Herbivory and disease symptoms in non-native, invasive plants co-occurring in the deciduous forest herb layer: garlic mustard, Japanese stilt-grass, and Norway maple.

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Abstract

Forest herb layers in urbanizing landscapes are colonized by multiple non-native species, but few studies compare their ecology within their shared communities. Invasive species are thought to be affected little by natural enemies, so comparison of enemy damage on these species should show little difference. We tested this idea with garlic mustard (*Alliariapetiolata*, ALPE), Japanese stilt-grass (*Microstegiumvimineum*, MIVI), and Norway maple (*Acer platanoides*, ACPL). In an experiment replicated across three New Jersey forests, we planted 120 seedlings of each into individual plots in a randomized design. Each focal seedling grew alone, with two seedlings of one of the other species, or with two sugar maple seedlings (a native). We harvested survivors near the end of the growing season, scanned the leaves digitally, and quantified herbivory (holes) or disease symptoms (necrosis). Presence of competitors had no effect on herbivory for any of the focal species, which was similar for all, at 15% leaf area missing, indicating that these invasive species have not escaped herbivory. Necrosis in ALPE and MIVI was decreased by an order of magnitude in the presence of ACPL, to only 0.2% leaf area for ALPE and 0.4% for MIVI. Presence of the native maple had no effect. After excluding ALPE and MIVI plants with ACPL competitors, we could compare all three focal species. ALPE leaves had about half the necrosis (6%) of MIVI and ACPL (13-14%) , which could confer an advantage to ALPE in communities invaded by a mixture of these species.

Introduction

- Three forest herb-layer species, *Alliariapetiolata* (garlic mustard - ALPE), *Microstegiumvimineum* (Japanese stilt grass - MIVI), and *Acer platanoides* (Norway maple - ACPL), are non-native invasive species in suburban/exurban forests in the northeastern United States. The Enemy Release Hypothesis predicts that non-native species such as these may become invasive due to escape from their natural enemies, allowing them to thrive in their new environments relative to native species, which are vulnerable to greater attack by their resident enemies.

- However, few studies have measured and compared symptoms of enemy attack on co-occurring invasive species in situ. Also, when they co-occur, these species may interact strongly with each other, and with native species. An important indirect interaction may be in the mediation of plant-enemy interactions.

- We conducted a field experiment to compare herbivory and disease symptoms among these three important invasive species, when grown with and without neighboring individuals of either one of the invasives or a native, *Acer saccharum* (sugar maple – ACSA).

Alliariapetiolata

Microstegiumvimineum

Acer platanoides

Methods

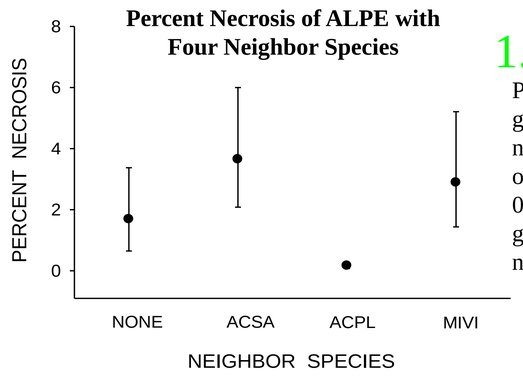
- Seedlings of all four species (ALPE, MIVI, ACPL, ACSA) started from locally collected seed in the greenhouse at The College of New Jersey.

- In May, seedlings planted into individual 1-m^2 cleared plots within three forests in central New Jersey : Mercer County Park Northwest (MCP), Washington Crossing State Park (WCR), and Stony Brook/Millstone Watershed (WSHD).

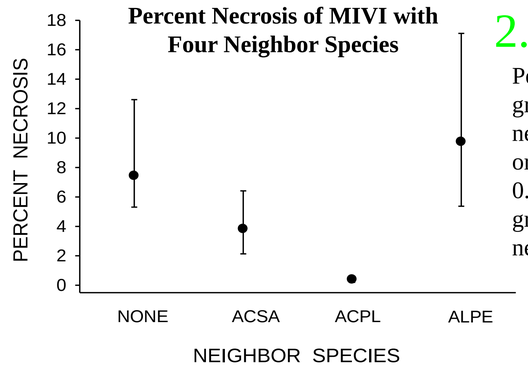
- 120 focal seedlings planted total, assigned to one of four treatments: focal species 1) alone; 2/3) with two seedlings of one of the other invasive species; or 4) with two individuals of the native ACSA.

- Surviving focal plants harvested in September; fresh leaves scanned, digitally analyzed for herbivory and necrosis (disease) using CIAS 2.0.

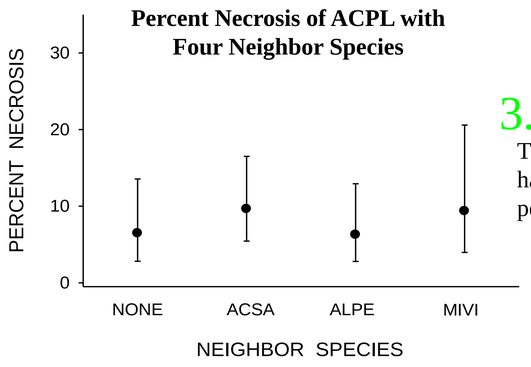
Results



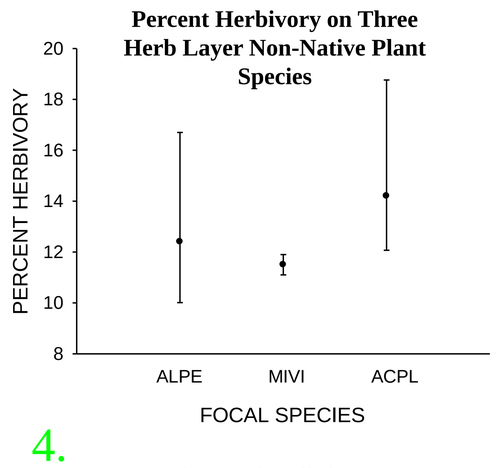
1. Percent necrosis of ALPE growing with ACPL as a neighbor decreased by an order of magnitude (to 0.17%) in comparison to its growth with other species as neighbors.



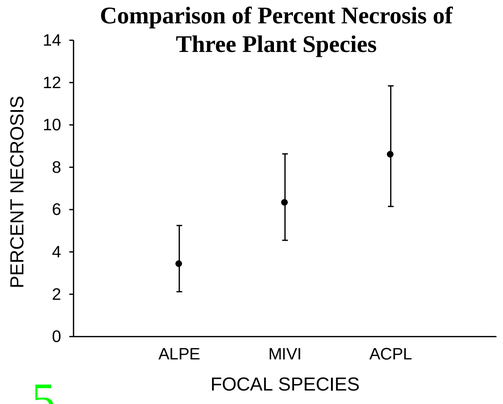
2. Percent necrosis of MIVI growing with ACPL as a neighbor decreased by an order of magnitude (to 0.39%) in comparison its growth with other species as neighbors.



3. The neighboring species had similar effects on the percent necrosis of ACPL.



4. Percent herbivory for all three species was very similar, with the highest value approximately 15% (the presence of competitors was not influential, so the data were pooled across competitor treatments).



5. ALPE has the lowest percent necrosis, approximately 3.5%, about half of the necrosis of MIVI (6.3%) and ACPL, 8.6% (ACPL competitors were removed from the ALPE and the MIVI data).

Discussion

This study revealed that herbivory and disease symptoms were present and substantial for all three non-native invasive plant species. These results are contrary to the Enemy Release Hypothesis, which predicts that non-native species that become invasive have escaped their natural enemies. However, our leaf herbivory and necrosis data suggest that garlic mustard, Japanese stilt-grass, and Norway maple all experience symptoms from natural enemy attack in the invaded range.

We also observed a strong indirect effect between certain invasive-invasive neighbor pairs. The presence of Norway maple dramatically mitigated the cause(s) of leaf necrosis in both garlic mustard and Japanese stilt-grass. Such a protective effect of one invasive species on others could lead to facilitation of the protected species' invasions, if that protection is strong enough to affect survival. Further study is warranted to determine the mechanism of this facilitative effect and whether it could provide a window of opportunity for colonization, or even could lead to invasional meltdown.

Finally, our comparison of necrotic symptoms among the three species showed that garlic mustard, Japanese stilt-grass, and Norway maple experienced greater leaf tissue loss than the others. Assuming that this correlates to lower photosynthetic capacity, such variability in susceptibility would provide an advantage to garlic mustard in communities undergoing co-invasions by these species.

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