TESTING FIELD METHODS TO ASSESS INTERACTIONS BETWEEN NATIVE CADDISFLIES AND THE INVASIVE NEW ZEALAND MUDSNAIL (*POTAMOPYRGUS ANTIPODARUM)*

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✦ ABSTRACT

In Polecat Creek, WY, located in the Greater Yellowstone Ecosystem, the invasive New Zealand mudsnail (*Potamopyrgus antipodarum*) has been found to reach densities exceeding 500,000 individuals/m². At this extremely high density, *P. antipodarum* has been observed to consume most of the gross primary production and have a negative impact on native macroinvertebrates such as the *Hydropsyche* caddisfly. The current population of *P. antipodarum* in Polecat Creek has declined suggesting the population "boomed and busted"; the population was booming in 2000-2001, but in 2011 the population had decreased substantially suggesting a "bust" period for *P. antipodarum.* Native *Hydropsyche* caddisflies have increased dramatically in biomass during the 10-year span of data, which may indicate that some native macroinvertebrates have increased in biomass due to release of suppression by *P. antipodarum*. Consequently, during my research this summer I assessed several possible methods to test suppression of *Hydropsyche* by *P. antipodarum*. I devised a method to collect *Hydropsyche* and determined whether *Hydropsyche* can survive in experimental chambers for use in a future field experiment. I built wooden tiles to colonize *Hydropsyche* out of 4x4x2 inch wood blocks with 1/2 inch grooves along the length of the tile. Colonization was successful with approximately two *Hydropsyche* collected per tile in a 24-hour period. Based on low survival of *Hydropsyche* within experimental chambers, the use of different experimental chambers will be necessary. Specifically, chambers that are open on the upstream side should be used to better allow a fast flow of water, which is a requirement for *Hydropsyche* to collect food.

✦ INTRODUCTION

Non-native species that cause ecological or economic harm are commonly referred to as invasive species (Lockwood et al. 2007). The invasive New Zealand mud snail (*Potamopyrgus antipodarum*) is indigenous to New Zealand and is currently considered an invasive species in Australia, Europe, and North America (Zaranko et al. 1997). Although in its native range *P. antipodarum* reproduces both asexually by parthenogenesis and sexually, in its invaded range it reproduces only parthenogenically (Alonso and Castro-Diez 2008). This means that one female snail can colonize a new stream without a mate and that all snails are clones; embryos develop into identical female offspring without fertilization.

P. antipodarum first invaded streams and rivers in the Greater Yellowstone Ecosystem (GYE) of Wyoming in 1994 and has since reached extremely high population densities in some invaded streams and rivers (Kerans et al. 2005, Hall et al. 2006). In my study stream, Polecat Creek WY, densities exceeding 500,000 individuals/m^2 have been documented (Hall et al. 2006). Because of its abundance in Polecat Creek, *P. antipodarum* can control fluxes of carbon and nitrogen (Hall et al. 2003), dominate the flux of nitrogen from primary producers (Hall et al. 2003), consume 75% of the gross primary production, and represent 97% of invertebrate biomass (Hall et al. 2003, 2006). *P. antipodarum* are primarily grazers and consume periphyton, macrophytes, and detritus (Haynes and Taylor 1984, James et al. 2000).

P. antipodarum may also alter the Polecat Creek ecosystem by negatively affecting native macroinvertebrate species. For example, the high

biomass of *P. antipodarum* found in Polecat Creek nearly ceased growth of a native snail (Thon et al. in prep). In field experiments conducted in Polecat Creek, *P. antipodarum* growth also outpaced growth of a different native snail when the two species co-occurred (Riley et al. 2008). Other native taxa may also be negatively affected by *P. antipodarum*: mayflies in the genus *Ephemerella* overlap with *P. antipodarum* in their preferred diet (Krist and Charles 2012) and a colonization experiment in the Madison River of Yellowstone National Park showed that the number of native macroinvertebrates colonizing experimental tiles decreased with increasing *P. antipodarum* abundance (Kerans et al. 2005). Taken together, these negative effects of *P. antipodarum* on individual taxa, along with their consumption of up to 75% of gross primary production (Hall et al. 2003), suggest the possibility of widespread resource competition between *P. antipodarum* and native macroinvertebrates.

The abundance of *P. antipodarum* in Polecat Creek has significantly decreased since 2001 (Thon et al. in prep.). This severe decline may represent a population that has "boomed and busted": a population that reached high abundance (boom) followed by a sharp decline in abundance (bust). Moore et al. (2012) documented a boom and bust of *P. antipodarum* in the Upper Owens River, California. Moore and colleagues (2012) collected data over a 10-year period from the beginning of a *P. antipodarum* invasion and through the population bust. Immediately following the invasion of *P. antipodarum*, native grazing invertebrates decreased in abundance by 80% and then doubled in abundance after *P. antipodarum* abundance declined (Moore et al. 2012). Because *P. antipodarum* affects community structure (Moore et al. 2012) and ecosystem processes (Hall et al. 2003), its decline in Polecat Creek will also likely cause changes in the macroinvertebrate community. In support of this prediction, Thon et al. (in prep.) found that the decrease in *P. antipodarum* biomass from 2001-2009 coincided with an increase in biomass of a native snail species (*Fossaria sp.*) in Polecat Creek.

By comparing 2000-2001 and 2011 data, I have identified several native invertebrate taxa that were likely suppressed by *P. antipodarum* during the boom period (their abundance has increased greatly since the bust of *P. antipodarum).* Of those taxa, *Hydropsyche* caddisflies showed one of the greatest increases in abundance. In preparation for performing field experiments to elucidate the mechanisms by which *P. antipodarum* suppresses *Hydropsyche* caddisflies, I tested one method of collecting *Hydropsyche* and determined whether these caddisflies can survive inside experimental chambers.

✦ METHODS

Hydropsyche collection

Hydropsyche caddisfly larvae spin silk nets, which they use to collect and gather food. To take advantage of this behavior, I constructed colonization tiles from 4x4x2 inch wooden blocks. I used a circular power saw to cut 1/2 x 1 inch grooves down the length of the topside of the tile (Figure 1). I attached collection tiles to bricks to anchor them to the stream substrate (Figure 2). I left 12 tiles in Polecat Creek for 24 hours to assess whether *Hydropsyche* caddisflies would colonize the tiles.

Figure 1. Two *Hydropsyche* collection tiles attached to a brick.

Figure 2. Six *Hydropsyche* collection tiles placed in Polecat Creek.

Hydropsyche survival

In a future experiment, I plan to house *Hydropsyche* caddisflies and the invasive *P. antipodarum* together in experimental chambers. For the experimental chambers, I will use modified, square plastic sandwich containers (156.3 cm^2) with mesh (600-µm) windows on the top and sides to keep invertebrates in the chamber and allow fresh, oxygenated water to flow through the chamber (Figure 3). To determine the efficacy of these chambers, I

Figure 3. Modified sandwich container used as an experimental chamber.

wanted to know if *Hydropsyche* could survive in them for a duration of 5-7 days.

I placed 12 collection tiles, containing 1-3 colonized *Hydropsyche* caddisflies (29 larvae total), into experimental chambers and anchored them to bricks (Figure 4). I recorded the number and position of caddisfly larvae on the tiles before closing the chamber. I left the chambers in Polecat Creek and recorded the number of caddisfly larvae present within the chambers after seven days.

In a separate experiment, I placed six chambers in Polecat Creek as described above (13 larvae total). I also placed five colonized tiles in the creek without housing them inside chambers to determine if the chambers affected survival of larvae (12 larvae total). After five days, I recorded the number of larvae present on tiles of both treatments, ignoring new colonizations on tiles outside of chambers.

Figure 4. Eight *Hydropsyche* collection tiles within anchored experimental chambers.

✦ RESULTS

Hydropsyche collection

Hydropsyche collection was successful. After 24 hours in Polecat Creek, a total of 29 *Hydropsyche* larvae colonized the 12 collection tiles. All tiles were colonized by larvae with a minimum of one and a maximum of three larvae per tile (Figure 5).

Figure 5. *Hydropsyche* collection tile with three colonized caddisflies.

Hydropsyche survival

For the first experiment, after seven days in Polecat Creek, a total of 7 of 29 *Hydropsyche* larvae were present within the 12 experimental chambers (21.4%). In the second experiment, after five days in the creek, 4 of 13 larvae were present in the six chambers (30.8%). Five tiles not contained in chambers contained 11 of 12 larvae after five days in the creek (91.7%).

✦ Discussion

The *Hydropsyche* collection tiles performed above expectation. In 24 hours I collected 29 *Hydropsyche* larvae. Importantly, the tiles were colonized *only* by the target taxa, making separation of *Hydropsyche* from other taxa unnecessary.

Survival of *Hydropsyche* larvae within the experimental chambers was low (21-30%). These percentages represent larvae present, however, and may not have resulted from death, but departure of larvae from the chambers. The mesh size on the chamber windows was large enough for larvae to escape and larvae may have migrated out of the chambers due to undesirable conditions. Because *Hydropsyche* larvae require a fast flow of water in order to collect food in their nets, reduced flow from the chamber mesh may have caused larvae to migrate out of the chamber in search of better flow conditions.

In contrast, tiles that remained outside of chambers contained ~90% of the original larvae present. These results indicate that the experimental chambers used in future experiments must be modified. Accordingly, I will remove the mesh from the upstream side of the chambers to allow faster flow of water through the chamber. Escape from the open side of the chamber is unlikely since a large portion of larvae remained on tiles even when left in open water.

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