A comparison of successful and unsuccessful invasive lineages Study organism
by Jonathan A. Finger

In the summer of 2010 I was awarded a grant from the Pacific Northwest Shell Club towards my dissertation work on the invasive New Zealand mud snail *Potamopyrgus antipodarum* (**figure 1**). This project began that summer with collections from sample sites in Idaho. Offspring of collected individuals were grown in the lab for multiple generations. After all that, with the manuscript in progress, it seemed a logical time to provide feedback and insight into some of my findings.


figure 1

Looking back through the PNWSC's newsletters I realized that your organization is quite familiar with this organism (and its particularly noxious impacts) in Capitol Lake and other western locations. My work, however, focuses not on its current spread but its origins and the dynamics of its initial expansion. While the NZMS has spread to numerous western states since its arrival in the late 80s, the supposed origin of the western U.S. lies along the Snake River near Hagerman, Idaho (40 minutes southeast of Boise).

My work focuses on the origin because of the unique population genetics there. All US invasive populations of NZMS are asexual, and invaded areas outside of the origin, anywhere outside of the small stretch of the Snake near Bliss and Hagerman, are composed of solely one genetic clone of NZMS (Dybdahl and Drown 2010). In plain terms, any individual from, say, Capitol Lake, WA is genetically identical to an individual in Yellowstone, Oregon, California, or any other site in the Western US (this genotype is called US1). Now, if you travel to Hagerman, Idaho things are quite different. Here, multiple genetically different clones of NSMZ exist alongside one another (Hershler, Liu, and Clark 2010). So far, I have identified the common genotype, found outside the origin, and three others that are found only near Hagerman, ID. The rarest genotype (called US4) looks almost identical to the common invader while the other two (identified as US2 and US3) restricted genotypes look similar but with a slight difference in coloration and size (f**igure 2**).

This leads to one of the questions for my thesis and more specifically this project. If you assume that these different genotypes arrived at or near the same time (which is the general consensus), then why is every population on the west coast made of only US1 individuals? Why have the US2, US3, and US4 genotypes not expanded like their counterpart? This question is related directly to the NZMS invasion (why is this clone so invasive?), but also to the wider field of ecology (why do some species spread quickly while others remain endangered or threatened?).

figure 2

To answer this question I tested one of the possible mechanisms that can lead to an invasive species becoming so successful: phenotypic plasticity. Phenotypic plasticity is a complex idea in biology that involves the connection between an organism's genetics and its environment. We label an organism as phenotypically plastic when one genotype can lead to multiple phenotypes given different environments. Imagine a clone of yourself. We would expect your clone to look approximately identical to you. But what if raising your clone in a different state changed the color of its hair? or its height? Here, identical genetic information would lead to different physical traits depending on its environment. This is phenotypic plasticity.

The common invasive NZMS genotype (US1) has already been shown to be phenotypically plastic (Drown, Levri, and Dybdahl 2011). Physical traits of this genotype (such as length) changed based on the abiotic environment; despite being genetically identical. Based on this information I tested how plastic each genotype was in various environments. Perhaps increased plasticity (the ability to produce a more suitable phenotypes despite being clonal) in the widespread, invasive genotype is what allows it to live outside the origin. Put differently, the restricted genotypes could be phenotypically rigid; meaning they are limited in their ability to produce different phenotypes in different environments.

Preliminary results show support for this idea. When clonal strains of US1, US2, US3, and US4 were raised in a series of different environments, the common invader, US1, looked to have higher survival and reproduction rates across multiple environments. Their genotype was able to survive and reproduce in extreme conditions better than the restricted genotypes. This would imply that US2, US3, and US4 could be restricted to the origin because of their inability to produce phenotypes suitable to habitats outside the origin of the Snake. Meanwhile, US1 is able to produce viable phenotypes in habitats outside those of its counterparts.

Right now this is only one possible explanation for why we see monocultures of one genotype outside the origin. The rest of my thesis will explore other possible explanations. Ecology is ripe with different ideas of what controls the ranges of organisms: abiotic conditions, evolutionary forces, genetic predispositions, and many more. Future plans of mine include testing some of these hypotheses using this incredibly interesting snail system.

As mentioned before, I am in the process of writing the manuscript and will gladly make the final copy available when published. I would also be happy to provide additional information or answer questions on the subject material for those who are interested. The Pacific Northwest Shell Club grant has been invaluable to me in maintaining our lab's growth chambers, equipment, and supplies. I would like to extend a note of thanks to your organization for supporting me in my research and education.

References Cited

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Dybdahl, Mark F, and Devin M Drown. 2010. "The Absence of Genotypic Diversity in a Successful Parthenogenetic Invader." Biological Invasions 13 (7) (December 14): 1663–1672. doi:10.1007/s10530-010-9923-4.

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Previous articles about New Zealand mudsnail:

***The Dredgings* Volume 48 No. 3, 2008, p. 8.** A first report of the New Zealand mudsnail in British Columbia by George P. Holm

***The Dredgings* Volume 50 No. 6, 2010, pp. 5-7.** Freshwater mollusks found during a survey for *Potamopyrgus antipodarum* (New Zealand mudsnail) within a five-mile radius of Capitol Lake, Thurston County, Washington. by Edward J. Johannes