

**Global Survey of  
*Ex situ* Oak Collections**



**Botanic Gardens Conservation International**

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## Acknowledgements

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Cover image: *Quercus rubra* by Cinghialino ([www.flickr.com/photos/cinghialino/3163610044](http://www.flickr.com/photos/cinghialino/3163610044))

## Summary

In 2007, BGCI and FFI jointly published *The Red List of Oaks* under the partnership of the Global Trees Campaign. The report called for action to ensure that the 29 taxa listed in the report as Critically Endangered or Endangered were conserved. The first stage of this action is to establish which of these very threatened taxa are held in *ex situ* collections around the world by carrying out a global survey.

The survey identified 3,796 Oak records<sup>1</sup> from 198 institutions in 39 countries. However, only 91 *ex situ* records representing just 13 of the most threatened Oaks were located. This means that more than half of the Critically Endangered or Endangered taxa are currently not known to cultivation and therefore at great risk of extinction if threats that they are facing in the wild are not addressed.

The report concludes by making a call for further information to fill gaps in our knowledge of collections and by making a series of recommendations based on the results of the survey including: the strengthening of existing *ex situ* collections, establishing new collections, implementing restoration and reintroduction activities, involving local communities and organisation in conservation activities, developing public awareness programmes and enhancing BGCI's *PlantSearch* database. The report also calls for further information to fill gaps in our knowledge of *ex situ* collections.

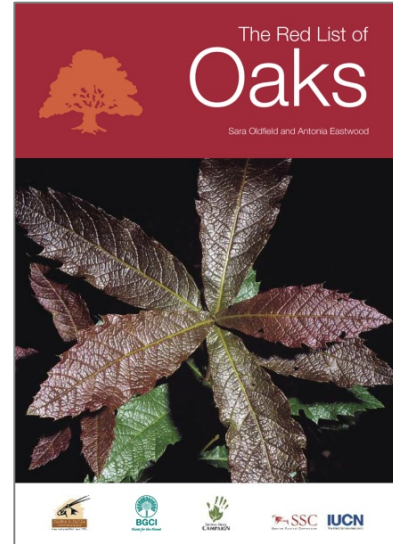
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<sup>1</sup> For the purposes of this survey, a record is the presence of a single *Quercus* (Oak) taxon within a gardens' collection and may include multiple accessions and/or individuals.

## Introduction

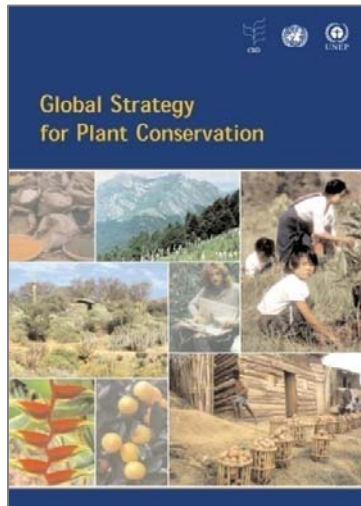
*The Red List of Oaks* was published jointly by Botanic Gardens Conservation International (BGCI) and Fauna & Flora International (FFI) in April 2007, under the partnership of the Global Trees Campaign. Electronic copies of the report are available from the BGCI website ([www.bgci.org](http://www.bgci.org)).

Oak (*Quercus*) is a large genus with around 500 taxa, excluding naturally occurring hybrids. However, in 2007 sufficient information was only available to apply the IUCN Red List Categories and Criteria version 3.1 to 216 taxa leaving c.300 taxa not evaluated. Of the 216 evaluated taxa, 109 taxa have been identified to be in danger of extinction if the threats that they face are not addressed.



Based on the information presented in the Red List report, urgent attention is required for the 29 taxa considered to be at most risk of extinction (Endangered or Critically Endangered) according to the IUCN Red List Categories and Criteria.

Some of these threatened Oaks are reduced to a handful of individuals in the wild and it would be a tragedy if such species are needlessly lost. It is clearly important that all Critically Endangered (CR) and Endangered (EN) taxa are represented in well-managed *ex situ* collections as an insurance policy for the future and in support of Target 8 of the *Global Strategy for Plant Conservation* (GSPC).



### *Global Strategy for Plant Conservation, Target 8:*

*60% of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10% of them included in recovery and restoration programmes*

At the same time habitat protection and restoration should be reviewed and mechanisms put in place for local people to be involved in and benefit from the *in situ* conservation and management of these globally important trees.

## Methods

An international survey of *ex situ* collections of globally threatened Oak (*Quercus*) taxa, building on information held within BGCI's *PlantSearch* Database, was undertaken by BGCI. The results of the survey have enabled us to identify precisely which Critically Endangered (CR) and Endangered (EN) species are currently held in *ex situ* collections. From this information, the gaps and the opportunities have been identified in order to develop a prioritised plan for the long term integrated conservation of the most threatened Oaks.

All BGCI's institutional members were invited to participate in the survey; however participation in the survey was not limited to BGCI members. Awareness of and invitations to participate in the survey was promoted through BGCI's website ([www.bgci.org](http://www.bgci.org)) and a range of networks, organisations and events including: American Public Gardens Association (APGA), Asociación Mexicana de Jardines Botánicos (AMJB), Chinese Academy of Science (CAS) Botanic Gardens Committee, European Consortium, Jardins Botaniques de France et des Pays Francophones, National Council for the Conservation of Plants and Gardens (NCCPG) (UK), PlantNetwork (UK), The Japanese Association of Botanical Gardens.

An important component of the Global Survey of *Ex situ* Oak Collections was to access information on species held in botanic garden collections in China by working closely with the Chinese Academy of Science (CAS) Botanic Gardens Committee and other gardens in China. All known *ex situ* collections in China were individually invited to contribute to the survey.

The survey also benefited greatly from the work of APGA North American Plant Collections Consortium (NAPCC) which carried out an extensive survey of collections in North America. The results of this separate survey are presented in APGA's *Public Garden* (Vol. 23 No. 1, 2008).

The survey primarily focussed on collecting data on the Critically Endangered (CR) and Endangered (EN) taxa since these are of the highest conservation priority. Although information on all Oaks listed in *The Red List of Oaks* was also collected.

Oak taxa which were not evaluated in the 2007 *The Red List of Oaks*, including hybrids and cultivars were not included at any stage of the survey, since this survey aimed at evaluating the value of *ex situ* collections with respect to the long term conservation of taxa known to be under the threat of extinction.

The survey of *ex situ* collections was carried out via through a range of methods, including:

- Analysis of data held in BGCI's *PlantSearch* database ([www.bgci.org/plant\\_search.php](http://www.bgci.org/plant_search.php))
- Completion of an online form or submission of a downloaded survey form
- Through direct contact with botanic gardens and networks holding Oak collections
- Data collected from online databases of living collections:
  - The multisite BG-BASE search facility maintained by Royal Botanic Garden Edinburgh ([rbg-web2.rbge.org.uk/multisite/multisite3.php](http://rbg-web2.rbge.org.uk/multisite/multisite3.php))

- Database of Asian Plants in Cultivation maintained by Quarryhill Botanical Garden and California Academy of Sciences  
([research.calacademy.org/research/botany/quarryhill/index.asp](http://research.calacademy.org/research/botany/quarryhill/index.asp))

In addition to the presence or absence of an Oak from a collection, the following closed questions were also asked:

- Is this Oak from a known wild source or from horticultural/unknown origin?
  - ↔ horticultural or unknown source
  - ↔ of known wild provenance
- What is the approximate size of the collection?
  - ↔ 1 individual
  - ↔ 2 to 10 individuals
  - ↔ 11 to 30 individuals
  - ↔ 31 to 50 individuals
  - ↔ more than 51 individuals
- Is this Oak collection part of a restoration or reintroduction programme?
  - ↔ no
  - ↔ Reclamation
  - ↔ Rehabilitation
  - ↔ Ecosystem restoration
  - ↔ Translocation
  - ↔ Re-inforcement/Supplementation
  - ↔ Conservation/Benign Introduction

The resulting submissions were cross-checked with the published *Red List of Oaks* and accepted synonyms.

Although efforts were made to limit their impact on the final results, the survey has inherent limitations which mean that it can never be considered to be truly exhaustive and final. Surveys, such as this one, can be limited by issues of non-stable taxonomy, unclear synonymy, correct identification of specimens, the degree of participation by collection holders in the survey and the dynamic nature of *ex situ* collections which evolve and change over time. Also, important additional oak specimens may be held in private collections which are not covered by this survey.

## Results

### General findings

The survey identified 3,796 Oak records<sup>1</sup>, from 198 institutions in 39 countries. Of the 3,796 records included in the analysis, just 91 records of the most threatened Oak taxa (CR and EN) were identified.

The 91 records represent 13 of the 29 most threatened (CR and EN) Oaks:

#### Critically Endangered:

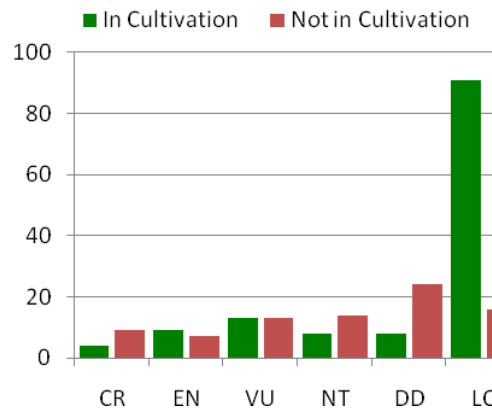
*Quercus boyntonii*, *Q. graciliformis*, *Q. hinckleyi*, *Q. marlipoensis*

#### Endangered:

*Quercus acerifolia*, *Q. argyrotricha*, *Q. brandegeei*, *Q. dumosa*, *Q. georgiana*, *Q. hintonii*, *Q. oglethorpensis*, *Q. orocantabrica*, *Q. parvula*

**Table 1. Summary results – the number of Oak taxa in or not in cultivation**

	In Cultivation	Not in Cultivation	Total
CR	4	9	13
EN	9	7	16
VU	13	13	26
NT	8	14	22
DD	8	24	32
LC	91	16	107
<b>Total</b>	<b>133</b>	<b>83</b>	<b>216</b>



With 13 of the most threatened taxa present in *ex situ* collections to some extent, means 9 CR taxa and 7 EN taxa are currently unknown to horticulture. Therefore if the wild populations disappear, then there are no secure *ex situ* collections available to return the species to the wild or prevent the taxa from becoming extinct.

Of the 13 (CR or EN) taxa found in collections, 6 are only found in very few collections ( $\leq 3$  collections) and therefore should still be considered a priority for new *ex situ* collections: *Quercus hinckleyi*, *Q. marlipoensis*, *Q. argyrotricha*, *Q. brandegeei*, *Q. hintonii*, *Q. orocantabrica*

<sup>1</sup> For the purposes of this survey, a record is the presence of a single *Quercus* (Oak) taxon within a collection and may include multiple accessions and/or individuals.

## Collections in the country of origin

Target 8 of the GSPC calls for *ex situ* collections to be held where possible in the country of origin. Of the CR and EN taxa currently found in cultivation, only eight taxa are found in cultivation in their country of origin, according to the results of this survey:

### Critically Endangered collections in country of origin:

- *Quercus boyntonii* (United States of America),
- *Q. graciliformis* (United States of America),
- *Q. marlipoensis* (China)

### Endangered collections in country of origin:

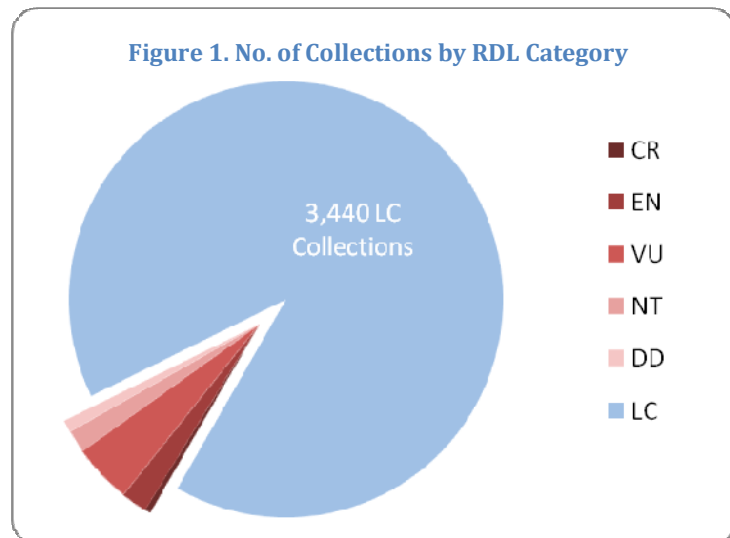
- *Quercus acerifolia* (United States of America),
- *Q. dumosa* (Mexico, United States of America),
- *Q. georgiana* (United States of America),
- *Q. hintonii* (Mexico),
- *Q. oglethorpensis* (United States of America)

Efforts should be made to ensure that new *ex situ* collections of all other very threatened Oaks (21 taxa) are developed in their countries of origin as soon as possible. However, at the same time with Sudden Oak Death being a major threat to oak populations in the United States and is becoming so in Mexico back up collections are also needed outside the natural range of the species.

## Collection balance

The most obvious characteristic of the global *ex situ* collections of Oaks is that currently over 90% of the known 3,796 known collections are of 107 Least Concern taxa. This means that relatively few known collections (356 collections) exist of the 109 threatened taxa (Data Deficient to Critically Endangered) despite their importance to conservation.

Three-quarters of all surveyed collections contain *Quercus robur* (LC); in total eight Least Concern species of oaks occur in half of all surveyed collections: *Quercus robur*, *Q. rubra*, *Q. cerris*, *Q. ilex*, *Q. acutissima*, *Q. coccinea*, *Q. palustris*, *Q. macrocarpa*.





### Ex situ collections representativeness

The survey attempted to gauge how representative the *ex situ* collections are by requesting information on the size of the collection and whether the collection is derived from known wild sources or not.

It is likely that many of the collections of the very threatened Oaks are based on wild collected material simply because of their rarity they are not available via the traditional horticultural sources. However, relatively little information about the source of the material and the size of the collections was submitted (See Table 2) and it is difficult to draw conclusions about how representative the known *ex situ* collections are and their value to restoration and recovery action. Even if the collections are based on wild collected material, it does not guarantee that the associated documentation linking the collections to their sources exists or is at a level which supports their value to restoration and reintroduction activities.

**Table 2. Number of records by RDL category and source of material**

	Unknown or horticultural source	Known wild source	
	No. of collections	No. of collections	No. of species
CR	13	4	2
EN	57	17	5
VU	141	26	9
NT	44	20	5
DD	25	9	6
LC	2918	522	79

Collections that are known to be based on wild collected material of the very threatened Oaks include:

**Critically Endangered:**

*Quercus boyntonii* (2 records), *Q. graciliformis* (2 records)

**Endangered:**

*Quercus acerifolia* (4 records), *Q. brandegeei* (2 records), *Q. dumosa* (3 records), *Q. georgiana* (6 records), *Q. oglethorpensis* (2 records)

## Recommendations and the way forward

Whilst there is a great need to conserve all the threatened Oaks, there is a significant number of the most at threat (CR and EN) Oaks which are currently absent from representative *ex situ* collections and integrated conservation activities to demand that efforts currently focus on these taxa over the Vulnerable (VU), Near Threatened (NT) and the Data Deficient (DD) taxa.

With these very threatened taxa in mind the report recommends the following actions:

- **Strengthen and develop existing *ex situ* collections to ensure that they are representative, accessible and safe.** Several of the very threatened Oaks are found in one or two collections; other collections contain a small number of individuals or single specimens. It is important that all of the very threatened Oaks are held in at least 2 secure *ex situ* collections that are representative of the natural diversity of the taxa and located when possible in the country of origin (see Annex 2 for the Oak priority list).
- **Establish *ex situ* collections of taxa which are currently not in cultivation.** Efforts should be made to bring taxa in to cultivation to ensure that if the threats facing wild populations continue, the taxa will be safe in *ex situ* collections. Where possible these new *ex situ* collections should be developed within the country of origin.
- **Develop and implement restoration and reintroduction activities for the most threatened taxa.** There are a number of taxa which are well known to science and are under extremely high risk of extinction, these taxa should be the focus of concerted conservation efforts to strengthen and conserve the remaining wild populations by appropriate methods.
- **Involve local communities and organisations in conservation activities.** As with all successful conservation activities, the involvement of the local communities and organisations is critical to the long term conservation of threatened species, and should be encouraged and supported from the earliest stages of planning conservation activities.
- **Develop public awareness and understanding programmes in regions where Oaks are at most threat.** To support current conservation efforts and develop new opportunities, public awareness and understanding programmes need to be developed and implemented as an integral component of conservation activities. This includes both areas where Oaks naturally occur and are utilised, as well as regions where they are of horticultural importance.
- **Enhancing BGCI's PlantSearch database to include more botanic gardens and explore the possibility of including additional information.** Currently the number of botanic gardens contributing information to the *PlantSearch* database is limited, as is the quality of the information included. This can be improved through reviewing and cleaning the current *PlantSearch* dataset and by implementing a new upload mechanism to facilitate a more efficient method for institutions to contribute their data whilst maintaining the required standards. If new data can include details such as whether or not the accessions are based on wild collected material, then this would add significant value to the data.

Additional functionality will add value to the *PlantSearch* database, such as dynamically linking to existing online databases of living collections, the synonymised working list of known plant species, as well as linking other databases back to *PlantSearch* database. An enhanced and more extensive *PlantSearch* database would be a significant tool when carrying out surveys and planning conservation activities by individual botanic gardens.

## Annex 1 Very threatened Oak collection count

The number of collections which include the very threatened taxa (CR and EN) is given, noting whether the collection is in the country of origin for the taxa.

Species	Number of collections		Country of origin
	in country of origin	not in country of origin	
<b>Critically Endangered taxa</b>			
<i>Quercus albicaulis</i>	0	0	China
<i>Quercus bawanglingensis</i>	0	0	China
<i>Quercus boyntonii</i>	4	0	United States of America
<i>Quercus delicatula</i>	0	0	China
<i>Quercus fimbriata</i>	0	0	China
<i>Quercus graciliformis</i>	5	5	United States of America
<i>Quercus hinckleyi</i>	0	2	Mexico, United States of America
<i>Quercus jinpinensis</i>	0	0	China
<i>Quercus marlipoensis</i>	1	0	China
<i>Quercus obovatifolia</i>	0	0	China
<i>Quercus pauciradiata</i>	0	0	Spain
<i>Quercus sichouensis</i>	0	0	China
<i>Quercus tenuicupula</i>	0	0	China
<b>Endangered taxa</b>			
<i>Quercus acerifolia</i>	5	7	United States of America
<i>Quercus alpestris</i>	0	0	Spain
<i>Quercus argyrotricha</i>	0	2	China
<i>Quercus austroglauca</i>	0	0	China
<i>Quercus brandegeei</i>	0	2	Mexico
<i>Quercus daimingshanensis</i>	0	0	China
<i>Quercus dumosa</i>	4	13	Mexico, United States of America
<i>Quercus georgiana</i>	4	14	United States of America
<i>Quercus hintonii</i>	1	2	Mexico
<i>Quercus kouangsiensis</i>	0	0	China
<i>Quercus miquihuanensis</i>	0	0	Mexico
<i>Quercus oglethorpensis</i>	5	10	United States of America
<i>Quercus orocantabrica</i>	0	1	Spain
<i>Quercus parvula</i>	0	4	United States of America
<i>Quercus parvula var. tamalpaisensis</i>	0	0	United States of America
<i>Quercus skutchii</i>	0	0	Guatemala, Mexico

## Annex 2 Priority List for new *ex situ* collections

According to the results of the survey, the following taxa are a high priority for inclusion in *ex situ* collections:

<b>Critically Endangered (CR) taxa currently absent from <i>ex situ</i> collections:</b>	
<i>Quercus albicaulis</i>	China
<i>Quercus bawanglingensis</i>	China
<i>Quercus delicatula</i>	China
<i>Quercus fimbriata</i>	China
<i>Quercus jinpinensis</i>	China
<i>Quercus obovatifolia</i>	China
<i>Quercus pauciradiata</i>	Spain
<i>Quercus sichouensis</i>	China
<i>Quercus tenuicupula</i>	China
<b>CR taxa currently in very few <i>ex situ</i> collections and therefore still a priority for new collections:</b>	
<i>Quercus hinckleyi</i> <sup>1</sup>	Mexico, United States of America
<i>Quercus marlipensis</i>	China
<b>Endangered (EN) taxa currently absent from <i>ex situ</i> collections:</b>	
<i>Quercus alpestris</i>	Spain
<i>Quercus austroglauca</i>	China
<i>Quercus daimingshanensis</i>	China
<i>Quercus kouangsiensis</i>	China
<i>Quercus miquihuanensis</i>	Mexico
<i>Quercus parvula</i> var. <i>tamalpaisensis</i>	United States of America
<i>Quercus skutchii</i>	Guatemala, Mexico
<b>EN taxa currently in very few <i>ex situ</i> collections and therefore still a priority for new collections:</b>	
<i>Quercus argyrotricha</i> <sup>1</sup>	China
<i>Quercus brandegeei</i> <sup>1</sup>	Mexico
<i>Quercus hintonii</i>	Mexico
<i>Quercus orocantabrica</i> <sup>1</sup>	Spain

<sup>1</sup> Existing *ex situ* collections of these taxa are not in the country of origin.

## Annex 3      Ranked botanic garden collections

The most significant botanic garden collections of Oaks as determined by assigning a score for each taxa within the garden's collection, according to the Red List Category (CR-10, EN-7, VU-5, NT-3, DD-2, LC-1, NE-0 points) with the wild sourced collections doubling the score. For example, a collection of CR Oaks will score 10 points, but if the collection is based on known wild source material then it will score 20. The number of the most threatened taxa (CR and EN) and the number of unique or rare collections (taxa occurring in fewer than 3 gardens) is also given for each garden in the table.

	Botanic garden	No. of CR & EN taxa	No. of unique or rare collections	Collection Score
1	The Morton Arboretum, USA	9		242
2	Arboretum Trompenburg, Netherlands	4	2	241
3	Arboretum des Pouyouleix, France	8	5	213
4	The Sir Harold Hillier Garden and Arboretum, UK	7	4	181
5	Arboretum National des Barres, France	3		177
6	University of Washington Botanic Gardens, USA	3		154
7	Atatürk Arboretum, Turkey	2		151
8	University of California Botanical Garden, USA	1	6	142
9	L'Arboretum de Chèvreloup, France	1		131
10	Royal Botanic Gardens, Kew, UK	3		123
11	Davis Arboretum, USA	1	2	114
12	Arboretum Bokrijk, Belgium	4	3	111
13	Chicago Botanic Garden, USA	1		108
14 =	The Royal Horticultural Society's Garden, Wisley, UK	3	1	104
14 =	Gisborne Eastwoodhill Arboretum, New Zealand			104
16	The Holden Arboretum, USA			97
17	The Scott Arboretum of Swarthmore College, USA	3		91
18	The Arnold Arboretum, USA	1		87
19	Royal Botanic Gardens, Kew - Wakehurst Place, UK	2	2	86
20	Westonbirt Arboretum, UK	2		85
21	Arboretum de Pezanin, France	1		82
22	Bartlett Arboretum & Gardens, USA	3		79
23 =	Morris Arboretum, USA			78
23 =	Cornell Plantations, USA	1		78
25	Jardin Botanique National de Belgique, Belgium	2		73
26	Botanic Gardens of Adelaide, Australia	2		72
27	Royal Botanic Gardens, Melbourne, Australia	1		69
28	Rancho Santa Ana Botanic Garden, USA	1	2	67
29	Arboretum de Ripaille, France	1		65
30	Maribor University Botanic Garden, Slovenia	4	1	64

## Annex 4 Participating institutions

The following 198 institutions from 39 countries are gratefully thanked for their contribution of data to this report:

"African Safari" at Caribben Gardens Inc., United States of America; Agricultural Research Center of Northern Greece, Greece; Arboretum at the University of California, Santa Cruz, United States of America; Arboretum Bokrijk, Belgium; Arboretum d'Amance, France; Arboretum de Cardeilhac, France; Arboretum de Gratteloup et Arboretum de Ruscas, France; Arboretum de la Jonchere, France; Arboretum de Pezanin, France; Arboretum de Ripaille, France; Arboretum des Pouyouleix, France; Arboretum du Cranou, France; Arboretum Freiburg-Guenterstal im Staedischen Forstamt Freiburg, Germany; Arboretum Kalmthout, Belgium; Arboretum Kirchberg, Luxembourg; Arboretum Lesnicke mistrovske skoly, Czech Republic; Arborétum Mlyňany, Slovakia; Arboretum National des Barres, France; Arboretum of the Barnes Foundation, United States of America; Arboretum Oudenbosch, Netherlands; Arboretum SGGW w Rogowie, Poland; Arboretum Trompenburg, Netherlands; Atatürk Arboretum, Turkey; Bartlett Arboretum & Gardens, United States of America; Beijing (Northern) Botanical Garden, China; Benmore Botanic Garden, United Kingdom; Botanic Garden of Eötvös Loránd University, Hungary; Botanic Gardens of Adelaide, Australia; Botanic Gardens of Toyama, Japan; Botanic Gardens Trust, Sydney, Australia; Botanical Garden - University of Oslo, Norway; Botanical Garden of Kawaguchi-City, Japan; Botanical Garden of Vilnius University, Lithuania; Botanical Gardens, Koishikawa, Japan; Botanische Gärten der Universität Bonn, Germany; Botanische Tuinen, Netherlands; Botanischer Garten der C. v. O. Universität, Germany; Botanischer Garten der Friedrich-Schiller-Universität, Germany; Botanischer Garten der J.W. Goethe-Universität, Germany; Botanischer Garten der Johannes Gutenberg Universität Mainz, Germany; Botanischer Garten der Justus-Liebig Universität, Germany; Botanischer Garten der Philipps-Universität, Germany; Botanischer Garten der Ruhr-Universität Bochum, Germany; Botanischer Garten der Technischen Hochschule, Germany; Botanischer Garten der Universität Bern, Switzerland; Botanischer Garten der Universität des Saarlandes, Germany; Botanischer Garten der Universität Düsseldorf, Germany; Botanischer Garten der Universität Freiburg, Germany; Botanischer Garten der Universität Kiel, Germany; Botanischer Garten der Universität Osnabrück, Germany; Botanischer Garten der Universität Ulm, Germany; Botanischer Garten der Wilhelm-Pieck Universität, Germany; Botanischer Garten Dresden, Germany; Botanischer Garten und Botanisches Museum Berlin-Dahlem, Germany; Botanischer Versuchs- und Lehrgarten, Germany; Botanisches Institut und Botanischer Garten, Germany; Botaniska Trädgårderna vid Uppsala Universitet, Sweden; Brisbane Botanic Gardens, Australia; Bristol Zoo Gardens, United Kingdom; Brooklyn Botanic Garden, United States of America; Brookside Gardens, United States of America; Bukavu Arboretum/Garden, Rwanda; Cambridge University Botanic Garden, United Kingdom; Center for Plant Conservation - Bogor Botanic Gardens, Indonesia; Chicago Botanic Garden, United States of America; Conservatoire Botanique National de Brest, France; Conservatoire et Jardins Botaniques de Nancy, France; Cornell Plantations, United States of America; Davis Arboretum, United States of America; Denver Botanic Gardens, United States of America; Descanso Gardens, United States of America; Desert Botanical Garden, United States of America; Dunedin Botanic Garden, New Zealand; Fairchild Tropical Botanic Garden, United States of America; Forstbotanischer Garten, Germany; Forstbotanischer Garten Tharandt, Germany; Forstbotanischer Garten und Arboretum, Germany; Fukuoka Municipal Botanical Garden, Japan; Fundación Xochitla A.C., Mexico; George Landis Arboretum, United States of America; Gisborne Eastwoodhill Arboretum, New Zealand; Grugapark und Botanischer Garten der Stadt Essen, Germany; Hamamatsu City Flower Park, Japan; Higashiyama Botanical Garden, Japan; High Beeches Gardens Conservation Trust, United Kingdom; Hof ter Saksen, Belgium; Hortus Botanicus Amsterdam, Netherlands; Hortus Botanicus Catinensis, Italy; Hortus Botanicus Lovaniensis, Belgium; Hortus Botanicus Reykjavicensis, Iceland; Hunan Forest Botanic Garden, China; Jardí Botànic de la Universitat de València, Spain; Jardim Botânico - Museu Nacional de História Natural, Portugal; Jardim Botânico da Ajuda, Portugal; Jardín Botánico "Efraim Hernandez Xolocotzi", Mexico; Jardín Botánico "Ignacio Rodríguez de Alconedo", Mexico; Jardín Botánico "Louise Wardle de Camacho", Mexico; Jardín Botánico "Rey Netzahualcōyotl", Mexico; Jardín Botánico Cecon, Guatemala; Jardín Botánico del Instituto de Biología (UNAM), Mexico; Jardín Botánico Francisco Javier Clavijero, Mexico; Jardín Botánico Nacional, Chile; Jardín Botánico Regional Xiitbal nek', Mexico; Jardin Botanique de la Ville de Lyon, France; Jardin Botanique de le Villa Thuret, France; Jardin Botanique de l'Universite Louis Pasteur, France; Jardin Botanique des Plantes Médicinales et Aromatiques, France; Jardin Botanique Henri Gaussen, France; Jardin Botanique National de Belgique/Nationale Plantentuin van België, Belgium; Jardin des Plantes, France; Jardin des Serres d'Auteuil, France; Jardins des Plantes de l'Universite, France; Kagoshima Botanical Garden, Japan; Kanagawa Prefectural Ofuna Botanical Garden, Japan; Kobe Municipal Arboretum, Japan; Kruckeberg Botanic Garden Foundation, United States of America; Kunming Botanical Garden, China; Kusatsu Aquatic Botanical Garden, Japan; L'Arboretum de Chèvreloup, France; Ljubljana

University Botanic Garden, Slovenia; Longwood Gardens, United States of America; Lushan Botanical Garden, China; M.V. Lomonosov Moscow State University Botanical Garden, Russian Federation; Maribor University Botanic Garden, Slovenia; Milner Gardens and Woodland, Canada; Missouri Botanical Garden, United States of America; Montgomery Botanical Center, United States of America; Morris Arboretum, United States of America; Mount Auburn Cemetery and Arboretum, United States of America; Mount Usher Gardens, Ireland; Nanjing Botanic Garden Mem. Sun Yat-Sen, China; National Botanic Gardens, Ireland; National Botanic Gardens of Latvia, Latvia; Natural History Museum of Denmark, Denmark; Neuer Botanischer Garten der Universität Göttingen, Germany; Niigata Prefectural Botanical Garden, Japan; Oekologisch-Botanischer Garten Universität Bayreuth, Germany; Orto botanico di Cascina Rosa, Italy; Orto Botanico Università degli Studi di Padova, Italy; Oxford University Botanic Garden, United Kingdom; Paignton Zoological and Botanical Gardens, United Kingdom; Parco botanico friulano "Cormor", Italy; Park for the Preservation of Flora and Fauna, Greece; Parque Botânico da Tapada da Ajuda, Portugal; Philodassiki Botanic Garden, Greece; Phipps Conservatory, Inc., United States of America; Plantentuin Universiteit Gent, Belgium; Quail Botanical Gardens, United States of America; Quarryhill Botanical Garden, United States of America; Rancho Santa Ana Botanic Garden, United States of America; Real Jardín Botánico, Spain; Research Institute of Subtropical Forestry, China; Rimba Ilmu Botanic Garden, Malaysia; Royal Botanic Garden Edinburgh, United Kingdom; Royal Botanic Gardens, Kew, United Kingdom; Royal Botanic Gardens, Kew - Wakehurst Place, United Kingdom; Royal Botanic Gardens, Melbourne, Australia; San Diego Wild Animal Park, United States of America; Sentier de Découverte, France; Shanghai Botanic Garden, China; South China Botanical Garden, China; Stichting Arboretum Wespelaar, Belgium; Stichting Rotterdamse Diergaarde 'Blijdorp', Netherlands; Tatton Garden Society, United Kingdom; Tbilisi Botanic Garden, Georgia; The Arnold Arboretum, United States of America; The Botanic Garden of Smith College, United States of America; The Grounds and Gardens University of Exeter, United Kingdom; The Hiroshima Botanical Garden, Japan; The Holden Arboretum, United States of America; The Kyoto Botanical Garden, Japan; The Los Angeles County Arboretum & Botanic Garden, United States of America; The Makino Botanical Garden, Japan; The Morton Arboretum, United States of America; The New York Botanical Garden, United States of America; The Niagara Parks Commission - Botanical Gardens and School of Horticulture, Canada; The Royal Horticultural Society's Garden, Harlow Carr, United Kingdom; The Royal Horticultural Society's Garden, Hyde Hall, United Kingdom; The Royal Horticultural Society's Garden, Rosemoor, United Kingdom; The Royal Horticultural Society's Garden, Wisley, United Kingdom; The Scott Arboretum of Swarthmore College, United States of America; The Sir Harold Hillier Garden and Arboretum, United Kingdom; Timaru Botanic Garden, New Zealand; Tokyo Metropolitan Jindai Botanical Garden, Japan; Trinity College Botanic Garden, Ireland; United States Botanic Garden, United States of America; Università Degli Studi di Lecce, Italy; Université Paris-Sud, France; University of California Botanical Garden, United States of America; University of Copenhagen, Denmark; University of Helsinki Botanic Garden, Finland; University of Washington Botanic Gardens, United States of America; Utrecht University Botanic Garden, Netherlands; VanDusen Botanical Garden, Canada; Wentworth Castle Gardens, United Kingdom; Westonbirt Arboretum, United Kingdom; Wuhan Botanical Garden, China; Xishuangbanna Tropical Botanical Garden, China.