildup of harmful mutations.

In her *PLOS ONE* paper, Neiman notes that population density plays a central role in many important evolutionary and ecological hypotheses, including, but not limited to, those addressing why most organisms reproduce sexually.

Provided by University of Iowa

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