Comparison of native *Acer saccharum* and non-native *Acer platanoides* seedling biology

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Abstract

The congeneric trees *Acer saccharum* (the native sugar maple) and *A. platanoides* (the non-native Norway maple) share the same environment in eastern forests of the United States, where *A. platanoides* is considered invasive. We conducted a field experiment to compare several key aspects of their seedling biology to aid our understanding of *A. platanoides* invasiveness. We transplanted month-old seedlings into three second-growth deciduous forests in central New Jersey and allowed them to grow from May-October. Each seedling was randomly assigned to either a caging treatment to exclude mammalian herbivores or an open treatment. We measured in situ photosynthesis, water use efficiency (WUE), mortality rate, leaf number, foliar insect herbivory and disease damage, and dry mass and root:shoot ratio at harvest. An additional set of seedlings remained in the ground for an additional year and on these we measured overwinter mortality, spring phenology, and summer mortality. *Acer saccharum* showed an advantage only for WUE; for all other variables the two species either were not significantly different or else *A. platanoides* had advantageous values. Specifically, the first year *A. platanoides* had more leaves per seedling and greater root:shoot ratio at harvest time. Also, overwinter mortality was less for *A. platanoides* and spring bud break was a week earlier. Protection from mammalian herbivores was protective for both species during both growing seasons. Our results suggest that non-native *A. platanoides* can be at least as successful as native *A. saccharum* at establishing seedlings in these forests, thus contributing to its invasiveness.

Acer saccharum seedling (native)

Acer platanoides seedling (non-native invasive)

Introduction

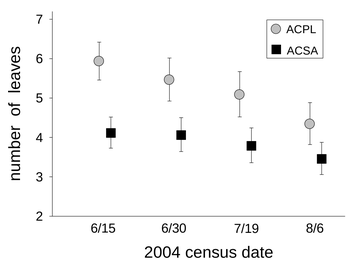
Invasion of forests by non-native canopy trees poses the most serious invasive species problem for native forest communities because canopy trees have such strong influences on species in all forest layers. An invasive tree's success at reaching the canopy depends on its earlier ecology, particularly during the vulnerable youngest seedling stage. Comparing seedling ecology between invasive non-native trees and common, ecologically successful native congeners provides insight about mechanisms responsible for the ecological success of non-natives.

The shade tolerant *Acer platanoides* (Norway maple) is an important non-native invasive canopy tree in North American deciduous forests; native species diversity and abundance is greatly reduced under its canopy. We conducted a field experiment to compare key aspects of its seedling ecology with a common shade tolerant native, *Acer saccharum* (sugar maple).

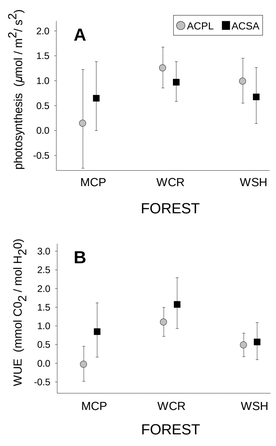
Methods

- Collected seeds of both maples from five natural populations, stratified, and grew them for 1 month in the greenhouse.
- Transplanted seedlings into cleared plots in three replicate forest sites in May: 160 seedlings of each per forest, assigned to random positions on a 100 x 100 m grid, with 110 in individual uncaged plots and 50 in individual plots caged to exclude deer and rabbits.
- Followed 20 caged and 20 uncaged of each species in each forest from May-October, with measurements on leaf number, photosynthesis rate and water use efficiency (measured with Li-Cor 6400 portable photosynthesis system), herbivory and disease symptoms, mortality, and mass and root:shoot ratio at harvest in October.
- Followed 30 caged and 90 uncaged of each species in each forest over the winter and through the second growing season, with measurements on winter mortality, spring leaf bud phenology, and growing season mortality.

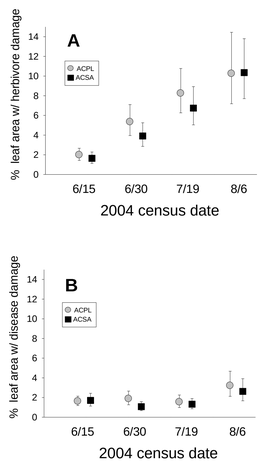
Results



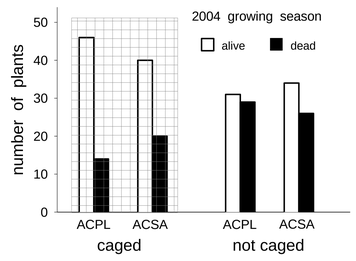
1. First-year *A. platanoides* were larger than *A. saccharum* as measured by leaf number during the growing season. The difference was highly significantly different in the first, second, and third censuses (ANOVA, P<0.001) but narrowed somewhat by the time of the fourth census in August (P<0.05). The caging treatment had no effect on leaf number.



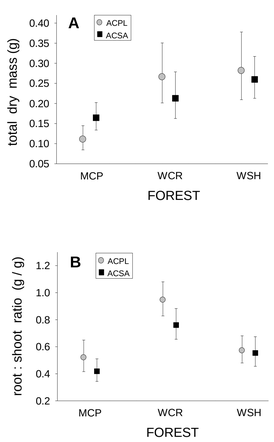
2. The two species did not differ significantly for in situ photosynthesis rate, but *A. saccharum* had higher WUE (pooled across forests, ANOVA, P <0.05)



3. The two species did not differ significantly either in insect herbivory or disease symptoms; both species experienced increasing damage as the season progressed.

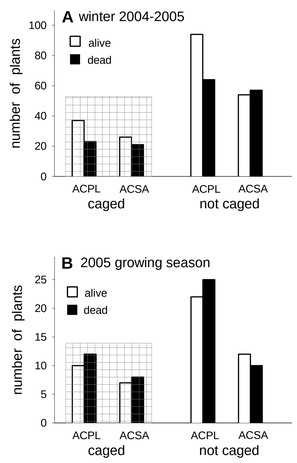


4. The two maples experienced similar mortality rates between planting in May 2004 and harvest in the fall (G = 0.17, P=0.68). Both species benefited similarly from caging (G = 7.77, P=0.005).

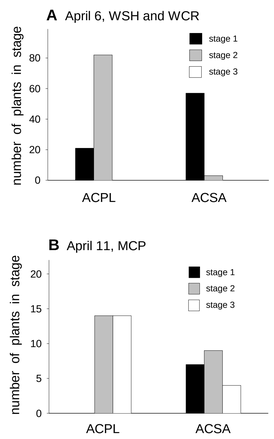


A. saccharum *A. platanoides*

5. The two species had similar total dry mass at harvest, but root:shoot ratio was higher for *A. platanoides* (pooled across forests, ANOVA, P<0.05). Both species were smaller at the MCP forest site (P<0.001).



6. Over-winter mortality was marginally higher for *A. saccharum* than for *A. platanoides* (G=3.38, P=0.07). Seedlings of both species had similar mortality rates in the second growing season, and caging had no effect on mortality in either time period.



7. Spring phenology of leaf bud development was about a week earlier for *A. platanoides* (G=97.66, P<0.0001; Stage 1 = swollen buds; Stage 2 = buds burst; Stage 3 = leaves expanding).

Discussion

Our comparison of *Acer platanoides* and *A. saccharum* revealed significant differences in four key seedling characteristics that indicated superior performance by *A. platanoides*, the invasive non-native tree species. It produced more leaves than *A. saccharum*, had higher root:shoot ratios during the first growing season, died at a lower rate over the first winter, and commenced spring growth earlier. Other measurements were similar for the two species, including foliar herbivory and disease symptoms, photosynthesis rates, total mass after one growing season, benefits of protection from mammalian herbivores, and mortality rates in both growing seasons. *Acer saccharum* seedlings were superior only in WUE.

These results suggest that the seedling establishment phase of the *A. platanoides* life history is an important contributor to its general success as an invasive species. Its equal or superior seedling characteristics relative to a widespread native congener sets the stage for a level of ecological performance at least equivalent to the native congener. To become a dominant member of the forest canopy, as *A. platanoides* does in heavily invaded forests, a tree species must be able to pass through a gauntlet of challenges beginning with the seed and seedling stages. *Acer platanoides* is able to run this gauntlet at least as well as *A. saccharum*, thus providing the opportunity for *A. platanoides* to establish seedling populations that can lead to later life history stages and ultimately, the canopy.