

Genetic Limits on Evolution in Invasive Species

The introduction and spread of invasive species is a serious environmental and economic problem for Canada, but scientists are still not sure why some introduced species spread rapidly and reach high densities, while others remain rare and relatively benign. What causes biological invasions to speed up or slow down and what factors serve to limit their geographical spread? Canadian researchers are investigating these questions and finding some unexpected answers.

As part of NSERC Discovery Grant funded research on the genetics and ecology of purple loosestrife (*Lythrum salicaria*) invasions in eastern North America, Ph.D. student Robert Colautti with supervisor Dr. Spencer Barrett (Univ. of Toronto) and collaborator Dr. Christopher Eckert (Queen's Univ.) were puzzled to find that purple loosestrife plants from northern Ontario were much smaller than those from the southern portion of the range, and that this difference in stature had evolved since human introduction from Europe.

Not only was the tempo of evolution surprisingly rapid, but natural selection during invasion would have been expected to favour larger plants because they produce thousands more seeds than smaller plants. So why should smaller plants with far fewer seeds be favoured during the northern migration of purple loosestrife in Ontario?

The main clue was the discovery that northern plants flowered up to 50 days earlier than southern plants when grown under common garden conditions (Fig. 1). This suggested to Colautti and colleagues that genes causing early flowering may also reduce plant size. This could occur if there was a trade-off between resources allocated to growth versus reproduction, resulting in what is termed a 'genetic constraint'. Such constraints arise when genes for particular trait combinations, in this case flowering early at a larger size, are absent from populations.

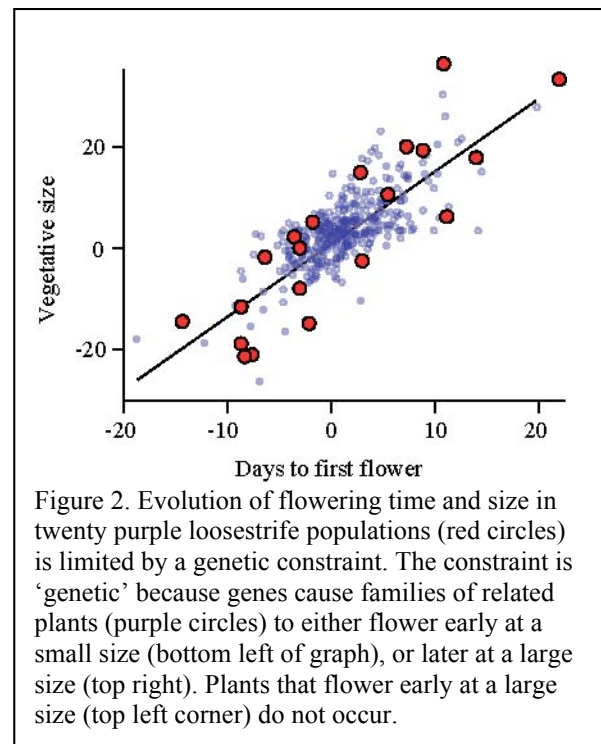


Figure 1. Common garden comparison of invasive populations of purple loosestrife. Seeds were sampled from throughout eastern N. America and grown at the Koffler Scientific Reserve in Ontario. By comparing populations under similar growing conditions, genetic differences in life history and reproduction among the populations were evaluated.

To investigate if genetic constraints might limit invasive spread, the Canadian researchers used a combination of mathematical modelling and common garden experiments involving 20 populations sampled along a latitudinal gradient from Maryland USA to Timmins, Ontario. They found evidence for a genetic constraint on the evolution of flowering time and size (Figure 2), with dramatic effects on the seed production of northern populations, as predicted. The shorter growing season at northern locations was associated with a 70-fold reduction in seed production compared to southern populations. Their work was recently published in the *Proceedings of the Royal Society of London B* (2010) 277: 1799-1806 and featured in *Nature* 463, 1002 (25 February 2010).

These results have important implications for predicting how plant populations may evolve in response to climate change. Longer growing seasons could increase the rate of invasion of species like purple loosestrife in northern Canada as a result of natural selection on flowering time, plant size and seed production.