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Botanical Gardens and their Role in ex Situ Conservation and Research

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Botanical Gardens hold living collections of plants for a bunch of purposes since many centuries. Following a definition given by P. WYSE-JACKSON 1999 Botanical Gardens are: "...institutions holding documented collections of living plants for the purposes of scientific research, conservation, display, and education." In recent years Botanical Gardens have been founded in biodiversity rich and economically developing countries to give a broadly visible value to the local flora. Thus they contribute to the conservation of threatened plant diversity. Biodiversity is endangered worldwide and plant species disappear in an alarming and increasing rate. Mankind may have accelerated the rate of extinction by 100- to 1,000-times the natural rate (RICKETTS & al. 2005). Because of the increased loss of biological diversity emphasis has been given to in situ and ex situ measures to halt the loss of plant populations and taxa. National and international strategies and documents have been developed.

The Convention on Biological Diversity (CBD 1992) is the framework for traditional and new duties of Botanical Gardens which support the CBD in many ways. An Action Plan for Botanical Gardens in the European Union (CHENEY & al. 2000) and an International Agenda for Botanical Gardens in Conservation (WYSE JACKSON & SUTHERLAND 2000) have been published. More specifically, the CBD adopted the Global Strategy for Plant Conservation, GSPC (WYSE JACKSON 2001), including 16 outcome-oriented global targets for 2010. The CBD so far has been signed by 189 Parties and the GSPC is binding also for the European Community. The most relevant targets of this strategy are related to the understanding and documenting of plant diversity, the development of models for plant conservation based on research and practical experience, and the conservation

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of plant diversity. Sub-target eight aims at "60 per cent of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes" until the year 2010.

Resolutions for example of the International Botanical Congress are supporting the maintenance of genetically adequate and generally available samples of the world's plant species in Botanical Gardens and gene banks throughout the world, and thus building on the 30 percent of plant species already estimated to be in cultivation. Others claim that 50% of threatened and 75% of critically endangered species should be safeguarded in ex situ conservation collections by 2010. More than 80,000 species in 6 million accessions and 142 million specimens are cultivated in more than 2,000 Botanical Gardens world wide and Botanic Gardens Conservation International (BGCI) estimates 60,000 – 100,000 endangered plant species world wide. Two third of them will be extinct in less than a hundred years and Botanical Gardens harbour more than 9,000 endangered taxa. Diversitas International in its Oaxaca Declaration on Biodiversity (Diversitas International 2005) urges that „scientific knowledge of biodiversity must be substantially increased, ambitious interdisciplinary research programmes to explore the Earth's biodiversity shall be launched and supported, resources to build and greatly expand the capacity, especially in developing countries shall be committed, and biodiversity research and implementation of the conservation and sustainable use of biodiversity should be undertaken".

Botanical Gardens seem to be the right address for ex situ cultivation or conservation. Ex situ conservation is being realized by means of seeds, cuttings, tissue- or cell cultures and should secure genetically representative permanent collections for conservation, (re-) introduction, research, and education. Global objectives of conservation refer to biological theories of abundance (establishment, vegetative growth, fecundity, population size), extent (dispersal, number of populations, distribution of populations), resilience (genetic variation, resistance to perturbation, dormancy), and persistence (self-sustainability, microhabitat variation, community "membership"). However, controversial discussions on the value of ex situ conservation highlight artificial conditions of cultivation, hybridisation, inbreeding, and artificial selection or bottleneck effects on genetic diversity etc. Conservation in tissue cultures and seed banks is cost effective but results in the conservation of a status quo of the sampled material with the goal to avoid any biological interaction and hence population development. Examples for mixed strategies combining ex situ, in situ, and seed bank or tissue conservation are scarce.

Regarding priorities for ex situ conservation immediate threat of extinction, local economic importance, local ecotype, local 'flagship' species,

and special economic interest among others are commonly stated. Conservation needs understanding of biology, ecology, and genetics of the endangered species in question. Based on a diversity of Red Lists or priority lists database systems have been developed to give information on the biology of endangered species to take appropriate measures for conservation. However, searching for applicable data important information is lacking quite often. Especially data on parameters with influence on reproductive output and on survival rates at different age stages are missing. Few studies on threatened species lead to in situ conservation management directly.

The fundamental question "Why are plant species endangered?" is as complex and as simple as life. Two hundred years ago T. R. Malthus formulated the fundamentals of population growth. In endangered populations the outcome of birth and death rate is negative and hence population size is decreasing. Numerous factors may force populations out of birth-death-equilibrium. A variety of causes for threat has been investigated. Among them are ecological parameters like environmental variability, population density, intra-specific competition, herbivory, mutualism, pathogenes, pollination, and dispersal or genetic factors like heterozygosity, allele diversity, and self incompatibility. They all either have impact on rates of birth, growth or death. Ecological and genetic studies on population growth of endangered species are relevant to different steps in plants life cycle e.g., pollination, seed set, dispersal, germination, seedling establishment, juvenile mortality, and survival of reproductive adults. Available space and resources, positive or negative interactions with other organisms and variability at population level act on or result from these processes. Research on these factors is mostly driven by personal interest of researchers, by challenges of infrastructure and methods and by rules that govern the distribution of available money for research (on endangered species).

Effective research on endangered plants should be developed by deductively identifying critical steps in the life cycle of the species and a strategic approach is needed to execute this kind of research. If only a few individuals are left in an endangered plant species or population, immediate action should be taken. If low population size (or number of populations) is given, a demographic study should first be executed in order to identify the less vital phases. Only then research hypothesis should be elaborated in order to enhance these phases and to increase population size. Despite the controversial discussion on ex situ conservation, Botanical Gardens are in a prominent position to produce data on several of these life phases of endangered species. Information on seed set, germination success, juvenile mortality, and reproductive offspring under known growth conditions and reduced stress and competition will be highly useful for comparison with in situ conditions.

Scientific research may not always be a major issue for botanical gardens but if affiliated to a university priority should be given to research on conservation since programmes to produce applicable information for conservation of endangered species are urgently needed.

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