Do cultivars of native plants support food webs as well as their parent species?

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Abstract

Homeowners, land managers, landscapers, landscape architects, and landscape designers around the country are beginning to use more native plant species in their gardens than they have in the past with hopes of boosting local biodiversity. A problem they encounter immediately is that most native plant species in the trade are available only as cultivars. If an important goal of native plant landscaping is to improve the ecological integrity of the landscape, it is necessary to learn whether cultivars of native species support food webs as well as their parent species. This study will use selected woody plants in replicated common gardens to measure the impact of altering leave color, agricultural productivity, disease resistance, and plant habit on the diversity and abundance of caterpillars. (Changes in flower color and shape will be addressed in a different study). Data from this study will be used to predict the ecological consequences, if any, of altering leaf color and plant habit in native plants to increase their aesthetic value.

Justification and Rationale

Past landscaping paradigms have treated plants as decorations and ignored the many ecological roles that plants play in human dominated ecosystems. Plants that hosted insects were anathema to the goals of growing perfect decorations and so they were avoided. No one was troubled by this approach to land stewardship because humans had always expelled nature from their settlements without apparent problems; there was plenty of nature somewhere else. Explosive growth during the last century and the associated erosion of ecosystem function has demonstrated that the geographic separation of humans and nature is no longer ecologically viable if we hope to nurture the production of the ecosystem services we require.

Several lies of recent research lend urgency to changing our current landscaping paradigm:

1) The degradation of functional ecosystems world wide has simultaneously degraded the earth's ability to produce the ecosystem services that support human populations by 60% (Millennial Ecosystem Assessment 2005);

2) Ecosystem function is directly related to the number of species within that ecosystem (Reich et al. 2012, Maestra et al. 2012, Naeem et al. 2012);

3) The use of ornamental plants from Asia and Europe reduces the biodiversity needed to produce ecosystem services in managed landscapes (Tallamy and Shropshire 2009; Burghardt et al. 2010);

4) Bird populations are in decline: there are now 50% fewer birds than their were 40 years ago (Stutchbury 2007);

5) 96% of terrestrial bird species feed their young insects (Dickinson 1996).

As the public has learned about this information, they have become more enthusiastic about using native plants in residential and corporate landscapes. The first challenge they encounter, however, is obtaining straight species of native plants. Nearly everything that is currently available in the nursery trade is a cultivar of a native plant. Because one important justification for the use of native plants is to restore ecosystem function in managed ecosystems, and since that cannot be accomplished without restoring complex food webs to residential landscapes, the public wants to know whether cultivars of native plants are as effective at supporting food webs as are their parent species.

Predictions about insect herbivores

Because insects that eat leaves select host plants based on leaf chemistry, we can predict how they will do on cultivars based on how much the leaf chemistry was changed during the creation of the cultivar. Many cultivars are natural variants that were found in nature and then brought into cultivation. These should be just as productive as the straight species because there was no active breeding program that might have changed the leaf chemistry. If a cultivar is bred to be fat instead of skinny (or bred for any shape change), leaf chemistry may not have changed in a way that would decrease that plant's usefulness to insect herbivores. However, if leaf color is changed (a green leaf turned into a purple or variegated leaf), then the leaf chemistry is undoubtedly changed. Purple leaves are loaded with anthocyanins, chemicals that deter insect feeding. Variegated leaves have less chlorophyll and are therefore less nutritious. Such cultivars are likely to be less productive in terms of supporting insect herbivores.

The impact of selections for resistance to disease is not as easily predicted. For example, "Princeton" American Liberty" and valley Forge" are cultivars that all show good resistance to Dutch elm disease. Whether or not this resistance also makes them unpalatable to insect herbivores has not been tested. Similarly, cultivars of fruit bearers such as in high bush blueberries have not been compared to parent species for use by insect herbivores.

Objectives

The primary objective of this research is to quantify whether genetic changes that commonly create cultivars reduce the ability of cultivars to support viable food webs. This will be done by comparing changes in leaf color (green to purple; green to variegation), changes in plant habit (tall to short; loose to compact), changes in disease resistance (resistant cultivars vs susceptible parent species), and changes in agricultural productivity (parent species vs enhanced agricultural selections) in terms of the number and diversity of insect herbivores that use these plants.

Methods

This project will focus on woody plants because they support more caterpillars than herbaceous plants (Tallamy and Shropshire 2009). Caterpillars are the currency by which food web complexity is measured in eastern deciduous ecosystems. because they are inordinately important in the diets of breeding birds and other insectivores.

Using a common garden approach we will compare 5 cultivars of *Viburnum dentatum, Acer rubrum, Ulmus americana, Juniperus virginiana, Vaccinium corymbosum,* and *Rhus copalina* to the parent species in a common garden setting. Using these species allows us to compare cultivars that change plant habit, plant leaf color, the resistance of the parent to disease, and enhanced fruit production. Five cultivars of each species will be grown near the parent species and under the same conditions. Five individuals of each cultivar and the parent species will serve as replicaltes. Thus, the study will be comprised of 150 plants.

Each parent-cultivar grouping will be planted in a different location so that the insect populations tested will not be peudoreplicated. All plants will be sampled once in the first week of May, June, July, August, and September. Plants will be sampled for caterpillars using the beating stick and total search methods (Wagner 2005). All plants within a parent-cultivar grouping will be sampled the same day. Other insect herbivores will be sampled by vacuum using a reverse leaf blower as in Burghardt et al. 2010. A sample will consist of vacuuming, beating or searching the entire plant in question. Insects will be stored in 80% ethanol, identified to the least taxonomic unit in the lab, dried and weighed. Samples will be collected for two years following plant establishment.

Assuming each parent-cultivar comparison has approximately the same amount of leaf biomass, the insects using the parent species will be compared to those using each cultivar in terms of abundance, species richness, species diversity, and biomass. Statistical comparisons will adjust fro rarefaction issues if necessary.

Results

This study is designed to test how common genetic changes that lead to the creation of cultivars impact insect herbivore communities. It is impossible to test all cultivar combinations (there are many thousands), but if particular alterations of parent plants repeated show similar impacts on insect herbivores, it will be possible to extrapolate to untested species-cultivar combinations. Results will be published in a refereed journal as well as disseminated through the popular and horticultural literature. Results should also be posted on Mt Cuba's web site.

Personnel

The primary responsibilities for this project will be with a master's student. Sampling days will require additional labor that can be supplied by seasonal interns or undergraduates from the University of Delaware pursuing a summer research project.

Potential Pitfalls

This is a risk free project that will produce results that have been requested for years by the gardening public. The only foreseeable stumbling block might be if plantings are slow to establish and are too small to sample productively in the first year. If that happens we simply sample an additional year.

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