Are new genes always better?

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Re-vegetation seems like a beneficial strategy for conserving and restoring damaged ecosystems, and using a variety of species can help increase biodiversity in these systems. But what are the risks involved with introducing seeds from other locations to plants located near the damaged site? Introduced populations often hybridize with the local populations from the same species, which can result in "polluting" neighboring populations with genes that are poorly adapted to local conditions. Long-term consequences of such "pollution" could negatively impact the survival of the existing native populations.

A recent article in the January issue of the American Journal of Botany by Lisčle Crémieux and colleagues from the University of Fribourg in Switzerland looks at how gene flow from two distant populations and one local, but ecologically distinct, population affected a local population of Plantago lanceolata, a short-lived perennial herb. Seedling size, adult vegetative biomass, and estimated seed production were measured for two hybrid generations plus the first generation backcrossed with the local parents.

"We wanted to know whether the provenance of the seed material used in ecosystem restoration had an effect on the fitness of neighboring, locally adapted, populations," Crémieux said, "and not only on the success of the restored area itself."

The farther away two populations are, the larger the genetic differences are assumed to be and the more negative the consequences of hybridizing them. Crémieux and colleagues found that by the end of the growing season, the parental plants from the two distant (foreign) populations were smaller and produced fewer seeds than the local plants, indicating they were not well-adapted to the local environment. However, while the first generation of offspring resulting from local plants crossed with foreign plants did not do as well as the local parents, some second-generation offspring and all the backcrossed plants performed as well as the local plants. Thus, over time the poorer performing foreign genes were diluted with parental genes from the local population with the end result of fewer maladapted genotypes overall.

If distance from the site did not show long-term negative effects, how would genes from populations located closer to the damaged site but from a contrasting environment affect local plant populations? When local plants were crossed with plants from a nearby, but much drier, site, seedling performance in the first and second generation of progeny was much worse than in the distant crosses.

Although the study is relatively small scale, three generations of offspring were followed, which is relevant for assessing long-term consequences of introducing new genes to populations. The authors conclude that when new, foreign genes are introduced to a damaged site, the neighboring populations may experience initial negative effects; however, over time, as long as the populations do not experience additional foreign gene input, the negative effects may diminish and the maladapted foreign genes will decrease. Moreover, when selecting seeds or plants for re-vegetating damaged sites, it may be more important to match up habitat types or environments than be concerned with distance per se.

"More research on the long-term effects of gene flow introduced into local populations and their consequences for population persistence in widespread and rare plant species is needed to determinate the generality of these findings," said Crémieux.

More information: Crémieux et al. 2010. Gene flow from foreign provenances into local plant populations: Fitness consequences and implications for biodiversity restoration, Am J Bot 97: 94-100, www.amjbot.org/cgi/content/full/97/1/94

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