BOTANIC GARDEN PROFILE

THE BALKAN BOTANIC GARDEN OF KROUSSIA, NORTHERN GREECE: A GARDEN DEDICATED TO THE CONSERVATION OF THE NATIVE PLANTS OF GREECE AND THE BALKANS

Eleni Maloupa[1] & Nikos Krigas[2]

ABSTRACT

In this paper the profile of the Balkan Botanic Garden of Kroussia (BBGK) is outlined and basic illustrations are provided. The location, establishment, facilities, organization and staff of BBGK, as well as the topography, soils and climate of its grounds, are presented. The plant conservation targets and policies formulated by BBGK in order to fulfil its mission are also described. This includes eight different complementary policies. These are the Only Native Plants Policy, Important Plant Species (IPS) Policy, Explicit Plant Documentation Policy, Propagation of the IPS First Policy, DNA Barcoding Policy, Combined *ex situ* and *in situ* Conservation Policy, Evaluation for Sustainable Exploitation Policy and the Environmental Awareness on Native Plants Policy. The living native plant collections of the BBGK are presented quantitatively and the number of plant sections and displays designed in the BBGK and in the newly established Garden of Environmental Awareness are described. BBGK's mission is to support research, maintenance, propagation, evaluation, conservation and sustainable use of the native plants of Greece and the Balkans, combined with raising public awareness of the environment.

LOCATION, ESTABLISHMENT, FACILITIES, ORGANIZATION AND STAFF

The Balkan Botanic Garden of Kroussia (BBGK), Greece was funded in the framework of the Inter-Regional Developmental Initiatives of the European Union (INTERREG II-External Borders). The BBGK was founded on 19 May 2001 as an initiative of the National Agricultural Research Foundation (NAGREF).

The BBGK is situated in northern Greece (Figs. 1, 2), about 70km from Thessaloniki (the second biggest Greek city), near the mountain village of Pontokerasia in the Prefecture of Kilkis (41°05′N/23°06′E). It is located close to the borderlines of Greece, the former Yugoslav Republic of Macedonia (FYROM) and Bulgaria, lying between two important conservation areas included in the Natura 2000 Network, Lake Kerkini and surrounding mountains (GR1260001: Limni Kerkini-Krousia-Koryfes orous beles, Agistro-Charopo) and the Mouries hydrophilous lake forest (GR1230002: Ydrochares Dasos Mourion). The BBGK has been developed within a deciduous oak forest (*Quercus*

[1]Eleni Maloupa is Director and Curator of the Balkan Botanic Garden of Kroussia.
Address: Balkan Botanic Garden of Kroussia-Laboratory for the Evaluation and Conservation of Native and Floricultural Species, National Agricultural Research Foundation, P.O. Box 60125, Thessaloniki, GR-57001, Greece.
Email: bbgk@bbgk.gr
[2]Nikos Krigas is a Biologist and Plant Taxonomist.
Address: Laboratory of Systematic Botany and Phytogeography, Department of Botany, School of Biology, Aristotle University of Thessaloniki, GR-54124, Greece.
Email: nkrigas@bio.auth.gr

pubescens and *Q. frainetto*) that has been traditionally managed for a long time, at an altitude of 600m (Mount Mavrovouni, Kroussia Mountain Range). Today it covers an area of 31ha which is dedicated to the combined *ex situ* and *in situ* conservation of native plants of Greece and the Balkans (15ha and 16ha, respectively), as well as to raising the environmental awareness of, and educating, the public.

The BBGK is open for visitors throughout the year (Figs. 1, 2). Since its establishment in 2001, there has been a continuous increase in visitor numbers and to date the BBGK receives about 10,000 visitors per year, of which 40% are schoolchildren, students or teachers.

The facilities for visitors include:

- a connection with the road network
- peripheral forest roads
- two parking areas
- guest houses
- information centre
- fencing
- compost areas
- resting kiosks
- wooden tables and benches
- water taps
- semi-natural ponds
- pond platforms
- a botanic greenhouse
- artificial lakes and waterfall
- road signs
- direction signs
- bilingual signage for the thematic displays
- plant labels
- well-defined paths and steps in the wooded area.

Art-works are also displayed in the garden and leaflets and descriptive maps in English and Greek are provided for self-guided tours around the area.

The BBGK's symbol-plant is *Fritillaria pontica* (Fig. 1) due to the wild populations discovered in the grounds of BBGK. This plant has been adopted as a symbol for its recognized ornamental value, its restricted general distribution area (Balkan countries and northern Turkey), its uncommon occurrence in Greece and its protection by the Greek Presidential Decree 67/81; these are properties that may illustrate the targets and policies of the BBGK.

Fig. 1 Information Centre and guest house in the Garden of the Senses of the Balkan Botanic Garden of Kroussia (BBGK) along with its logo plant (*Fritillaria pontica*). Photo: BBGK archives.

Since the beginning, the BBGK has been continuously supported by a well-equipped nursery and laboratory facilities of 10ha located at sea level, in Thermi, metropolitan Thessaloniki – Laboratory for the Conservation and Evaluation of Native and Floricultural Species (LabCENFS, NAGREF). LabCENFS includes a nursery complex with six indoor computer controlled greenhouses of 150m^2 each (with mist propagation, hydroponics, production areas, floating irrigation/hydroponic systems), extensive open-air mother plantations with irrigation system and seasonal shading, cold frame areas, compost areas, pilot experimental fields, seed bank, growth chambers, herbarium, laboratories for tissue culture, plant physiology, molecular biology, soil analysis, quantitative and qualitative analysis of essential oils, library, reception hall, foyer, offices, and parking areas.

The BBGK-LabCENFS (abbreviated to BBGK) are supported by a head researcher, 3 Postdoctoral researchers, 7 scientists, 6 horticulturists, 2 technicians and 8 labourers. Unfortunately, almost half of them still work under short term contracts.

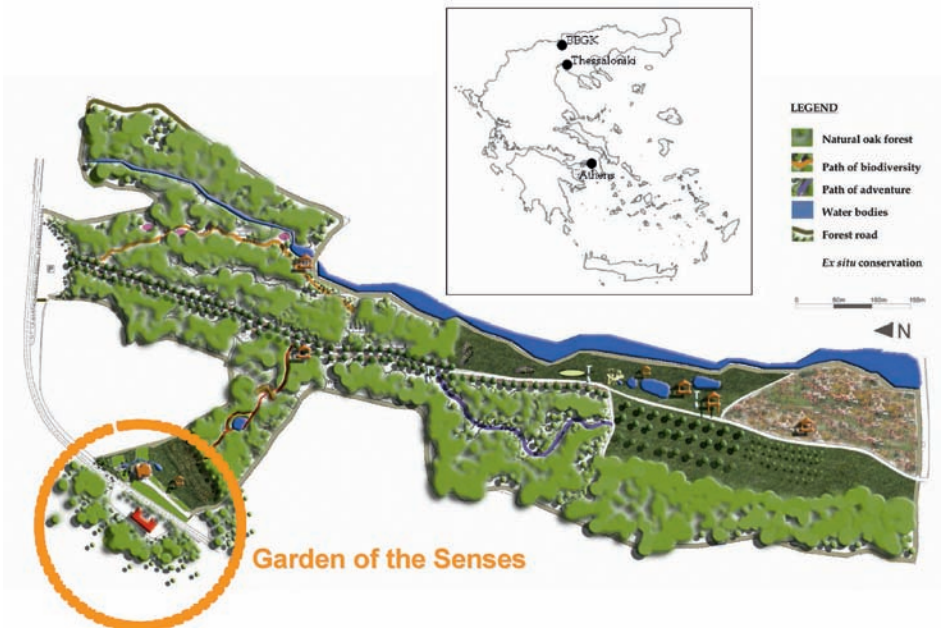

Fig. 2 Rough sketch and location of the BBGK in northern Greece. For thematic plant displays see Table 1. Photo: BBGK archives.

TOPOGRAPHY, SOILS AND CLIMATE

The relief within the BBGK rises from 620m at the car park (Fig. 2) to 520m at its highest point in the south-west corner. From the north-east entrance the ground rises gently along a central axis of 5–10m wide, forming relatively flat hills and gradually dropping down towards the south-west and south-east corners. This results in varying soil depths ranging from 100–300mm along the central axis to 700–1,500mm on the slopes. Natural watercourses appear seasonally, ending in two semi-natural ponds. From the ponds the water can be directed towards a water reservoir of c. 50,000m^3 at the lowest point in the south-east. These gentle slopes afford varying aspects, exposures and micro-climates, providing a range of suitable locations for planting.

The substrate of the BBGK is composed mainly of schist and gneiss, and amphibolites in the south. The soil within the BBGK comprises a shallow stony loam with the stone size ranging from gravel to boulders of medium size and with several pockets of rich soils along stream sides and around ponds. Generally the BBGK's soils can be classified as Mollisols and Entisols (Inceptisols and Alfisols), with a pH ranging from 6.5 to 7.

The relatively high altitude of the BBGK in northern Greece (near the borderline with FYROM and Bulgaria) and its location in the south-west relief of Mt Mavrovouni (Kroussia Mountains) results in a sub-mediterranean climate with a relatively strong continental influence. This is also illustrated by the absence of many typical evergreen-

deciduous plant species in the area which are dominant in other lowland and coastal regions of the Mediterranean. Relatively warm dry summers with mean temperatures reaching 22.7 °C in July are common, as well as relatively cool dry winters with mean air temperatures falling below 3.2 °C in February (the mean temperature range is 19.5 °C). In some years late winter frosts can cause considerable damage not only to flowers but to plant growth as well.

Rainfall is more common in spring and autumn, ranging from 53mm in May and 50mm in October down to 27.5mm in July. The dry warm period lasts from mid-July to the end of September, with a break in August. Natural water is easily available from November to April, and then gradually starts to decrease. By the end of July it becomes completely absent and starts gradually increasing again in August.

NECESSITY FOR THE ESTABLISHMENT OF BBGK, MISSION, TARGETS AND POLICIES

Plant diversity in Greece and the Balkans is exceptionally rich and unique, presenting a higher degree of endemism in relation to surface than any other comparable area of Europe or the Mediterranean region. About 60% of the endemic plants of the European continent are restricted to the Balkans. Greece, with at least 5,700 native plant species and subspecies (Phitos *et al*., 1995; Strid & Tan, 1997), is one of the floristically richest areas of Europe, hosting 45–50% of the total European native flora (Akeroyd & Heywood, 1994) and about 80% of the Balkan flora (Polunin, 1980). About 15–20% of the plant taxa (species and subspecies) found in Greece are unique, found nowhere else in the world (Greek endemics), and therefore the country is considered to be among the most valuable regions for plant conservation in Europe and the Mediterranean (Akeroyd & Heywood, 1994).

The uniqueness and rarity of the Greek and the Balkan flora demands effective conservation efforts as it is under increasing threat from climatic change, fires, land reclamation, over-grazing and urban and tourist development. With these threats to the region's vegetation the BBGK has formulated a conservation strategy (Maloupa *et al*., 2008) and has adopted the Mission Statement to "support research, maintenance, propagation, evaluation, conservation and sustainable use of the native plants of Greece and the Balkans, combined with raising the environmental awareness of the public".

Since its establishment the BBGK has been focused on the conservation and the sustainable use of native plants of Greece and the Balkans ('Only Native Plants' Policy), leaving aside the exotic and ornamental plants. All plant displays in BBGK have been created using plant material originating in the wild that has been sustainably managed.

All mother plant material in conservation is obtained with explicit and precise information regarding its collection in the wild such as geographical coordinates and site description, specific location, region, prefecture, and country. No accession number is given to plant collections arriving with poor documentation and no subsequent propagation is carried out. Habitat information is also collected for each individual

plant collected from the wild (substrate, soil type, forest zone, habitat type, slope and altitude). This information is valuable and necessary for future *ex situ* conservation activities (Krigas *et al*., 2007a). All these site and habitat characteristics are documented on special collection forms *in situ*. They accompany each accession number throughout its subsequent propagation. The document describing these standards of data collection is the 'Explicit Plant Documentation' Policy.

BBGK appreciates that there is a need to reveal the genetic identity of different accession numbers for many reasons, such as uniqueness of specimens from different native plant populations originating in different phytogeographical regions, possible sustainable exploitation of selected accessions, accurate plant documentation, and copyright. This is covered in BBGK's 'DNA Barcoding' Policy. Therefore a molecular DNA-based procedure has been adopted in the laboratories of BBGK using the nrDNA ITS1 and ITS2 molecular markers (Tsoktouridis *et al.*, 2007; Maloupa *et al.*, 2008).

Not all of the Greek and Balkan native flora is a prime priority of BBGK. Taking into account the International Agenda of Botanic Gardens in Conservation (Wyse-Jackson & Sutherland, 2000), five principal plant categories have been targeted for initial action and these are identified in the 'Important Plant Species (IPS)' Policy:

(i) **Greek endemic plants** (plant species found exclusively in Greece and nowhere else in the world), including:
   (a) Single-island endemics such as *Origanum dictamnus*, *Campanula hierapetrae*, *Anchusa samothracica*, *Viola cephalonica*;
   (b) Single-mountain endemics such as *Helichrysum sibthorpii*, *Anthemis sibthorpii*, *Thymus plasonii*, *Achillea occulta*, *Centaurea cithaeronea*;
   (c) Single-area narrow endemics such as *Limonium antipaxorum*, *L. ithacense*, *Muscari cycladicum*;
   (d) Regional endemics (restricted to few phytogeographical regions of Greece) such as *Crocus hadriaticus* subsp. *hadriaticus*, *Scaligeria moreana*, *Stachys ionica*, *Campanula incurva* (Fig. 3), and
   (e) National endemics (restricted to numerous phytogeographical regions of Greece) such as *Anchusella variegata*, *Cerastium candissimum*, *Dianthus corymbosus.*

(ii) **Balkan endemics of narrow distribution**: This category includes native plants occurring around the boundaries of Greece with neighbouring Balkan countries and/or Turkey such as *Lilium rhodopaeum*, *Centaurea pawlowskii* (Fig. 3), *Marrubium thessalum*, *Stachys iva*.

(iii) **Other rare plant taxa found in Greece**: This category includes native plant species of wider distribution than (i), (ii) or (iv) with one or only a few scattered populations in Greece such as *Poa molinieri*, *Datisca canabina*, *Galanthus nivalis*, *Dianthus crinitus* (Fig. 3).

(iv) **Balkan (sub-) endemics**: This category includes plant taxa found exclusively in the Balkan countries and/or extending to western Turkey and/or parts of Italy

with scattered populations such as *Dianthus giganteus*, *Hypericum olympicum*, *Scabiosa crenata* subsp. *dellaportae*, *Thymus thracicus* (Fig. 3).

(v) **Potentially ornamental and/or medicinal plants native to Greece and/or the Balkans** such as *Geranium macrorrhizum*, *Coridothymus capitatus*, *Digitalis grandiflora*, *Salvia officinalis*, *Crataegus monogyna*.

Plant propagation in the BBGK follows the conservation prioritization contained in the 'Propagation of the IPS First' Policy. All propagation and *ex situ* cultivation efforts of the BBGK aim at developing species-specific propagation and cultivation protocols that can be used for the sustainable exploitation of IPS and possibly for future reintroductions of IPS in the wild.

Fig. 3 Conservation Important Plant Species (IPS) in the BBGK: local Balkan endemics *Thymus thracicus* (top left) and *Centaurea pawlowskii* (top right), rare Greek endemic *Campanula incurva* (bottom left) and rare in Greece *Dianthus crinitus* (bottom right). All photos: BBGK archives except bottom left: Yannis Syllignakis.

In an attempt to decrease transplantation shock and increase cultivation and propagation success, all IPS are maintained in experimental *ex situ* fields and/or in pots in the fully equipped and extensive mother plantations and nurseries of BBGK under ideal conditions which are as similar as feasibly possible to the wild habitat of each taxon studied (Maloupa *et al*., 2003; Krigas *et al*., 2007a; Mouflis *et al*., 2007).

Each mother plant collected from the natural environment is treated as a clone; it is asexually propagated if possible and considered to be the fundamental propagation material for the reproduction of the IPS. Emphasis is also given to the hygienic state of the mother plants and all the initial propagation material obtained from mother plants is treated with exceptional care. *In vitro* production of elite pre-basic material has been developed for IPS that could not adjust and grow in the conditions found in the nursery, for IPS that it has not been possible to propagate using conventional methods or for the massive reproduction of socio-economically valuable plants.

It is a target of BBGK not only to contribute to the *ex situ* conservation of the IPS of Greece and the Balkans but also to raise the public's environmental awareness of their native plants by organizing activities and projects for citizens and schools. This is detailed in the 'Environmental Awareness on Native Plants' Policy (Krigas *et al*., 2007b).

In the context of the global efforts to halt biodiversity loss by 2010 and beyond, emphasis is also given to the creation of a link between the *ex situ* and the *in situ* conservation actions regarding the IPS of Greece and the Balkans ('Combined *ex situ* and *in situ* Conservation' Policy). Consideration has also been given by adjusting BBGK's individual conservation actions in light of the targets of the Global Strategy for Plant Conservation (GSPC, 2002) and the European Plant Conservation Strategy (EPCS, 2002).

During the last 5 years, BBGK has undertaken efforts in order to contribute to the implementation of targets 1, 2, 3, 7, 8, 9, 14 and 16 of the GSPC and EPCS at local, national, regional and international levels (Maloupa & Krigas, 2007). These efforts include: population monitoring of IPS in the wild, investigation into the genetic variability of endemic *Crocus* spp. and socio-economically valuable cultivated saffron, monitoring of invasive aliens, pilot labelling of plant populations in the wild, transplanting of protected plants into safer areas, development of IPS-specific propagation and cultivation protocols aiming at future reintroduction into the wild, actions regarding the raising of environmental awareness on native biodiversity issues, efforts towards the establishment of new botanic gardens dedicated to plant conservation across the different phytogeographic regions of Greece, influencing policy and holding meetings with institutions and stakeholders involved or interested in plant conservation. All these activities are contained within BBGK's 'Environmental Awareness on Native Plants' policy (Maloupa *et al*., 2007a; Krigas *et al*., 2007b). Nowadays, BBGK is an active member of Botanic Gardens Conservation International (BGCI), the International Plant Exchange Network (IPEN) and the Planta Europa Steering Committee. It aims to lead the effort towards the establishment of an official network of Greek botanic gardens that are dedicated to native plant conservation.

Botanic gardens play a key role in ensuring that plant resources are not only conserved but are also used sustainably for the benefit of all people, in order to improve human well-being (Wyse-Jackson & Sutherland, 2000; GSPC, 2002). Currently, wild populations of several plants (e.g. *Sideritis* spp., *Salvia* spp., *Cistus* spp., *Paeonia* spp., etc.) in several areas of Greece and the Balkans suffer from extensive, uncontrolled and heavy collections made both by local inhabitants for personal use and by foreign people trading in herbs and medicinal plants; however, such actions are internationally deplored (IUCN Threatened Plants Committee Secretariat, 1982).

With this in mind, the BBGK has undertaken initiatives and has developed a strategy for the sustainable exploitation of the native IPS – the 'Evaluation for Sustainable Exploitation' Policy. This includes the maintenance of extensive mother plantations, development of protocols for large-scale propagation and cultivation, evaluation of the market potential of native IPS prior to commercialization, estimation of the market potential for possible introduction of new products in ornamental floriculture and horticulture, cosmetology, pharmaceuticals, food flavourings (such as herbs and spices), and landscaping. It also includes information on studying the market, production procedures, pilot contract agriculture practices, estimation of postharvest and transportation requirements, analysis of market economics and co-operation with private companies (Maloupa *et al*., 2008).

THE LIVING PLANT COLLECTIONS

Every year BBGK organizes a series of botanical expeditions to all areas of the country (which is divided into 13 phytogeographical regions) in order to obtain wild propagation material from various native IPS (Fig. 4). With a special permit provided by the Ministry of Agriculture which is renewed every year, the scientific staff of the BBGK are able to collect plant material even from protected areas, Natura 2000 sites and the Nature Reserves of Greece.

To date, at least 60 plant collecting expeditions have been organized (Fig. 4) and more than 2,300 accessions of propagation material (Fig. 5) and > 1,300 specimens have been collected from the wild. This equates to 1,200 taxa, which is > 20% of the Greek flora. Accession numbers of plant material collected in the wild have been increasing constantly since the establishment of BBGK and cultivation of this material has been improved (Figs. 5, 6), with survival rates reaching 75% in 2007.

All native taxa collected in the wild are currently cultivated and maintained *ex situ* in BBGK for different numbers of years (Figs. 5, 6). More than 70% of the IPS have been in *ex situ* cultivation for more than one year (Figs. 5, 6). In total, about 40% of them belong to target IPS categories (i), (ii), (iii) and (iv), and approximately another 45% belong to IPS category (v).

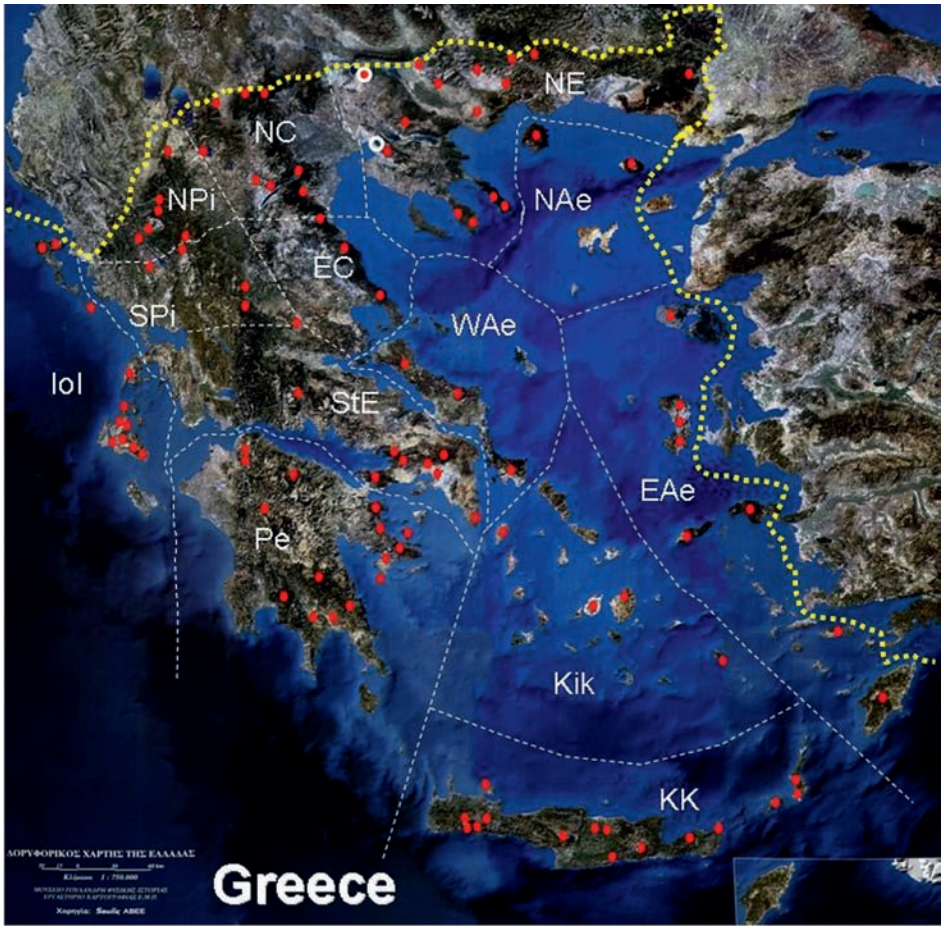

Fig. 4 Collection areas of IPS: rare, endangered, vulnerable, protected and endemic taxa of Greece and/or the Balkans currently in *ex situ* conservation at BBGK, northern Greece and distribution of the IPS collection areas across the different phytogeographical regions of Greece (see Strid & Tan, 1997). Each dot on the map shows the location of at least one botanical expedition and collection of at least one accession number of IPS. The white circles show the location of the BBGK's *ex situ* conservation sites. Photo: BBGK archives.

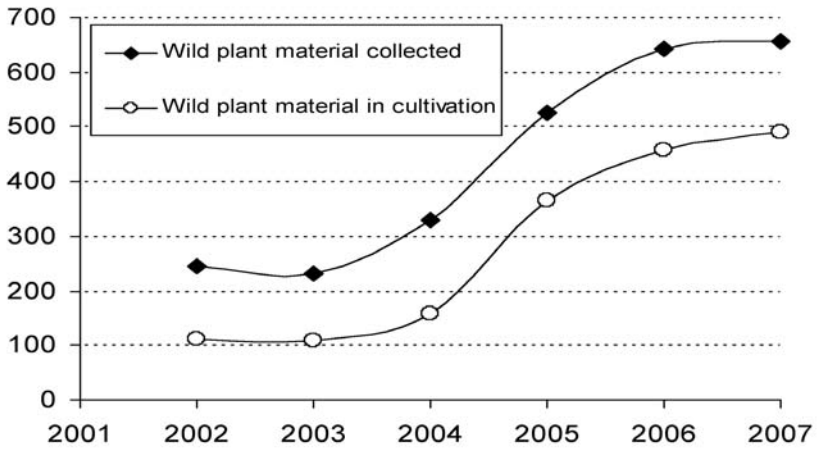

Fig. 5 Accession numbers of wild plant material collected and accession numbers of wild plant material in cultivation in BBGK for the period 2002–2007.

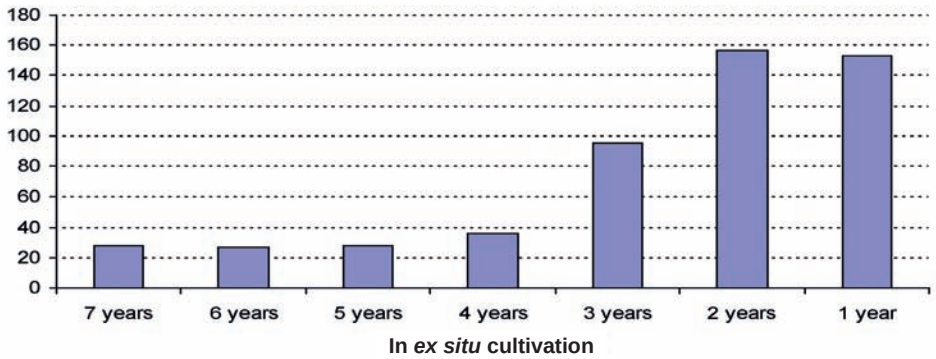

Fig. 6 Accession numbers of conservation Important Plant Species (IPS) showing their period of *ex situ* cultivation in BBGK.

All of the IPS have been or are currently subject to propagation research in the nursery and laboratories of BBGK (Fig. 7). In total, 326 taxa of IPS belonging to IPS categories (i), (ii), (iii) and (iv) are maintained (176 taxa as stock mother plants and 150 taxa as seeds preserved within controlled environments).

Fig. 7 Maintenance and propagation of native plants in the Laboratory for the Evaluation and Conservation of Native and Floricultural Species, at Thermi, metropolitan Thessaloniki. Photos: Stelios Phillipou.

Already, 45% of the IPS (139 taxa) have been successfully propagated and mass species-specific multiplication protocols have been developed. Taking into account their ornamental characteristics and/or aromatic-medicinal properties, these taxa could possibly be considered as commercially valuable plants for sustainable cultivations (Maloupa *et al.*, 2008). Additionally, about 100 propagation and cultivation protocols have already been developed for IPS target category (v) plants.

PLANT SECTIONS AND DISPLAYS

The BBGK is composed of two basic areas, the Garden of the Senses (Figs. 1, 2, 9) and the main Conservation Area (Figs. 2, 8). Almost half of the BBGK's territory is a natural oak forest and at least 300 wild growing plant taxa (species and subspecies) thrive there and their populations are being conserved along with their habitats (*in situ* conservation, Figs. 2, 8). Different parts of the forest receive different management practices (management for conversion from coppice to high forest, coppice management, high forest management, recreational forest management or no management).

The different plant species that appear in the *ex situ* conservation area of BBGK originate in the wild and they are organized into various thematic sections according to their characteristics and properties for scientific, research and educational purposes. To date 46 thematic sections and displays have been organized (Table 1, Figs. 8, 9). The arrangement of the thematic sections serves educational purposes and aesthetic criteria of landscaping.

Aiming first to promote to urban citizens environmental awareness issues regarding native plant conservation and second in order to facilitate the maintenance of the increasing mother plantations, the BBGK has recently established the Garden of Environmental Awareness (GEA) in Thermi, metropolitan Thessaloniki area (at sea level, Fig. 10). This garden comprises another 15 thematic sections and displays (Table 1). The majority of botanic gardens present 2D graphic media for visualization and communication purposes, as well as for the gardens' own monitoring and management. GEA's design work has used all standard techniques from draft work to computer generated scaled drawings and has even progressed to 3D modelling and rendering (Fig. 10). For the rendering process of all scenic elements, digital images of hard materials and native plant species from BBGK's photographic records have been applied. Simulation of lighting effects and digital control of model functionality have also been carried out through different positioning of cameras and viewpoint settings.

Garden of the Senses	BBGK's main Conservation Area	Garden of Environmental Awareness
Ornamental beds of native flowers	Tree-lines	Plants in mythology and tradition
Aromatic plants (Labiatae family)	Path of biodiversity	Ancient medicinal plants
Perennial herbs	*In situ* conservation of wild orchids	Rare, endangered and endemic plants
Aromatic plants (various families)	Adventure trail	Invasive alien plants
Water loving plants	Conservation in oak forest	Systematic beds
Waterfall, Watercourse and Artificial lake	Recreational forest	Vegetation zones of Greece
Bulbous plants	Coppice forest	Subalpine garden
Stone garden	High forest	Experimental fields
Rock garden	Conversion from coppice to high forest	Compost exhibition area
Information Centre	Arboretum	Compost heaps
Educational garden	Fruticetum	Green rooms
Scents and forms of thyme	Meadow phytodiversity	Greenhouse
Orchard	Vegetation zones of Greece	Open-air classroom
Biological agriculture garden	Artificial lakes	Reception hall
Which is the sage?	Plants of high mountains / (sub-) alpine plants	Formal landmark area
Hortus officinarum	Conservation Important Plant Species	
Are plants innocent?	*Ex situ* plant conservation beds	
Laissez faire	Medicinal garden and Human body	
Silver garden	Botanic greenhouse and Insular phytodiversity	
Coastal garden	Fruits of the forest	
White lilies		
Wild tulips		
BBGK's living acronym		
Autumn and Winter garden		
Wild carnations		
Wild campanulas		

Table 1. Thematic sections and plant displays in the BBGK and the GEA.

Fig. 8 Aspects of the main Conservation Area of the BBGK. Top: *in situ* conservation actions for wild orchids. Middle: the path of biodiversity. Bottom: artificial lakes and resting kiosk. Photos: Spyros Markogiannis.

From a construction viewpoint, this model (Maloupa *et al.*, 2007b, Fig. 10): (i) facilitates monitoring of the progress of implementation works, (ii) allows for future readjustments, (iii) enables the photorealistic representation of changes in scene elements and floristic features through time and space, and (iv) controls human capacity and flow in the 3D environment. From a promotion viewpoint, it can become an important tool for virtual tours and printed guide maps, thus raising public environmental awareness. To our knowledge, this is the first time a model process has been used for the creation of a botanic garden in Greece.

Fig. 9 Views of the Garden of the Senses. Top: Water loving plants. Middle: Mediterranean aromatic plants. Bottom: Scents and forms of thyme and Which is the sage? Photos: BBGK archives.

In this paper we have described the establishment and purpose of BBGK and outlined its strategy and efforts in plant conservation. In the next few years we will be concentrating on various projects which will include:

1. the enrichment of the BBGK *ex situ* collections of conservation important species;
2. the conservation of wild germplasm of socio-economically valuable plants;
3. the evaluation and sustainable exploitation of the phytogenetic resources of Greece, and
4. the development of new small-scale botanic gardens that are dedicated to native plant conservation across the different phytogeographic regions of the country.

Fig. 10 Photorealistic summer view of the vegetation zones (top) and in a green room (bottom) at the newly established GEA in Thermi, metropolitan Thessaloniki. All specific view-materials shown (plant species, pergolas, rocks and texture) have been extracted from the photo gallery of the BBGK (From Maloupa *et al.,* 2007b).

We hope that our activities will have a significant impact on plant species protection and the public's understanding of conservation issues in this botanically important region of Europe.

REFERENCES

AKEROYD, J.R. & HEYWOOD, V.H. (1994). *Regional overview: Europe*. Pp. 39–54 in: Davis, S.D., Heywood, V.H., Hamilton, A.C. (eds), *Centres of Plant Diversity: A Guide and Strategy for Their Conservation*, Vol. 1 (Europe, Africa, South West Asia and the Middle

East). The World Wide Fund for Nature (WWF) and IUCN-The World Conservation Union, Oxford, UK.

EPCS (2002). *European Plant Conservation Strategy.* Council of Europe and Planta Europa Secretariat, London, UK.

GSPC (2002). *Global Strategy for Plant Conservation.* Secretariat of the Convention on Biological Diversity & Botanic Gardens Conservation International, Kew, UK.

IUCN Threatened Plants Committee Secretariat (1982). The rare, threatened and endemic plants of Greece. *Annales Musei Goulandris*, 5, 69–105.

KRIGAS, N., MOUFLIS, G., KARYDAS, A. & MALOUPA, E. (2007a). *Ex situ* conservation of important plant species of Greece in the Balkan Botanic Garden of Kroussia utilizing botanic expedition data and ecological databases in a GIS environment. *5th Planta Europa Congress, Cluj-Napoca, Romania* (Available online: http://www.plantaeuropa.org/pe-conferences-overview.htm).

KRIGAS, N., VERGOU, A. & MALOUPA, E. (2007b). What's new in an oak forest? The path of biodiversity of the Balkan Botanic Garden of Kroussia, N Greece. *Proceedings of the 3rd Global Botanic Garden Congress, Wuhan, China* (Available online: http://www.bgci.org/wuhan/papers_author/).

MALOUPA, E. & KRIGAS, N. (2007). A young "David" botanic garden and a giant "Goliath" 2010 target: a critical encounter to halt biodiversity loss in Greece. *5th Planta Europa Congress, Cluj-Napoca, Romania* (Available online: http://www.plantaeuropa.org/pe-conferences-overview.htm).

MALOUPA, E., ZERVAKI, D., GRIGORIADOU, K. & PAPANASTASSI, K. (2003). The development of native plant collection nursery in the Kroussia Balkan Botanic Garden. *Scripta Botanica Belgica*, 29, 15–20.

MALOUPA, E., KARYDAS, A. & KRIGAS, N. (2007a). The *in-situ* conservation actions of the Balkan Botanic Garden of Kroussia in Greece. *Proceedings of the 3rd Global Botanic Garden Congress, Wuhan, China* (Available online: http://www.bgci.org/wuhan/papers_author/).

MALOUPA, E., KRIGAS, N. & PANAGIOTIDOU, M. (2007b). Computer Design and Landscape Visualization: the case of the Botanic Garden of Environmental Awareness, Thermi, Thessaloniki, N Greece. *Proceedings of the International Conference Lant07-Landscape Architecture and New Technologies 249–258*, *Drama, Greece.*

MALOUPA, E., KRIGAS, N., GRIGORIADOU, K., LAZARI, D. & TSOKTOURIDIS, G. (2008). Conservation strategies for native plant species and their sustainable exploitation: Case of the Balkan Botanic Garden of Kroussia, N Greece. Pp. 37–56 in: Teixeira da Silva, J.A. (ed.), *Floriculture Ornamental Plant Biotechnology: Advances and topical issues*, Vol. 5 (1st ed.). Global Science Books, Isleworth, UK.

MOUFLIS, G., KARYDAS, A., KRIGAS, N. & MALOUPA, E. (2007). Species-specific baseline cultivation protocols: using GIS for the conservation of endemic plants of Cephallonia Island in the Balkan Botanic Garden of Kroussia, Greece. *5th Planta Europa Congress, Cluj-Napoca, Romania* (Available online: http://www.plantaeuropa.org/pe-conferences-overview.htm).

PHITOS, D., STRID, A., SNOGERUP, S. & GREUTER, W. (eds). (1995). *The Red Data Book of Rare and Threatened Plants of Greece*. WWF, Athens.

POLUNIN, O. (1980). *Flowers of Greece and the Balkans*. Oxford University Press, Oxford, UK.

STRID, A. & TAN, K. (eds). (1997). *Flora Hellenica*, Vol. 1. Koeltz Scientific Books, Koenigstein, Germany.

TSOKTOURIDIS, G., KRIGAS, N. & MALOUPA, E. (2007). The value of DNA sequence-based molecular markers to "barcode" plant species; Phylogenetic rDNA analysis of six Lamiaceae species through ITS1, 5.8S and ITS2 nuclear ribosomal region. *VI International Symposium on New Floricultural Crops, Madeira, Portugal*, p. 41.

WYSE-JACKSON, P.S. & SUTHERLAND, L.A. (2000). *International Agenda for Botanic Gardens in Conservation.* Botanic Gardens Conservation International, Kew, UK.