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A Comparison of Native and Invasive Plant Species Microhabitats in Western New York

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Erratum
Sponsored by Suann Yang

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Abstract

Across the United States, invasive plant species have had significant negative environmental effects due to certain unique characteristics they possess. Extended leaf phenology allows invasive plants to retain their leaves longer during the late summer and fall months, outcompete native plant species and provide cover for seed predators that would be vulnerable under its absence. Our past research concluded that the extended leaf phenology of invasive plant species *Lonicera maackii* (Amur Honeysuckle) reduced seed predation, which may be due to cooler and less favorable microclimates for invertebrate seed predators. In Fall 2019, we conducted a field experiment to observe the microhabitat preferences of snails. Snails consume leaves, fruits, and seeds, as well as being sensitive to the temperature, moisture, humidity, and light of their surrounding environment. In our study, we selected six pairs of invasive *L. maackii* and native *Cornus racemosa* (Gray Dogwood) throughout the Roemer Arboretum located in Geneseo, New York. Pairs were selected so both native and invasive species were in close enough proximity to receive the same environmental conditions (within 1 m of each other). Twice weekly, we recorded temperature, relative humidity, air velocity, light, soil pH, and soil moisture along with the number and size of snails found on the plant and within 0.3 m of its surrounding leaf litter. Preliminary results suggest that snail microhabitat preference was nonrandom with respect to the extended leaf phenology that *L. maackii* exhibits. We conducted a follow-up experiment to observe snail habitat preference in indoor enclosures. The snails were given the options between native and invasive leaves and branches, leaf litter from the field containing a mix of both native and invasive leaves, and individual leaf species litter (native and invasive separate). The snails moved from the native to the invasive environment and vice-versa, their movements appearing to be complex and variable but suggest preferences may be present. Thus, plant leaf traits appear to be an important factor in shaping microhabitat preferences for snails in invaded plant communities. As the

overall vegetative diversity decreases due to invasive plant species, increased shifts in microhabitat preference is likely to occur.

Across the United States, invasive plant species have had significant negative environmental effects. Extended leaf phenology allows invasive plants to retain their leaves longer during the late summer and fall months, outcompete native plant species, and provide cover for seed predators that would be vulnerable under its absence (Smith, 2013). My past research concluded that the extended leaf phenology of invasive plant species *Lonicera maackii* (Amur Honeysuckle) reduced seed predation, which may be due to cooler and less favorable microclimates for invertebrate seed predators. This led me to my research question: Do native and invasive plant species provide novel microclimate conditions and does this cause preferential habitat selection by invertebrate land snails? I predicted that there would be more snails found on invasive plant species due to their extended leaf phenology providing coverage later in the fall and conducted two experiments in Fall 2019 to test this prediction. A field experiment comparing the number of snails observed as well as the environmental conditions of six *L. maackii* and *Cornus racemosa* (Gray Dogwood) throughout the Roemer Arboretum, located in Geneseo, New York, followed by a cafeteria experiment—observing free-choice feeding—in environmentally controlled enclosures to observe snail preference of native and invasive leaf characteristics.

Methods and Materials

The field experiment was conducted in the Roemer Arboretum located on the south end of SUNY Geneseo in Geneseo, New York. In the fall of 2019, six pairs of invasive *L. maackii* and native *C. racemosa* were selected and flagged throughout the Roemer Arboretum. Pairs were selected so both native and invasive species were in close enough proximity to receive the same environmental conditions (within 1 m of each other). Two mornings each week, we recorded temperature, relative humidity, air velocity, light, soil pH, and soil moisture along with the number and size of snails found on the plant pairs and within 0.3 m of their surrounding leaf litter. An Extech 45170 Four in One Environmental Meter was used to record the temperature, relative humidity, air velocity, and light. While an Atree Soil pH Meter was used to record the soil pH and moisture. Microclimate conditions, snail presence, and snail size were all recorded in a spreadsheet, where a snail ID was assigned if a snail was repeatedly found on the same plant. Snails found were measured using a caliber, painted with nail polish, and numbered using a permanent marker for identification purposes, due to a concern that the leaf characteristics may be causing preferential behavior rather than novel preferred microclimates. A cafeteria experiment was conducted in which the environmental conditions remained constant and the leaf characteristics themselves were isolated. The snails were chosen at random and placed in enclosures inside SUNY Geneseo's greenhouse to provide more stable environmental conditions. The snail's enclosures had plastic bottoms lined with soil, with mesh walls and tops.

The enclosures were kept moist daily by spraying them with water after the data was collected. Three weeks of testing and observation for snail preference were conducted with a different variable being tested each week (*Table 1*).

Table 1.
Cafeteria experiment variables being tested

Date	Variable Being Tested
Week 1: 10/22/19-10/26/19	Native and invasive leaves on branches
Week 2: 11/2/19 – 11/6/19	Organic native and invasive leaf litter collected from the field
Week 3: 11/9/19 -11/13/19	Individual native and invasive leaf litter (native and invasive leaves kept separate

Enclosures were divided by cardboard walls, fitted to the enclosure with five "windows" cut in them to provide separate native and invasive leaf options. Snails could move freely between the two sides of the enclosure via openings in the divider. At the beginning of a test week, four yellow-painted snails numbered 1 through 4 were placed on the native side of the enclosure. Similarly, four red-painted snails numbered 1 through 4 were placed on the invasive side. Based upon their starting enclosure side, each snail's location was recorded every morning for a week to observe any movements between the "native" and "invasive" sides of the enclosure. A total of four enclosures were used per experimental week for replication.

Results and Statistical Analysis

Based on the field experiment data, of the plants observed with snails on them, a logistic regression revealed that snails are 2.44 times more likely on *C. racemosa* than on *L. maackii* (*Figure 1*, graph on left; x2 = 5.14, df = 1, p = 0.023). Of the total snails counted, there was roughly the same number of snails on *C. racemosa* as on *L. maackii* (*Figure 1*, graph on right; = 0.52, df = 1, p = 0.4724).

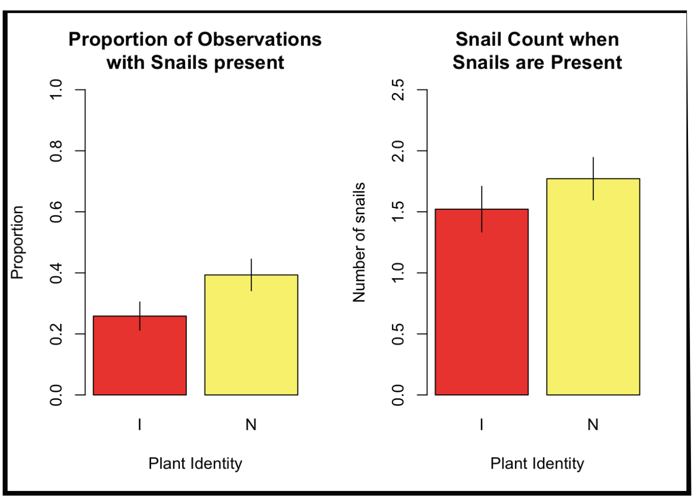

Figure 1. A logistic regression of the field experiment data

A two-dimensional plot of the field experiment data shows 95% confidence ellipses of the six environmental components of the native and invasive plant pairs. Axes in the same quadrant are positively correlated, while axes opposite of each other are negatively correlated. The alignment of the native and invasive ellipses indicate that the environmental microhabitats are not novel, but very similar (*Figure 2).*

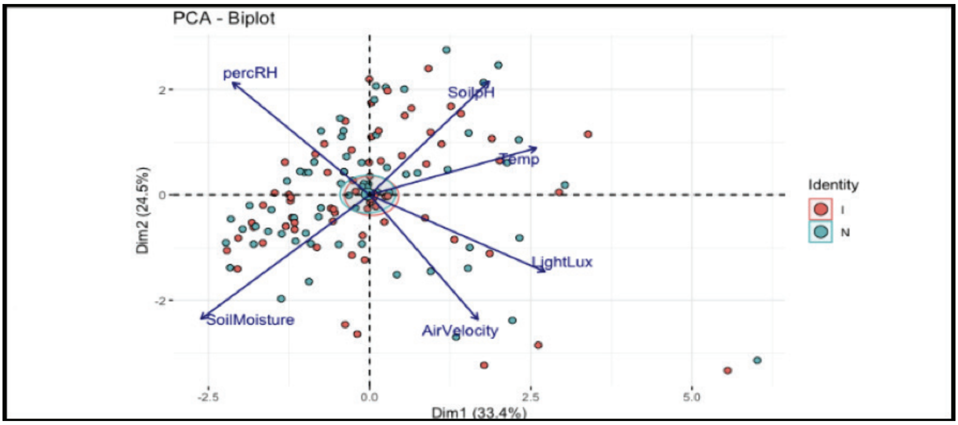

Figure 2. 2-D plot of the field experiment data

The cafeteria experiment data revealed an interaction between the original side of the enclosure the snails began on and the side the snails were later found on ($x2 = 16.8$, $DF = 1$, $p < 0.0001$). The bar graph representing the cafeteria experiment data indicates that the snails generally did not leave the side where they started. This demonstrates that the snails did not show any preference for the leaf characteristics, regardless of the trial type for either the native *C. racemosa* and invasive *L. maackii* (*Figure 3*).

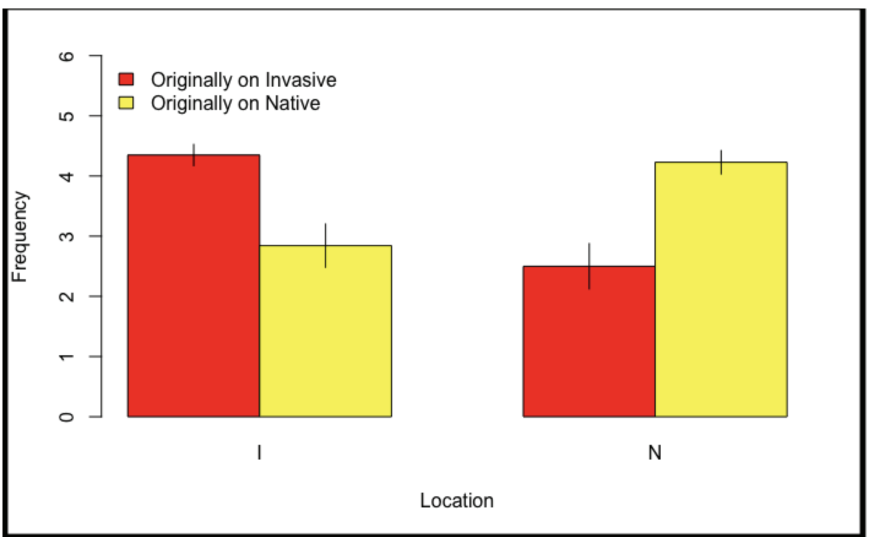

Figure 3. Logistic regression of the cafeteria experiment data

Both the cafeteria and field experiment were analyzed using generalized linear mixed effects models with binomial or Poisson errors. For the field experiment, plant identity (native, invasive) was a fixed effect, with date and pair as random effects. For the cafeteria experiment, original location and plant identity (native, invasive) were fixed effects, with date and enclosure as random effects. The generalized linear mixed effects models were conducted using the *lme4* package (Bates et al., 2015) in R (R Core Team, 2017). Tests of fixed effects were obtained using the *car* package (Fox & Weisberg, 2011). To test for novel microhabitat conditions, we conducted a principal components analysis in R using the *prcomp* function and generated a biplot using the *factoextra* package (Kassambara & Mundt, 2020).

Discussion and Ecological Implications

In the field experiment the snails displayed a significant preference for native Gray Dogwood (*C. racemosa*), only when observing both the presence and absence of snails. Of all the snails found on plants, there was not a significant difference in the number of snails found on either plants. The statistical analysis of the environmental conditions revealed native *C. racemosa* and invasive *L. maackii* do not create novel microclimate conditions. The cafeteria experiment revealed when environmental factors such as sunlight, temperature, wind speed, and moisture are kept constant, snails do not display a preference. This indicates that the specific leaf characteristics of the native *C. racemosa* and invasive *L. maackii* do not influence snail preference. These results show there is a preference for native *C. racemosa* demonstrated by snails, for reasons other than novel microclimates. I alternatively hypothesize that this preference may be due to the overall structural differences of the native and invasive plant, including how the snails are able get on the plant, the presence of a predator or competitor present on an invasive plant, or preference dependent on the snails being native or invasive themselves. This research experiment demonstrates that invertebrate seed predators exhibit plant preferences, in the case of snails for native plants. As invasive plant species continue to spread, they dominate the natural plant community and decrease the overall vegetative diversity, creating a less favorable habitat for most wildlife species (NRCS, 1996). A decrease in native plant species may lead to changes in microhabitats. This study demonstrates the importance and consequences of these changes for smaller animals. In the future, a repetition of this experiment during early summer months may reveal different preferences, as observations have shown that snails are likely more active during warm summer months.

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