Competition and herbivory in two co-invasive, non-native plants from the mid-Atlantic forest: garlic mustard and Japanese stilt-grass.

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ABSTRACT

Invaded plant communities often experience simultaneous invasion by multiple plant species. When co-invasive species become dominant, their own interactions may become important drivers of subsequent community dynamics. Also, in forests with overabundant deer, even invasive plants may become subjected to herbivory. We tested the interactive effects of competition and herbivory on garlic mustard (*Alliaria petiolata*, ALPE) and Japanese stilt-grass (*Microstegium vimineum*, MIVI), two co-invasive plants that can dominate the herb layer of mid-Atlantic forests with high deer pressure. We grew plants in the greenhouse from seedlings, for three months. We crossed three plant densities with four ALPE:MIVI ratios, crossed with clipping of ALPE, MIVI, ALPE and MIVI, or neither species, and we measured per capita dry mass of roots and shoots. Generally, growth of both species decreased as plant density increased, as intraspecific competition increased, and with clipping. Clipping influenced the outcome of competition; when a single species was clipped, it was outgrown by the other species, at all densities and ratios. Without clipping of either species, the species with lower intraspecific competition outgrew the other, except at the highest density, when MIVI always outgrew ALPE. When both were clipped, ALPE outgrew MIVI in all cases, because clipping was much more detrimental to MIVI than ALPE. The implications for natural populations should be field-tested; they include that MIVI should be able to invade and dominate dense ALPE stands, unless ALPE is a target for deer herbivory, which we have detected previously in forests with high deer pressure.

***Alliaria petiolata* (ALPE, top) and *Microstegium vimineum* (MIVI, bottom) growing intermingled in the forest herb layer.**

INTRODUCTION

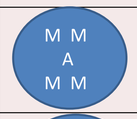
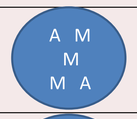
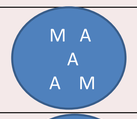
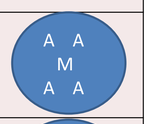
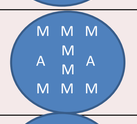
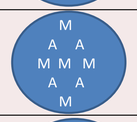
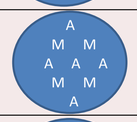
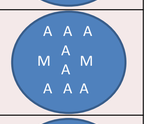
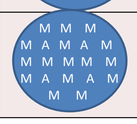
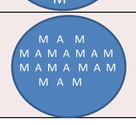
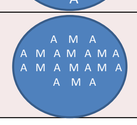
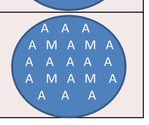
• Invasive plant species have great opportunity to thrive in communities that have experienced decline in native species due, for example, to disturbance or over-browsing by deer. Such communities are likely to be invaded by multiple species, which may develop into the dominant interacting species in the community.

• The incorporation of invasive plants into a forest biome is bound to have great effects on the interactions and dynamics of all inhabitants of the community. For example, simply the preference of one species over the other by deer, or how quickly or easily a plant can recover from deer browsing has the potential to reshape the whole community.

• Our aim was to examine the interactions between two dominant, non-native species of the forest herb layer, *Alliaria petiolata* (a biennial herb) and *Microstegium vimineum* (an annual grass), which have become co-invasive in the eastern United States.

• Specifically, in our greenhouse experiment we examined competition between the species using a response surface design that varied both plant density and the frequencies of the two species, for differing levels of intraspecific and interspecific competition. Additionally, we examined the interactions of competition with simulated deer browsing, using clipping treatments on one, both, or neither species. Invasive plants typically are thought not to be subject to deer browse, but in denuded forests where invasives become dominant, that can change. The future community structure may then depend not only on competitive interactions between co-invasive species, but also on their relative tolerance of herbivory.

METHODS

Density	Percent ALPE to MIVI			
	20/80	40/60	60/40	80/20
5				
10				
20				

Response surface planting design used in the greenhouse experiment, which crossed ALPE:MIVI species frequencies of 20:80%, 40:60%, 60:40% and 80:20% with pot densities of 5, 10 or 20 plants.

Locally collected seed; cold/moist stratified for 3 months; planted in flats; seedlings transplanted to pots in the greenhouse.

12 density x frequency treatments; 4 replicates each in 3 blocks (12 total/trt).

Grew for 2 months; harvested whole plants; separated roots and shoots of each species; oven dried at 60C.

Recorded dry mass of roots and shoots of each species from each pot; divided by number per pot for per capita mass per pot.

RESULTS

Figure 2: Density vs. Total Mass

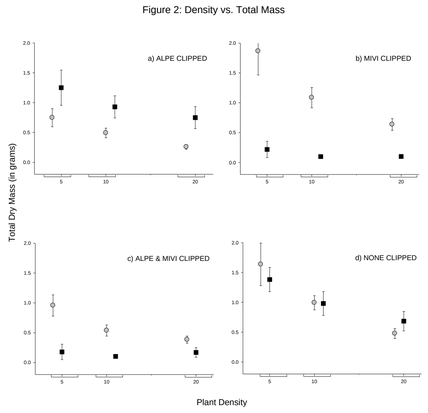
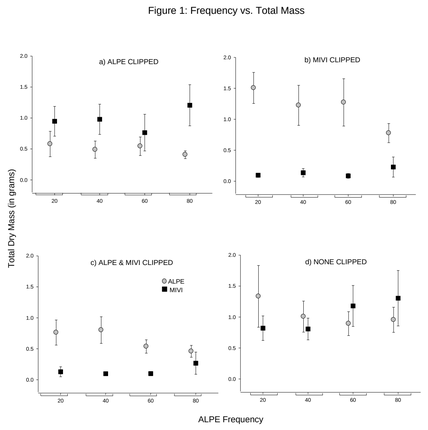
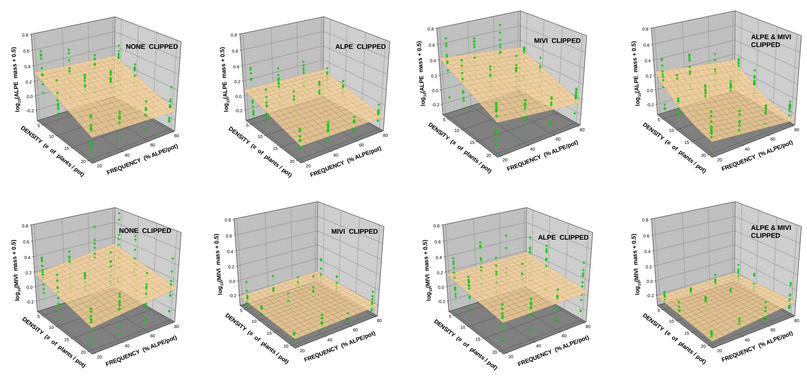


Figure 1: Frequency vs. Total Mass



1 Both ALPE and MIVI grew smaller as competition from other plants increased (i.e. density), under all clipping treatments (i.e. "herbivory"). Without clipping, they both grew to similar mass. When ALPE was clipped, ALPE plants experienced a 50-60% reduction in mass, and MIVI plants were unaffected. When MIVI was clipped, MIVI mass was reduced by 75-85%, and ALPE mass increased by 15-25%.

2 Intraspecific vs. interspecific competition (i.e. frequency) had weaker and more complex effects on plant growth, compared to density. With no clipping or when just ALPE was clipped, plants tended to grow smaller with greater intraspecific competition. This effect was more pronounced for MIVI than ALPE. When MIVI was clipped, the intraspecific competitive effect among ALPE plants increased and among MIVI decreased.



	EFFECTS AND SIGNIFICANCE OF REGRESSION TERMS					
	DENSITY	FREQUENCY (% ALPE)	DENS^2	FREQ^2	DENS*FREQ	R^2
ALPE						
NO CLIP	*** (-)	ns	ns	ns	ns	0.39
ALPE CLIP	*** (-)	ns	ns	ns	ns	0.29
MIVI CLIP	*** (-)	*** (-)	ns	ns	ns	0.37
BOTH CLIP	*** (-)	*** (-)	** (+)	ns	ns	0.33
MIVI						
NO CLIP	*** (-)	* (+)	ns	ns	ns	0.12
MIVI CLIP	ns	ns	ns	ns	ns	0.03
ALPE CLIP	** (-)	ns	ns	ns	ns	0.06
BOTH CLIP	0.09 (-)	ns	ns	ns	* (+)	0.10

3 The combination of density and frequency effects allowed for construction of response surface regression models for each species, which were much more predictive for ALPE than MIVI. The simulated herbivory treatments affected the surfaces mostly through the magnitude of the responses. The shape of the response was altered in some cases: clipping of either or both species removed the negative response of MIVI to increased intraspecific competition; for ALPE, clipping of MIVI or both revealed a negative response to increased intraspecific competition.

DISCUSSION

Many suburban/exurban forests in the mid-Atlantic region have few native plant species and are increasingly dominated by non-native, invasive plants. Interactions among these species and the ubiquitous deer may become driving forces in the future structure of these communities. Our experiment provides evidence for the likely outcome of interactions between garlic mustard (ALPE) and Japanese stilt-grass (MIVI) in deer-impacted forests.

If the species are not subjected to herbivory, then our results show that ALPE growth generally is more strongly influenced by competition (both intra- and inter-) than is MIVI growth, except when MIVI's competitive environment is mostly intraspecific. This suggests that MIVI should more easily invade dense ALPE stands.

However, if these species are browsed, then their competitive interactions are affected. MIVI was much less tolerant of clipping than ALPE, such that MIVI grew poorly even at low density, even under mostly intraspecific competition. In contrast, ALPE recovered quite well when it was clipped, and actually increased growth when its competitor MIVI was clipped, especially when it was under mostly interspecific competition. This suggests that ALPE would have an advantage in heavily browsed forests where deer have had to switch to both invasive species for browse. In future analysis of competition between these two plant species, it will be necessary to compare their in situ browse rates in forests with different deer pressures.

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