Type of article: Research article

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Mesocosm experiments revealed variable effects of non-native crayfish on native crayfish and aquatic ecosystems

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**ABSTRACT**

***Keywords:***

**INTRODUCTION**

Freshwater crayfish are one of the most imperiled groups of aquatic invertebrates in North America ( ) with about 50% of them threatened with extinction (Taylor et al. 2007). Despite their very restricted distribution coupled with habitat loss, non-native crayfish impacts cause a serious threat to the existence of native crayfish (Taylor et al. 2007; Richmon et al. 2015). Non-native crayfish are typically much aggressive than native counterparts and may outcompete native species for limited food and shelter ( ). Additionally, non-native crayfish may degrade the quality of aquatic habitats, mainly due to removal of aquatic macrophytes and macroinvertebrates ( ), and also act as vectors for diseases such as crayfish plague ( ).

Paragraph elaborating population/community level impacts- Sujan.

Paragraph elaborating ecosystem level impacts, heavy on leaf litter decomposition and water quality

Previous laboratory experiments showed that non-native red-swamp crayfish (*Procambarus clarkii*) and virile crayfish (*Orconectes virilis*) could outcompete native Piedmont crayfish (*Cambarus sp. C*) due to aggressive interactions and cause a significant reduction of survival of the native species under sympatry (Hale et al. 2016).

Although laboratory experiments generate limited information due to simplicity of the experimental systems and conditions under the results were generated, they may provide important first insights to understand the potential impacts and may help designing experiments to gather more realistic data. One approach would be to employ field mesocosm experiments which allow native and invasive species to interact under semi-natural conditions, allow experimenters to include natural variation of environmental conditions, adjust animal densities according to natural conditions and also to include other potential prey and predators (Henkanaththegedara and Stockwell 2014, 2015). Hill and Lodge successfully used large mesocosms to assess crayfish competition for habitats (1994) and effects of predation on crayfish growth and mortality (1999).

**METHODS**

*Collection, acclimation and preparation of crayfish*

Invasive virile crayfish (*O. virilis*) were collected from Clinch River at Dungannon in Smith County, Virginia using seines and dip nets. The native Piedmont crayfish (*Cambarus sp. C*) were collected from a first order tributary of Buffalo Creek in Prince Edward County, Virginia using dip nets. All crayfish were collected in fourth week of May 2016 and kept with stream water in coolers during transportation. Subsequently, crayfish were acclimated in 1250 L plastic mesocosms for 24 hours before stocking.

*Mesocosm setup and Experimental design*

We conducted a mesocosm experiment using thirty 1250 L circular plastic tanks as experimental units. Tanks were setup in an outside field at Longwood University, Farmville, Virginia allowing us to include the effects of natural variation of environmental conditions (e.g. temperature and precipitation) and natural colonizers of water bodies. Mesocosms were filled with treated tap water up to 30cm (XXX L) and aged for two weeks before stocking crayfish. Each mesocosm was provided with 8 pieces of 7.5 cm PVC tubes as shelter for crayfish and covered with poultry fence to exclude predators. About 70% of the tank surface was covered with shade cloth to mimic the average shade of a typical crayfish habitat and to avoid excess direct sunlight (Figure 1). Our experimental design included two controls and three treatments with 6 replicates for each group. We stocked crayfish according to following scheme allowing us to assess density-dependent invasive crayfish effects on native crayfish.

Table 1: Experimental design

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Crayfish species** | **Native control** | **Invasive low-density** | **Equal density** | **Invasive high-density** | **Invasive control** |
| Native *Cambarus sp. C* | 4 | 4 | 4 | 4 | 0 |
| Invasive *Orconectes virilis* | 0 | 2 | 4 | 6 | 4 |
| Total crayfish | 4 | 6 | 8 | 10 | 4 |

All crayfish were weighed for wet biomass (to the nearest 0.1 g) using a digital scale, and carapace length was measured (to the nearest 0.1 mm) using dial calipers before stocking. We attempted to stock each mesocosm with at least one male and one female reproductively mature crayfish of each species (carapace length > XX mm). We selected additional crayfish to represent a range of sizes and sexes depending on the availability of crayfish. This allowed us to track individual crayfish growth assuming equal growth rates of individuals within the same species. Additionally, we stocked only intermolt individuals and attempted to match average body size of invasive crayfish with native crayfish to eliminate any biased results due to extremely large crayfish.

*Crayfish sampling*

Crayfish were sampled using dip nets at day 18 (midpoint) and at the conclusion of the experiment at day 35. Individual crayfish were weighed for wet biomass (to the nearest 0.1 g) using a digital scale, and carapace length was measured (to the nearest 0.1 mm) using dial calipers.

*Leaf litter decomposition rate*

*Water quality measurements*

*Data analysis*

**Results**

**Discussion**

**Acknowledgements**

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**TABLES**

**Figure Legends**

Figure 1: Mesocosm setup utilized for current experiments.