Essential Role of Horticulture in Rare Plant Conservation

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Conservation of rare plant species has been a field of active investigation, experimentation, and debate during the last quarter century. As patterns and rates of plant extinction have been increasingly well documented, numerous theoretical and applied studies have considered demographic, genetic, evolutionary, and economic consequences of reduction in number and size of plant populations, as well as alternative methods for pursuing and prioritizing conservation efforts (Elías, 1987; Falk and Holsinger, 1991; Phillips and Meilluer, 1995; Simmons et al., 1976; Syngenta, 1981; Yatskievych and Spellenberg, 1993). Ultimately, preservation and enhancement of rare plant populations is a management problem, requiring typically a combination of on-site and off-site activities (Falk, 1990; Holsinger and Gottlieb, 1991). Horticultural science has an essential role to play in the conservation of rare plants; but, to date, formal horticultural research in this field has taken place on a fairly limited basis. Plant conservation as a scientific and practical discipline would benefit greatly from broader application of the rigorous approach characteristic of commodity-oriented horticultural research. This article provides an introduction to plant conservation efforts in the United States for horticultural scientists and students. For a comprehensive discussion of plant conservation strategies from an international perspective, see Given (1994).

WHAT ROLE DOES HORTICULTURE PLAY IN THE CONSERVATION OF RARE PLANTS?

Most efforts to conserve rare plants involve some form of intervention with natural populations. This may be nondestructive, such as taking a census or observing pollinators, or it may involve significant modification of the habitat, such as controlled burning in fire-adapted communities. Any research or conservation projects that involve propagating or maintaining living specimens of rare plants outside their natural habitats are likely to involve activities traditionally associated with horticultural science. Relevant fields of study include seed technology, propagation and tissue culture, mineral nutrition, growth regulation, soil management, and protection from pests and diseases. Even when the primary goal of conservation research is not horticultural knowledge, it is often necessary to develop techniques for cultivating a rarely species as a means to an end. For example, in an ecological study concerning causes of rarity, Aplet and Laven (1993) collected seeds of rare and common Hawaiian shrub species and grew various combinations in pots to compare competitive ability. In a study of genetic diversity in the rare mallee species Eucalyptus crucis Maiden, Sampson et al. (1988) grew seedlings from wild-collected seed to obtain fresh tissues for electrophoretic analysis.

Plant conservation biologists and land managers often make the distinction between on-site and off-site activities (also referred to as in situ vs. ex situ). Comprehensive recovery and management plans combine the two in what have been termed “integrated conservation strategies” (Falk, 1987). Although there is general agreement that long-term survival of endangered species is best assured by preserving natural habitat, off-site activities involving horticultural technology often provide an essential stepping stone on the path to recovery. In extreme cases, ex situ conservation collections of germplasm are the last line of defense against extinction. The Hawaiian flora, which has already lost 100 species to extinction (Wagner et al., 1990), provides many striking examples. Habitat loss and the impact of introduced species, combined with the extremely high level of endemism in the Hawaiian archipelago, have reduced dramatically the number and extent of many native plant populations. The flora now includes at least 12 taxa that have only one known plant left in the wild and 110 taxa with 20 or fewer individuals remaining in the wild (Center for Plant Conservation, 1994; Ray, 1995). In such circumstances, the significance of conserving rare species as ex situ germplasm is apparent. In the following discussion I will use the term “conservation horticulture” to refer to the application of the techniques and knowledge base of horticulture to rare plant conservation.

WHERE IS MOST HORTICULTURAL RESEARCH IN CONSERVATION CURRENTLY TAKING PLACE?

Many individuals and organizations currently propagate, grow, and study rare plants for conservation purposes. These include nonprofit conservation groups (e.g., Center for Plant Conservation, The Nature Conservancy, National Wildflower Research Center), government agencies (e.g., National Park Service, U.S. Natural Resources Conservation Service, National Forest System, state Natural Heritage Programs), commercial native plant nurseries and seed suppliers, native plant societies, and garden clubs. The National Wildflower Research Center’s Wildflower Handbook (1992) provides an extensive list of conservation organizations and governmental agencies that work with native plants.

Botanical gardens and arboreta are among the most active participants in endangered plant research. Like zoos, these organizations have embraced conservation of rare species as one of their primary missions. Active regional, national, and international networks have been established to coordinate conservation programs in gardens and arboreta, build data bases, disseminate information, and establish guidelines and standards (Given, 1994; New England Wildflower Society, 1992). Notable examples include the Center for Plant Conservation in the United States (CPC) at the Missouri Botanical Garden, St. Louis, and Botanic Gardens Conservation International (BGCI) based at Kew Gardens, United Kingdom. Thanks in large part to activities of these organizations, the quality of plant conservation research has increased steadily, particularly among their member institutions, and as a result of collaborative relationships they have established with research and governmental institutions.

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In spite of this progress, the majority of conservation horticulture activities carried out around the world today are not designed or implemented as formal scientific studies. Often the immediate objectives of a particular project do not require this approach. The purpose of propagating a rare plant may be simply to obtain a few specimens for display or distribution. In other instances, projects address questions that lend themselves well to formal investigation, but participants lack the training, time, interest, or resources (equipment, space, technical assistance) to conduct an experimental study. Organizations such as the CPC and BGCI have played a valuable role in establishing standards for documentation, study, and maintenance of rare plant collections through publications, conferences, and activities of their scientific advisory committees (Botanic Gardens Conservation Secretariat, 1989; Falk and Holsinger, 1991; Heywood and Jackson, 1991; Wieland, 1995).

More widespread participation in rare plant research by the academic horticulture community would enhance further the quality of plant conservation as a scientific discipline.

Most of the refereed scientific literature concerning rare plants is found in journals in the fields of botany, ecology, genetics, natural resource management, and conservation biology. Studies concerning native plants have been published in recent volumes of HortScience and the Journal of the American Society for Horticultural Science, but only a handful of these have dealt with rare species, e.g., with micropropagation studies (Anthony, 1992; Bunn and Dixon, 1992; Clayton et al., 1990).

HOW WOULD THE FIELD OF PLANT CONSERVATION BENEFIT FROM MORE ACTIVE PARTICIPATION BY THE ACADEMIC HORTICULTURE COMMUNITY?

Many plant conservation programs fail to take advantage of the power of the scientific method in designing and evaluating conservation projects. This approach is, however, fundamental to most commodity-oriented horticultural research and is applied easily to similar investigations involving endangered species. Studies designed to test statistically clearly defined hypotheses are likely to be: 1) better documented, 2) more accurately interpreted, 3) easier to compare to other studies, 4) more convincing, and 5) more easily disseminated. Successful results are also more likely to be reproducible by others working with the same, related, or ecologically similar species.

Plant conservation also stands to benefit enormously from the knowledge base, theory, and technical expertise of horticultural science. Horticultural scientists working in universities and other research laboratories work typically with plants of direct economic importance. Their skills and knowledge can be applied effectively to species that are valued for other characteristics.

In some cases, the objectives of conservation horticulture are different from those of traditional commodity-oriented research, but the techniques and theory remain equally applicable. The different ways in which commodity-based horticulture and conservation horticulture manipulate genetic diversity illustrate this point. Development of new commodity crops and cultivars often involves selection and breeding programs that are designed to narrow the spectrum of genetic diversity found in nature. Research programs are designed to achieve uniformity in plant size, flowering and fruiting phenology, chemical composition, or morphology. The overall pattern is from greater genetic diversity (in nature) to less diversity (in cultivation). Conversely, conservation biologists often begin with a very limited pool of genetic diversity in natural populations then look for the most effective ways to maximize the conservation of this diversity, through on-site or off-site activities. From the point of view of horticultural science, these two objectives are different sides of the same coin—the same technologies, theoretical principles, and knowledge base apply in either case. The tools of modern horticultural science have been used very effectively to channel biodiversity to useful ends. The field of conservation biology would benefit greatly if those same tools were used to slow the erosion of biodiversity in native plant species.

HOW WOULD HORTICULTURAL SCIENTISTS BENEFIT BY PLAYING A MORE ACTIVE ROLE IN RARE PLANT RESEARCH?

The profession of horticultural science has a great deal to gain by participating more actively in plant conservation programs. Benefits include an influx of new ideas, new people, and new resources.

Interaction with other scientific disciplines. Conservation biology is highly interdisciplinary and often provides a basis for new collaborations and an influx of new perspectives. At the University of Georgia, faculty and students in the schools and Departments of Ecology, Botany, Genetics, Forestry, Geography, Environmental Design, Anthropology, and Horticulture are involved in rare plant conservation projects, often collaboratively.

Access to new funding sources. In today's economic climate, most researchers are looking for opportunities to diversify their sources of funding. Many agencies that fund research and training programs in conservation biology would not be thought of as traditional sources of support for horticultural research programs. These include federal and state agencies as well as many private and corporate foundations. References such as "Environmental Grantmaking Foundations" (Environmental Data Research Institute, 1995) publish information on hundreds of funding organizations that include environmental projects among their top priorities. Horticultural aspects of my own research on native species (e.g., Spigelia gentianoides Chapm.) have been funded by The Nature Conservancy and the National Biological Survey. The Center for Plant Conservation regularly has funded rare plant research and is actively seeking research collaborations, particularly in the fields of rare plant genetics, seed storage technology, seed physiology, and micropropagation (B. Meijer, pers. comm.).

Expansion of the pool of undergraduate and graduate students. Many students at the university level are interested in environmental issues, but are unaware that formal training in horticultural science can provide them with tools and insights for pursuing this interest. My own experience suggests that most undergraduates majoring in biology, botany, ecology, forestry, or anthropology have little understanding of what the science of horticulture encompasses, yet they often become interested in specific subjects where the theory and techniques of horticultural science are highly relevant. Many of my students respond enthusiastically when given the opportunity to work directly with living plants, an approach that often receives more emphasis in horticulture than in these other disciplines.

Courses emphasizing the role of horticulture in plant conservation and preservation of biodiversity are likely to attract and introduce a new pool of students to the science of horticulture. We offered a course at the Univ. of Georgia in 1995 (cross-listed in the Deps. of Horticulture and Anthropology) titled "Biodiversity of the World's Food Crops: A Multilevel Analysis." This team-taught course explored the dependence of the world's food supply on genetic diversity in natural populations and traditional landraces of cultivated plants. The subject was addressed from three levels of analysis: molecular, organismal, and cultural. By the end of the course, anthropology students enrolled in the course had a new appreciation for the role of horticultural research in preserving biodiversity, and they requested more information concerning mainstream horticulture courses that would complement their research interests (e.g., vegetable crops, plant breeding, postharvest physiology).

Service to a growing industry segment and consumer interest. Rare plants are a subset of a much larger group of plants—native species—that are becoming increasingly important in commercial horticulture (e.g., Martinez, 1995; Phillips and Meijer, 1995; Thomas, 1995a; Van de Water, 1995). Design and maintenance trends that encourage use of native plants in the landscape, such as xeriscaping, will continue to build consumer interest and demand. Legal restrictions and mitigation regulations that require developers to restore or replace plant and animal communities create markets for large volumes of native plant species that do not necessarily have a history of commercial production (Sauer, 1995a, 1995b; Thomas, 1993b). Although acceptance in the marketplace ultimately depends upon many factors, native species benefit from the same research and marketing approaches that are successful for other species (Bir, 1996).

Federal and state mandates concerning use of native species for landscaping and restoration projects have stimulated numerous feature articles and opinion pieces in industry...