

Evolutionary change in *Ambrosia artemisiifolia* in response to climate warming and biocontrol herbivory: when is it adaptive?

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Master thesis in biology option ecology and evolution

Biological invasions have increased dramatically as a result of the expansion of the movement of people and goods around the world. The impacts from invasive alien species can be increasingly compounded by climate change and therefore increase their negative impacts on ecosystems, biodiversity, and human health. However, it is difficult to predict how climate change will affect invasive species and subsequently ecological systems. Humans are the primary agents for the deliberate or inadvertent introduction of alien species outside their native ranges, a need for management therefore becomes evidence. One way to mitigate the effects of invasive alien species is to introduce their natural enemies, a method called importation biological control.

Here, we used *Ambrosia* seeds of the fourth generation from a field experimental evolution study, where *Ambrosia* populations were subjected to climate warming and herbivory by the potential biocontrol beetle *Ophraella communa*. These seeds were germinated in growth chambers with temperatures of 25/15°C and 28/15°C (day/night) as a simulation of ambient and future climate warming conditions. The young seedlings were then transplanted to grow in two distinct greenhouses with temperatures of 32/17°C and 35°/17C (day/night) again as a simulation of ambient and climate warming conditions. Our results show evolutionary effects due to selection by the Beetle, resulting in smaller seeds, higher number of inflorescences, reduced time to first leaf appearance and flowering, and reduced internode number and height. Our results also show effects on offspring to higher temperature for example a slower seedling growth, longer time to flowering, increase size and internode number. In addition, we found that the Warming offspring treatment influence canopy expansion by increasing the specific leaf area. Noteworthy, we found that the number of inflorescences, biomass and size increased significantly for the offspring from Warming selection only after beetle selection (Beetle + Warming) when growing under climate warming condition, indicating adaptation.

In conclusion our findings demonstrate that *Ambrosia* will probably become more invasive under climate change, and that applying *Ophraella* as a biocontrol agent requires careful consideration and further investigations, as our results indicate evolutionary adaptation to climate warming only under biocontrol selection.

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