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## Botanical gardens and the conservation of Europe's flora

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### ABSTRACT

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Europe has a flora of some 12,500 species of flowering plants and ferns. Southern Europe has the most diverse flora, with a high proportion of endemic taxa. The continent's rich and important resources of wild plants, both the actual species and their many intraspecific variants, is under threat from increasing loss of natural and semi-natural habitats, as a result of more extensive, efficient agriculture, progressive urbanisation, an expanding tourist industry and, more recently, local political instability. There are also potential threats from uncontrolled commercial exploitation of wild plants and from long-term global climatic change. The conservation of Europe's flora necessitates an integrated approach, involving both in situ and ex situ measures. The European network of Protected Areas requires the support of a network of botanic gardens and other ex-situ collections of plant germ-plasm. Botanic gardens provide an essential link between the field, garden, herbarium and laboratory studies that provide the background research for conservation strategies. Plant material in cultivation is a basis both for the restoration of destroyed or degraded plant communities and for the protection of individual plant species and taxa that have undergone drastic reduction in numbers. Biodiversity is Europe's most precious resource and botanic gardens should have a central role in the protection of our native plants for the use and enjoyment of future generations.

### RÉSUMÉ

AKEROYD, J. R. (1993). Jardins botaniques et conservation de la flore européenne. Comptes-rendus du colloque "Nature et Jardins botaniques au XXI<sup>e</sup> siècle", Genève, 2-4 juin 1993. *Boissiera* 47: 32-39.

L'Europe compte une flore de près de 12.500 espèces de plantes à fleurs et de fougères. C'est en Europe du Sud qu'on trouve la flore la plus variée, avec un grand nombre de taxa endémiques. Les ressources importantes et riches du continent en plantes sauvages, aussi bien les espèces proprement dites que

leurs nombreuses variabilités intraspécifiques sont en danger par suite de la disparition de plus en plus accentuée de leurs habitats naturels et semi-naturels, causée par l'agriculture toujours plus efficace et étendue, l'urbanisation progressive, l'expansion de l'industrie touristique, et plus récemment, l'instabilité politique locale. Il existe également des menaces qui résultent de l'exploitation commerciale incontrôlée des plantes sauvages et de l'approche intégrée des changements climatiques globaux à long terme, comprenant des mesures in situ et ex situ. Le réseau européen de zones protégées demande le soutien d'un réseau de jardins botaniques et d'autres collections ex-situ de germes-plasmes. Les jardins botaniques constituent un lien essentiel entre le terrain, le jardin, l'herbier et les études de laboratoires, qui fournissent le fond de la recherche pour les stratégies de conservation. Les plantes en culture représentent une base aussi bien pour la régénération des communautés de plantes détruites ou dégradées que pour la protection des espèces de plantes individuelles et des taxa ayant subi des réductions considérables de leur nombre. La biodiversité est l'une des ressources les plus précieuses d'Europe et les jardins botaniques doivent avoir un rôle majeur dans la protection de nos plantes natives afin qu'elles puissent être utilisées et réjouir les générations futures.

## Introduction

Europe has a rich and varied flora of some 12,500 species of flowering plants, gymnosperms and ferns (AKERROYD & SYNGE, 1992). This important, indeed basic, natural resource is today under ever-increasing threat. Although Europe has witnessed a long history of human occupation and disturbance of habitats, the last 50 years have been a period of unprecedented acceleration of habitat loss and degradation. The continent's wild flora, both the actual species and their many intraspecific variants, is under threat from increasing loss of natural and semi-natural habitats. Ancient crops, old-fashioned garden plants and fruits and even certain weeds and ruderals are also threatened by progressive changes in husbandry and economics and as a result of the standardisation of cultivated material through insensitive legislation.

The progressive loss of our wild flora has arisen as a result of many factors. These include an expanded and more efficient agriculture, large-scale industrial, urban and suburban development, pollution of air, water and soil, increased affluence and consequently expanded leisure activities, and the unsustainable exploitation of natural resources, notably peatlands and timber, but also the uncontrolled exploitation of wild plants as a source of material by the horticulture trade. Events arising from the current political uncertainty in parts of eastern and south-eastern Europe represent a major potential threat to the rich floras of those regions, as well as to the future of the organisations and institutes charged with their protection. There may also be a significant, long-term problem of climatic change resulting from the global warming predicted by many climatologists.

## Europe's floristic riches

The richness and variety of our flora arose for several reasons. Europe extends from the cold deserts of the arctic to the warm-temperate Mediterranean region. For such a relatively small geographical area it has a diverse topography, geology, climate and vegetation. Much of central and southern Europe is mountainous, whilst in the east the continent levels out towards the plains of central Asia. The eastern extremity has been traditionally demarcated by the north-south range of the Ural Mountains, with the Caucasus region forming the south-eastern boundary. Plant communities range from the tundra of northern Scandinavia to the sclerophyllous scrublands of the Mediterranean region and the steppes of Ukraine and the Crimea. Europe has a range of temperate climates, the Atlantic Ocean that washes its western and northern shores having an ameliorating effect on the weather, especially in the more westerly parts. The Mediterranean itself has an Atlantic

weather system during the winter months, even in the most easterly parts. Human impact on Europe's flora has been greatest on the wetlands and forests. The majority of the most extensive wetlands have been drained, although a number remain, especially on coasts. Almost all native forest cover has been cleared from the lowlands, but substantial stands survive in the mountains and in the north.

Two factors have had a special influence on Europe's vegetation and flora. Firstly, extensive episodes of glaciation during the Pleistocene gave rise to major migrations and extinctions of plants (GODWIN, 1975; HUNTLEY & BIRKS, 1983); and secondly, some 10,000 years of agriculture and 3000 years of the dominant and expansive Western and Islamic civilizations, notably in the Mediterranean region (BRAUDEL, 1966), have modified or destroyed natural plant communities and have introduced a substantial alien element into the flora from other parts of the world. The areas of greatest biodiversity in Europe represent relics of the former native vegetation and flora, especially in the south. The flora and vegetation of many of them, however, are maintained by often ancient patterns of human management and exploitation of plant and animal resources.

The floras of the southern peninsulas (and islands) of Iberia, Italy and the Balkans were enriched as plants migrated southwards during the Pleistocene glaciations, these areas acting as refugia for more thermophilous floristic elements. Taxa in these refugia may not have expanded their range on a return to warmer climatic conditions and have thus become extinct elsewhere (PAWŁOWSKI, 1970). At the same time, it can be postulated that such migration brought taxa together within refugia, promoting episodes of hybridization and subsequent evolutionary radiation and speciation.

The flora of Europe has, for its size, received disproportionate levels of scientific study (IUCN, 1985). In recent years many botanists have queried this level of research, emphasising the rich and threatened floras of the tropics, especially those of the wet, equatorial tropical forests. Nevertheless, not only do the nations of southern Europe have floras of a comparable size to those of many tropical regions — Greece and Spain have some 5000 species — but we would be foolish not to study the plants that surround us, even in the floristically impoverished north. Europe's flora is a resource of immense economic and cultural importance. (When I was revising the first "Flora Europaea" during the 1980s I frequently reflected, with a mixture of amusement, anger and contempt for the scientific establishment, on the fact that, although botanists in then Communist nations were busily researching the flora of Europe, I was the only botanist in Britain actually to be paid a salary to study that same flora.)

Every European nation now has a Flora (or Floras) or other floristic publications and there are great numbers of local Floras, especially in Britain, Italy and Germany, and an increasing number of popular field guides, even for southern Europe. Substantial gaps in coverage do remain, although current projects to produce Floras for the Iberian peninsula and Greece will considerably consolidate our knowledge. "Flora Europaea" (TUTIN & al., 1964-80, 1993) provides a valuable synthesis of often disparate taxonomic treatments (AKERÖYD & WALTERS, 1987), and has become a standard text both for botanists and for legislative bodies such as the Council of Europe. The ongoing Med-checklist project will, in its entirety, complement "Flora Europaea", by cataloguing the 25,000 or so species that occur in the countries that border the Mediterranean Sea. It is to be hoped that the authors of these current regional projects will be able to reconcile some of the inconsistencies of taxonomic treatment that are again creeping into European taxonomic and floristic works. If this trend is not checked, it will undermine the unifying achievement of "Flora Europaea", give taxonomy an aura of disrepute amongst users, and make life harder, by failing to provide a practical and legal nomenclatural framework, for those seeking to conserve the continent's flora.

There are several major centres of diversity in Europe, especially around the Mediterranean basin. Some 75 genera and 3500 (i.e. more than 25%) species are endemic to Europe, mostly in



the mountains of southern and south-central Europe, although there are no endemic families (WEBB, 1978). South Europe, and to a lesser extent the mountains of Central Europe, is considerably richer floristically than northern Europe, with a higher proportion of endemic species (FAVARGER, 1972). These regions contain significant populations of wild crop relatives and other economically important plants.

Some localities have extraordinarily rich endemic floras. Mount Olympos in northern Greece has 26 endemic species and floristic links with other parts of the Balkans, the Alps and Anatolia, and has a total flora of at least 1700 species (STRID, 1980). The Sierra Nevada of south-eastern Spain have some 80 endemic species, and the Baetic Cordillera of which they comprise a part have more than 300. Remote and mountainous parts of Greece and southern Spain are still yielding a trickle of taxa new to science. Much of this endemism reflects the dissected topography of the high mountains, peninsulas and islands of southern Europe, and some of the islands of the Mediterranean such as Crete and the Tyrrhenian islands have particularly high levels of endemism. Corsica has 126 endemic taxa, with a further 76 shared with Sardinia. A minority of these can be recognised as good species at a European level — although there are several Corsican-Sardinian species that are quite remarkably distinct — but they represent an astonishing reserve of genetic diversity.

The Threatened Plants Database of the World Conservation Monitoring Centre, Cambridge, lists 25 species of flowering plants that have become extinct in the wild in Europe. Many more survive in low numbers or in very scattered localities. At both regional and local level there have been numerous extinctions, especially of wetland plants such as the insectivorous aquatic *Aldrovanda vesiculosa* (Droseraceae). The World Conservation Monitoring Centre have listed more than 2700 species in Europe as 'Endangered', 'Vulnerable', 'Rare' or 'Indeterminate', assessed on the basis of the categories of threat drawn up by the International Union for the Conservation of Nature.

These losses and threats can, at least to some extent and depending upon the species, be ameliorated by taking appropriate measures for in situ and ex situ conservation and carefully planned recovery programmes. Surviving habitats tend to be fragmented, often forming relict islands or strips within urban, industrial or intensively farmed landscapes. Conservation of natural or (in view of the extensive human disturbance of the continent's flora and vegetation) semi-natural habitats is to be preferred. Nevertheless, conservationists sometimes forget that the most species-rich and aesthetic habitats, such as grasslands and Atlantic or Mediterranean scrublands, are artefacts of careful, long-term human management. Most European, so-called 'ancient' woodland outside the remoter mountains and the great boreal forests has been carefully managed and exploited for centuries or millennia.

Even heavily damaged landscapes can exhibit high levels of floristic diversity, probably because ironically these sort of habitats provide ecological niches for new taxa as they evolve, perhaps following episodes of hybridisation between taxa brought together by human disturbance or 'hybridisation of the habitat'. The numerous narrowly endemic species of Knapweed (*Centaurea* spp.) in Greece, often in ruderal or semi-ruderal plant communities, may represent speciation since the Neolithic. I have long felt that the post-war construction of roads in the Balkan peninsula and elsewhere will have created a natural "genetical laboratory" for the evolution of weeds, recruited from different communities on to the new embankments and cuttings, where they may hybridise and evolve a new generation of endemics through introgression or polyploidy.

### Protected areas

Europe possesses considerable human and institutional resources devoted to the conservation of plants and their habitats, with each European nation having its own network of National Parks

and Protected Areas. These cover a range of plant habitats, concentrating on threatened wetland communities and the species-diverse montane regions (POLUNIN & WALTERS, 1985). Important gaps remain, especially in the south, and several nations lack enough effective legislation to protect fully the plants and animals for which reserves have been established. The total number of Protected Areas in Europe has been estimated at between 10,000 and 20,000, although many of these are small and few cover the vast areas that have been established in North America or parts of Africa. They frequently face a variety of threats, not least official indifference or neglect and poor management. The continent is a crowded one and land has become expensive, which means that there may be few future opportunities for the large-scale purchase of the land needed to establish major new Protected Areas.

The historical political fragmentation of Europe has delayed the development of continental conservation strategies. Important developments have been the European Community's Directive on the Protection of Natural and Semi-natural Habitats of Wild Fauna and Flora (Habitats Directive), requiring EC member states to legislate for the full protection of the habitats of selected rare species in the Annexes of the Directive. Similar listings, but with less legislative power, have been included in the Council of Europe's Bern Convention on threatened species, covering 500 "Strictly Protected Plants" in both EC member states and elsewhere, including nations formerly included in the Warsaw Pact.

It could be that the trend will be for land actually to be lost from existing reserves. This may well be the case in parts of eastern Europe, where (following the momentous political events of the last three years) former landowners are reclaiming land appropriated by Communist governments. It may also be the case in countries such as Britain, where economic recession has encouraged governments to consider the release of control of Protected Areas from state to private ownership and management. We should perhaps think ahead to a Europe where much long-term conservation of flora and fauna will have to be achieved outside Protected Areas and Nature Reserves.

We still lack data on the proportion of Europe's threatened plants that are covered by Protected Areas. Parts of Eastern Europe currently have a very good coverage. The Czech Republic and Slovakia have more or less 100% of their threatened species within protected areas, although in many parts of eastern Europe conservation is suffering from underfunding and levels of institutional chaos. Regions of southern Europe with the richest floras have much lower levels of protection. Greece and Spain, two of the most floristically diverse nations in Europe, each with a total of some 5000 native species, have just 35-40% of their threatened plants within Protected Areas, a dangerously low proportion at a time of so many environmental threats. The Mediterranean region must be seen by those responsible for planning conservation strategies as the priority goal for the expansion of Europe's network of Protected Areas.

### **Wild plants as a sustainable economic resource**

Some of the richest, most beautiful and culturally important ecosystems of Europe are those that are managed along traditional lines, often on the basis of the sustainable exploitation of particular plant communities and species. Strong economic and social pressures for agricultural change or the retreat from a traditional rural lifestyle greatly threaten these habitats, successional plant communities maintained by human management. They may indeed be better managed as protected landscapes, outside the framework of conventional Nature Reserves or National Parks. Such communities include lowland and Alpine grasslands, heath and boglands, Mediterranean scrublands, certain coastal and subcoastal landscapes such as the machair grasslands of Scotland and Ireland,

Les Landes of S.W. France and the deltas of southern Europe. The huge region occupied by the Alps, from the French Riviera into the heart of Mitteleurope, is of special concern in this respect. Here a traditional pastoral lifestyle is being rapidly replaced by the use of the landscape as a giant recreation park for the people of Europe. We must think hard about how we are to conserve the landscape and flora of the Alps within this new, radically altered concept.

In northern and western Europe, far less use is made than in the past of native plants. Heathlands were once a source of turf and brushwood for fuel, and native woodlands provided timber and a variety of forest products. An exception is the peatlands, which in Ireland, Finland and northern Russia are heavily (and many of us would say excessively) exploited for their peat, which is stripped mechanically for use as domestic and industrial fuel, and also as a growth medium, mulch and compost in a rapidly expanding horticultural industry (PLANTLIFE, 1992). Forestry in north-western Europe is today dominated by exotic conifers, although native conifers are exploited in Scandinavia and in the mountains of central and southern Europe. The biodiversity represented by managed landscapes is a major resource, especially of plants such as grasses and forage legumes. Remaining species-rich grasslands are now particularly at risk, either from destruction by the plough, by reseeding or the application of fertilizer, overgrazing or, where grazing patterns have changed, encroachment by scrub and trees. Within an intensive modern agricultural system such as we have in Britain, where we have lost more than 95% of our ancient meadows since 1945, 10% of the little remaining semi-natural grassland disappears each year.

In southern and to a lesser extent eastern Europe, local people still employ native plant products for a variety of uses. Indeed, in parts of the Mediterranean region, especially more mountainous areas, wild plants contribute a significant amount to the local economy. Mediterranean and sub-Mediterranean scrublands and woodland-pasture provide local inhabitants with timber for fuel, fencing and building, charcoal, bark for tanning, gums, oils and resins, forage and fodder for animals, herbs and medicines, salads and fruits for food, wild flowers as a source of nectar for bees and for ornament, game, snails and edible fungi. The scrublands have long offered the the poor a living and have sheltered both fugitive and freedom-fighter.

Nevertheless, as in the Alps, the retreat from this older landscape accelerates and the new service industries developed around tourism are more attractive to the young.

Our links with the wild flora remain. The fruits of several native trees remain a valued crop over much of the continent: nuts of sweet chestnut (*Castanea sativa*), hazel (*Corylus avellana*), Filbert (*C. maxima*) and Stone Pine (*Pinus pinea*), and the fruits of various ericaceous and rosaceous genera. In Corsica the rural economy is still based to a great extent on free-ranging pigs, feeding on chestnuts, acorns and beech-mast. The sight of these animals, variable in appearance and sometimes interbred with wild pig, foraging under huge pollarded chestnuts, would have warmed the heart of a medieval monarch were he to return today! One wild species in particular in the Mediterranean region retains economic potential. Giant Reed (*Arundo donax*) is employed for fencing and a whole variety of domestic and horticultural uses — the bamboo of southern Europe — as well as the manufacture of oboe reeds.

### **The role of botanic gardens**

Pressure on Europe's flora is thus very great and it may not always be possible to protect our most precious species in situ.

Botanic gardens are the ideal vehicle for ex situ conservation, a back-up and a complement to Europe's network of Protected Areas. Reserve collections in gardens can now be established in

several different ways, extending the traditional living collections that are vulnerable to genetic impoverishment, hybridisation, accidents and episodes of neglect. The staff of the modern botanic garden or arboretum, armed with well-organised, computerised record-keeping and the technology of the seed or pollen bank, micropropagation and cryopreservation, have an array of techniques to supplement their living collections, only a proportion of which may be on display at one time.

The botanic garden ought too to be a centre for the study of threatened species in its collections, in conjunction with field and laboratory studies, not only their biology and taxonomy, but also their genetic variation, knowledge of which is essential if any reintroduction or restoration programme into the wild is envisaged. We currently have detailed information on the biology of less than 5% of the European flora and we know almost nothing about the vast majority of the threatened endemic species. Some are known only from a few field observations and less than a quarter are in cultivation. The current low intellectual regard for traditional botanical studies in some countries, particularly Britain, needs to be reversed, as the expertise of the botanist in the field and garden is vital if we are to try to save Europe's threatened flora.

Botanic gardens also have a role in the implementation of CITES and other practical and legal measures for the protection of wild plants. There is evidence that considerable quantities of wild plants are being gathered in Europe, as elsewhere in the world, to feed a profitable and expanding horticulture trade. Great numbers of bulbs such as cyclamen and miniature daffodils are dug up each year from the wild in Greece and Portugal and even, on a smaller scale, in Britain (mostly our native speciality, Bluebell (*Hyacinthoides non-scripta*)). Not only do botanic gardens possess the facilities and expertise to provide practical measures and advice to those charged with the protection of our flora, but they are in a position to act as intermediaries between scientific and commercial interests. In this respect they should promote measures to ensure that threatened plants will survive both in the wild and in cultivation, and be exploited in a positive and sustainable manner. By propagating and distributing material of threatened plants, they can ensure their survival in cultivation and also keep market prices down at acceptable levels. Europe's private gardens are themselves an astonishing reservoir of genetic variation, lovingly curated.

Above all, perhaps, botanic gardens should be seen as centres for conservation projects, possessing the techniques, infrastructure and botanically literate staff. They should be in a position to provide both the material and the techniques for restoration of plant species and communities into the wild, together with the appropriate after-care and management. Education and publicity are all-important, with gardens actively promoting the conservation of local, regional or internationally important species or taxa.

The conservation of Europe's flora necessitates a fully integrated approach, involving both in situ and ex situ measures. The European network of Protected Areas requires the support of a network of botanic gardens and other ex situ collections of plant germ-plasm. Botanic gardens provide an essential link between the field, garden, herbarium and laboratory studies that provide the background research for conservation strategies. It is important that this so-called "traditional" research be encouraged by European research councils, for it is the very basis of the protection of our floras. Plant material in cultivation is the raw material both for the restoration of destroyed or degraded plant communities and for the protection of individual plant species and taxa that have undergone drastic reduction in numbers. Many of the plants in botanic garden cultivation may one day be required by the geneticist or horticulturist for future programmes of plant breeding.

The great civilisations of the ancient Mediterranean world that provided the foundations of our contemporary European culture evolved as a result of the wise exploitation of plants and other natural riches. We still need those plants (and, of course, in our technological age, their genes) today for food, medicine, timber and other essential materials, and for aesthetic and spiritual pleasure.

Heed, for example, the wise words of Jean Baptiste Colbert (1619-83), Louis XIV's Minister of Finance, on the subject of trees: "France will perish without timber". Note, for example, that the proportion of ancient, indigenous wheat cultivars grown in Greece fell from 80% in 1930 to less than 10% by 1970 (BENNETT, 1971). Biodiversity is Europe's most precious resource, and botanic gardens must and, I am sure, will play a central role in the protection of our native plants for the use and enjoyment of future generations of Europeans.

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