

# Supporting Information

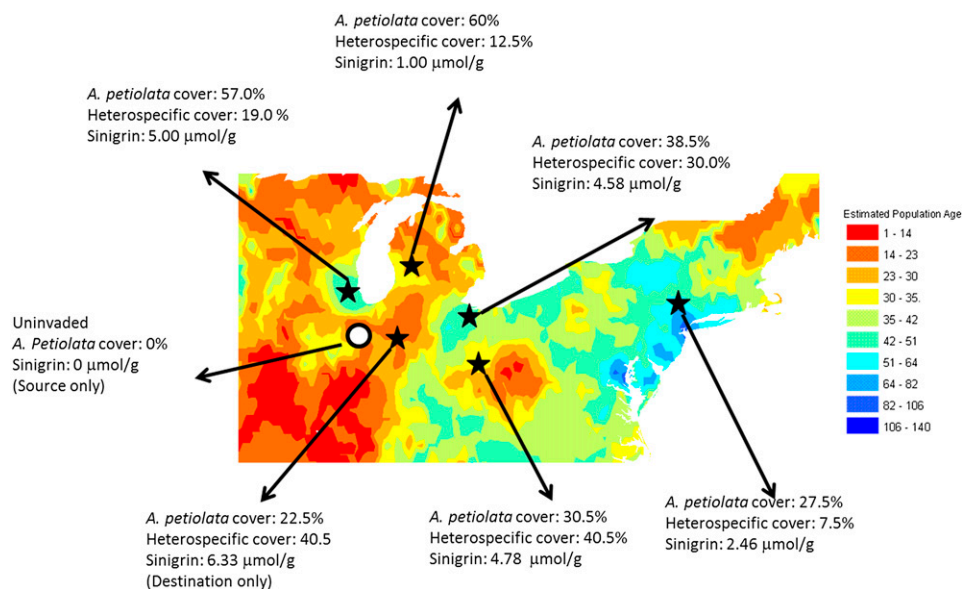
Lankau 10.1073/pnas.1201343109

## SI Text

**Tests of Alternative Hypotheses.** Unfortunately, it was not possible to control for maternal effects through either breeding schemes or intervening generations in a common environment. Therefore, I cannot conclusively say that the differences between native populations are solely attributable to genetic differences: it is possible that differing maternal environments may explain some of the patterns. The most likely source of maternal environmental effects on final biomass (the metric used in this study) is variation in provisioning of seeds. To control for this possibility, I weighed a sample of seeds from each native population before the experiments. Additionally, I counted the number of leaves on seedlings just before planting in the field reciprocal transplant experiment, as a measure of differences in early growth among populations before exposure to any potential selection from the invader. Seed weights and initial seedling leaf number varied among populations, but did not correlate with any of the four aspects of native populations studied here (i.e., the sinigrin concentration of the *Alliaria petiolata* population with which the native co-occurred, the tolerance to competition from *A. petiolata*, the response to soil biota in the absence of *A. petiolata*, and the resistance to loss of arbuscular mycorrhizal fungi (AMF) colonization in the presence of *A. petiolata*). The three-way interaction between the *A. petiolata* removal treatment, the percentage of cover of *A. petiolata* at destination sites, and the *Pilea pumila* population variable remained significant (usually increased in significance) when including seed weight and initial seedling size as covariates. Additionally, including all two- and three-way interactions between seed weight and initial seedling size and year, *A. petiolata* removal treatment, and percentage of cover of *A. petiolata* did not affect the significance of terms including the *P. pumila* population variables. Thus, any trans-

generational environmental effects must be specific responses to competition with high-sinigrin *A. petiolata*, rather than generic responses to greater or lesser maternal growth/resources.

**Correlated Environmental Gradients.** In a partially observational study like this one, in which experimental treatments (e.g., *A. petiolata* weeding) are imposed across a naturally occurring environmental gradient, it is possible that correlated environmental gradients may confound the interpretation of the results. To explore this possibility, I tested whether the two gradients of interest in this study (sinigrin concentration and density of *A. petiolata* populations) were correlated to the suite of abiotic factors measured at each site, including latitude and longitude as proxies for climatic variables and seven soil metrics (pH, lime buffer capacity, and concentrations of Ca, K, Mg, Mn, Zn, P, NO<sub>3</sub>, and NH<sub>4</sub>). None of these variables were significantly correlated to either *A. petiolata* sinigrin concentration or abundance; however, several correlations approached significance (when not correcting for multiple comparisons). Because the power of these tests was low (due to a sample size of only six sites), I explored the potential confounding effects of environmental factors that had marginally significant correlations to the gradients of interest (Ca, K, Mg, and NO<sub>3</sub> for sinigrin concentrations and latitude for percentage of cover of *A. petiolata*). The major result—that *P. pumila* populations originating from areas with high-sinigrin *A. petiolata* (or with the highest tolerance to competition with *A. petiolata*, the least dependence on soil biota in the absence of *A. petiolata*, or the highest resistance to loss of AMF colonization in the presence of *A. petiolata*) had the highest fitness in heavily invaded areas but the lowest fitness in the least invaded areas—was not changed by including any or all of these factors as additional covariates in the ANCOVA model.



**Fig. S1.** Map of *A. petiolata* invasion history in the eastern United States (modified from ref. 1), with locations of sites used in this study. Locations marked with stars served as a destination in the reciprocal transplant experiment. Five of these sites also served as a source for native and *A. petiolata* populations. The site marked with an open circle has never been invaded by *A. petiolata*, to the best of my knowledge, due to the vigilance of the land manager (S. Buck, personal communication). This site served as the source of one *P. pumila* population, as well as the source for the uninvaded soils used in the greenhouse experiment. The cover of *A. petiolata* and all heterospecific (non-*A. petiolata*) plants is marked for each site, along with the root sinigrin concentration of the *A. petiolata* population as measured from 10 individuals grown in a common greenhouse environment.

**Table S1. Results of ANCOVA models relating mean relative fitness of the native *P. pumila* populations in the reciprocal transplant experiment**

Effect Term	Num DF <sup>†</sup>	Den DF <sup>‡</sup>	<i>P. pumila</i> population variable							
			[Sinigrin] of <i>A. petiolata</i> at source population		Tolerance to competition		Response to soil biota		AMF resistance	
			F	P	F	P	F	P	F	P
Year	1	128	0.01	0.936	0.00	0.966	0.00	0.974	0.002	0.964
<i>A. petiolata</i> removal treatment	1	128	0.04	0.852	0.02	0.897	0.01	0.928	0.015	0.903
Year* <i>A. petiolata</i> removal treatment	1	128	0.03	0.861	0.01	0.911	0.01	0.922	0.016	0.901
% cover of <i>A. petiolata</i> at destination	1	128	0.00	0.947	0.00	0.997	0.00	0.954	0.003	0.957
Year*% cover <i>A. petiolata</i>	1	128	0.01	0.908	0.03	0.868	0.01	0.942	0.006	0.938
<i>A. petiolata</i> treatment*% cover <i>A. petiolata</i>	1	128	0.01	0.928	0.04	0.836	0.03	0.870	0.021	0.885
Year* <i>A. petiolata</i> treatment* % cover <i>A. petiolata</i>	1	128	0.00	0.952	0.01	0.932	0.02	0.888	0.014	0.905
<i>P. pumila</i> population variable	1	128	0.13	0.722	1.23	0.270	<b>6.50</b>	<b>0.012</b>	2.639	0.107
Year* <i>P. pumila</i> variable	1	128	1.75	0.189	0.05	0.830	0.02	0.897	0.534	0.467
<i>A. petiolata</i> treatment* <i>P. pumila</i> variable	1	128	0.05	0.817	0.05	0.819	0.10	0.754	0.068	0.795
Year* <i>A. petiolata</i> treatment* <i>P. pumila</i> variable	1	128	1.07	0.303	0.13	0.724	1.02	0.313	0.049	0.825
<b>% cover <i>A. petiolata</i>*<i>P. pumila</i> variable</b>	<b>1</b>	<b>128</b>	<b>9.95</b>	<b>0.002</b>	<b>8.22</b>	<b>0.005</b>	<b>3.36</b>	<b>0.069</b>	<b>6.274</b>	<b>0.014</b>
Year*% cover <i>A. petiolata</i> * <i>P. pumila</i> variable	1	128	3.02	0.085	<b>8.06</b>	<b>0.005</b>	0.63	0.430	1.878	0.173
<b><i>A. petiolata</i> treatment*% cover <i>A. petiolata</i>*<i>P. pumila</i> variable</b>	<b>1</b>	<b>128</b>	<b>4.78</b>	<b>0.031</b>	<b>7.54</b>	<b>0.007</b>	<b>6.14</b>	<b>0.015</b>	<b>5.723</b>	<b>0.018</b>
Year* <i>A. petiolata</i> treatment*% cover <i>A. petiolata</i> * <i>P. pumila</i> variable	1	128	0.76	0.386	1.79	0.184	2.29	0.133	2.377	0.126

Six native populations were reciprocally transplanted into six destination sites, with two experimental treatments (i.e., *A. petiolata* removed or left intact). Model terms can be split into two classes: those that refer to qualities of the destination site (year, *A. petiolata* removal treatment, and % cover of *A. petiolata* at the destination site) and those that refer to qualities of the source *P. pumila* populations. Four separate ANCOVA models were run, each testing a different *P. pumila* population variable: (i) the sinigrin concentration of the *A. petiolata* population at the source of the native population, (ii) tolerance to competition from *A. petiolata*, (iii) response to uninvaded soil communities in the absence of *A. petiolata*, and (iv) ability to resist declines in AMF colonization in the presence of *A. petiolata*. Tolerance to competition, response to soil communities, and resistance of AMF colonization were measured from the greenhouse experiment. Destination terms are constrained to have no main effect on relative fitness because the relativization removes any overall differences between sites, treatments, or years. However, destination terms can show significant interactions with source terms. Destination\*source term interactions test whether the relationship between the relative fitness of a population and some aspect of that population (e.g., tolerance to competition) differs across destination sites (e.g., across sites with high or low cover of *A. petiolata*), years, or treatments. All effects had one numerator degree of freedom and 128 denominator degrees of freedom. Bold type signifies model terms with  $P < 0.05$  in more than one model.

\*Denotes statistical interaction terms.

<sup>†</sup>Num DF: one numerator degree of freedom.

<sup>‡</sup>Den DF: 128 denominator degrees of freedom.

**Table S2. Correlations between two measures of maternal provisioning (population mean seed weight and initial leaf number of seedlings) and the four aspects of each population analyzed in detail**

	Seed weight		Initial leaf number	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Sinigrin at source	-0.34	0.51	-0.25	0.64
Tolerance to competition	-0.30	0.56	0.17	0.75
Response to soil biota	0.58	0.23	-0.08	0.82
Resistance of AMF colonization	-0.63	0.18	-0.05	0.93

Each correlation is based on the mean of six populations.

**Table S3. Correlations between the gradients of interest (sinigrin concentration and percentage of cover of *A. petiolata*) and a suite of other potentially confounding environmental gradients**

	Sinigrin of <i>A. petiolata</i> population		% cover of <i>A. petiolata</i>	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Latitude	-0.19	0.68	0.80	0.06
Longitude	0.04	0.94	-0.58	0.23
LBC	-0.07	0.89	0.00	1.00
pH	0.59	0.16	-0.36	0.49
Ca	0.72	0.07	-0.48	0.34
K	0.71	0.07	-0.21	0.69
Mg	0.73	0.06	-0.57	0.24
Mn	-0.41	0.36	0.02	0.98
Zn	0.39	0.39	-0.14	0.79
P	0.56	0.19	-0.50	0.31
NO <sub>3</sub>	0.74	0.06	-0.39	0.44
NH <sub>4</sub>	0.44	0.33	-0.53	0.28

LBC, lime-buffering capacity.