Competition between *Littoraria irrorata* and *Melampus bidentatus* in the high marsh zone

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Abstract

Strong pressures from abiotic conditions (e.g., temperature, salinity, inundation) and biotic interactions, such as competition, lead to unique distributions of the gastropods, *Melampus bidentatus* and *Littoraria irrorata*, in low, mid- and high-mash zones of southeastern salt marshes. Although *Littoraria* can displace *Melampus* from mid-marsh to high-marsh zones, *Littoraria* abundance and biomass is relatively high in the high marsh zone. Three *Littoraria* density manipulations were used in two habitats differing in dominant plant species *Juncus roemerianus* and *Salicornia virginica*, to test whether competition or abiotic conditions affected the distribution of *Melampus* in the high-mash zone. Growth rates and survivorship were recorded to assess the competitive effects of *Littoraria* on *Melampus*. Soil constituents (e.g., sodium, pH), soil temperature, and soil salinity analyses within patches of *Juncus* and *Salicornia* were used to examine if abiotic conditions influenced differences in distribution of *Melampus* in the high marsh. *Melampus* growth was not significantly different among the three density treatments in either *J. roemerianus* or *S. virginica* habitats. *Melampus* survivorship was significantly different between habitats (higher in *Juncus* than in *Salicornia*) but not among varying density treatments. Soil content was significantly different between *Juncus* and *Salicornia* for pH, phosphorous, and sodium. Temperatures were, on average, higher in *Salicornia* than in *Juncus*. No evidence for competition was found in either *Juncus* or *Salicornia*. Therefore, habitat suitability, in particular abiotic conditions such as salinity and temperature, are most likely determining gastropod assemblages in the high marsh zone of Waites Island.

Introduction

- Melampus bidentatus is known to be limited to the high marsh of southeastern US salt marshes by competitive displacement from the mid-mash by *Littoraria irrorata*. However, *Littoraria* may also be abundant in the high marsh zone. Patterns in *Littoraria* distributions suggest either abiotic conditions or biotic interactions may be structuring gastropod assemblages in the high marsh.
- The overall goal was to examine the effects of *Littoraria* on the growth and survivorship of *Melampus* in the high marsh and to understand the mechanisms structuring *Melampus* distributions.

Objectives

- Examine the distribution of *Littoraria irrorata* and *Melampus bidentatus* (Figure 1) in the high marsh.
- Examine effects of *Littoraria* on growth and survivorship of *Melampus* in habitats dominated by two plant species:
  - *Juncus roemerianus*  
  - *Salicornia virginica*
- Examine abiotic conditions in *Juncus* and *Salicornia* that may affect distributions of *Melampus* and *Littoraria*.

Methods

- Studies were conducted in the salt marsh behind Waites Island, SC (Figure 3).
- Distributions were estimated in 1 m x 1 m quadrats haphazardly placed in habitats differing in dominant plant species.
- Differences among habitats were statistically assessed using MANOVA.
- Individuals for growth and survivorship were collected, marked and were placed in square enclosures (area = 1 m² height < 0.5 m) (Figure 2).
- Three treatments included *Melampus* at a constant density of 40 individuals.
- *Littoraria* densities consisted of three levels: zero, an ambient density of 40 individuals, and 80 individuals (2x ambient). A control enclosure of zero individuals was used to estimate cage effects on habitat.
- Treatments were repeated in *Juncus* (n = 6) and *Salicornia* (n = 6).
- Growth and survivorship were estimated at end of experiment (12 weeks) on recovered individuals. Survivorship was repeated during Fall months to assess survivorship during cooler temperatures (*Melampus* were found dead during first two weeks of summer survivorship experiment).
- Differences among treatments were assessed statistically using a one-way ANOVA for growth and survivorship.
- Soil samples from *Juncus* and *Salicornia* were tested for concentrations of Na, Mg, Mn, B, Zn, Copper, Calcium, Potassium and pH.
- Temperatures(ºC) were measured during the 12-week experiment to assess differences in temperatures between habitats.
- Chlorophyll *a* and plant stem heights, density and percent coverage were also assessed.

Results

- A significant difference was found among habitats for *M. bidentatus* abundance (MANOVA, *F*<sub>3,20</sub> = 13.086, *P* < 0.001). *Melampus* individuals were found in higher numbers in *J. roemerianus* and *S. patens*. No difference was detected among habitats for *L. irrorata* abundance (MANOVA, *F*<sub>3,20</sub> = 2.044, *P* = 0.140).
- Differences in concentrations of soil constituents between *Juncus* and *Salicornia* were assessed statistically using a one-way ANOVA.
- Temperatures(ºC) were measured during the 12-week experiment to assess differences in temperatures between habitats.
- Chlorophyll *a* and a plant stem heights, density and percent coverage were also assessed.

Conclusions

- Growth and survivorship of *Melampus* were not affected by presence or density manipulations of *Littoraria* in either habitat.
- Survivorship was significantly different between habitats, suggesting abiotic conditions (i.e., higher temperatures) are structuring *Melampus* distributions in the high marsh.
- *Melampus* populations may not be affected by competition because the high marsh may be more heterogeneous than expected allowing for less overlap of resources and more suitable habitats.

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