



The Millennium Seed Bank Project:

Supporting global plant conservation activities



helping to create a brighter future . . .

Introduction

Seed banking is one in a series of tools that can be employed in the conservation of plant species¹. Seed banking cannot directly protect biological diversity of ecosystems, but it can ensure the protection of diversity between, and within, plant species. In particular, banking seeds provides a last resort for the protection of plant species that are condemned to extinction. In doing so it balances the greatly increased certainty of short-term survival against the risk of genetic stasis and reduced adaptation.

Seed banks also provide many further benefits that directly support the wider range of plant conservation activities. These are described in the following sections. The MSBP also endeavours to implement the letter and spirit of the Convention on Biological Diversity (CBD). It supports the CBD Work Programmes on Access and Benefit Sharing and Dry and Sub-humid Lands, and is working to meet targets set in the Global Strategy for Plant Conservation.

Seed banks provide insurance against threats to plants *in situ*

Habitat loss and degradation is the greatest threat to species, affecting 91% of all threatened plant species described in IUCN Red Lists.² Direct causes include conversion to, or intensification of, agriculture, urbanisation, and mining. This threat is not going away. Recent models predict that over the next 50 years, a further 1 billion ha of natural ecosystems will be converted to agricultural land in developing countries leading to the loss of about one third of all remaining natural tropical and temperate ecosystems.³

Properly enforced protected areas can safeguard habitat but there are limits to the area of land, which can be protected. It takes time to establish protected areas and it can be difficult to situate them for the optimal protection of plant species. Even in well-protected areas plants are subject to a number of threats:

- **Climate change:** Populations of many threatened species are expected to be placed at a greater risk by the stresses of changing climate, rendering portions of current habitat unsuitable. The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report predicts that some plant species could become extinct.⁴
- **Invasive alien species:** Already fifteen percent of all threatened plants are affected by invasive alien species.⁵ Invasive alien species can result in the local or complete extinction of endemic species by outcompeting them, predation, transmission of diseases or reduction of growth and survival rates.⁶
- **Over-exploitation by humans:** The impacts of over-exploitation are hard to quantify but as an illustration 25 000 species of plants are recognised as threatened in this way by the Convention on International Trade in Endangered Species (CITES), including all the cacti and orchids. In European countries alone, about 150 medicinal or aromatic plant species are reported to be threatened due to over-collection in the wild.⁷
- **Man-made and natural disasters:** Protected areas cannot be expected to safeguard plants from the effects of disasters such as volcanoes, fires or war. Disasters decimate habitats. In early 2002 forest fires in southern Chile destroyed around 20 000 acres of native forests within 3 days, including state nature reserves.⁸
- **Theft and vandalism:** Sadly neither legislation nor protected areas can guarantee that threatened plants are safeguarded from theft or vandalism. In the UK, English Nature reported that threatened plants, including orchids and strapwort, have been stolen from their nature reserves.⁹
- **Fragmentation:** The fragmentation of extensive habitats into small isolated patches can mean that they become too limited to maintain their plant populations.¹⁰ Furthermore, fragmentation seems to reduce genetic variation and seedling vigour¹¹ and leave species more vulnerable to airborne pollutants, fire, and drought.¹²

Seeds conserved by the MSBP are insured against loss from these threats. Collections have already been made in the fynbos biome in South Africa (a global hotspot of biodiversity) where invasions of woody species such as *Acacia* and *Pinus* pose a threat to many other plant species. The tree *Burkea africana* has been heavily exploited in Burkina Faso for its hard wood and highly valued medicinal bark. It is now extremely threatened in Burkina Faso but MSBP partners banked seeds in 2001.



Invasive sisal in Madagascar



Forest fire in Brazil



Threatened fynbos vegetation in South Africa



Seed banks provide options for the future conservation and utilisation of plants



Damasonium alisma



Seedbanks are a source of material for research



Many species of *Euphorbia* are under threat from over-exploitation

Seed banks ensure that even if species are lost in the wild, the plants will always be available for human utilisation; for medicines, crop improvements, building materials or any number of other uses.

As required by the CBD (Articles 8(f) and 9(c)) seed banks also provide a source of material, of high quality and genetic diversity, for the potential recovery and rehabilitation of threatened species and ecosystems. Seeds from the MSBP have already been used for re-introduction programmes in the UK. Kew staff have germinated and grown banked seeds of *Damasonium alisma*, (starfruit), which has been close to extinction in the UK for about 30 years. These plants were recently introduced into a specially prepared habitat by the plant conservation organisation Plantlife. Kew scientists used leaf samples to assess the genetic suitability of the plants for the site of their re-introduction.

MSBP partners also plan to use their seed collections for restoration and re-introduction activities. In Western Australia, the Threatened Flora Seed Centre aims to bank seeds of the 2340 taxa listed as rare, threatened or poorly known for that area. The collections will be used for the translocation of threatened plant species and the restoration of threatened communities. Species recovery plans for the collected species are already well developed.

Access and Benefit Sharing Arrangements

In support of the CBD, the MSBP recognises the sovereign rights of states over their own biological resources and the authority of national governments to determine access to genetic resources, subject to national legislation. The interests of other stakeholders, including indigenous and local communities and farmers, in biological resources and associated information are also acknowledged. Prior Informed Consent is always obtained from appropriate authorities and stakeholders, according to national legislation, before any seed collections are made and before duplicate seed is transferred to the MSB.

The MSBP actively seeks the fair and equitable sharing of the benefits arising from the use of genetic resources, their progeny and derivatives with the country that provided the genetic resource, and with other stakeholders as appropriate. Each project partnership is based on a legally binding Access and Benefit Sharing Agreement between RBG Kew and the partner institute and/or government. Although the benefits from the MSBP project partnerships will usually be botanical collections and conservation, associated data, and capacity building, the issues of possible commercialisation of genetic resources and their derivatives are addressed in each partnership. To date all MSBP Access and Benefit Sharing Agreements forbid any commercial use by RBG Kew of the genetic resources transferred to it, unless this is subsequently developed with the partner and stakeholders, and formalised in a separate written agreement.

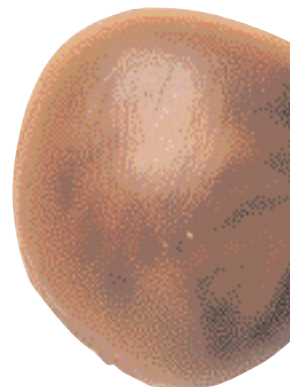
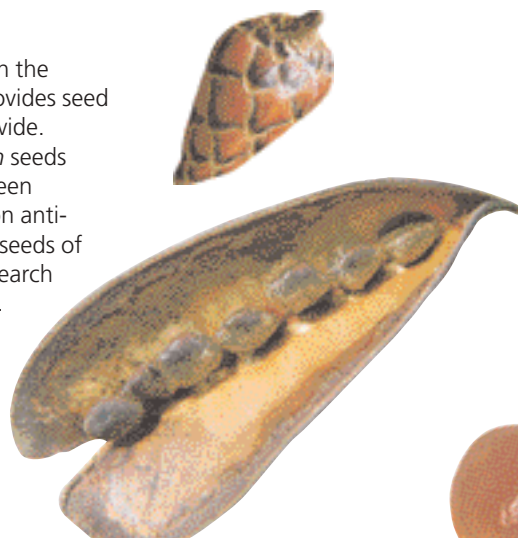


Seed banks provide a controlled source of plant material for research

Seed collections are a readily accessible and cost effective source of material for research. Material is quickly and easily accessible to researchers, without the need to carry out expeditions or to over-exploit wild populations. Terms and conditions can be attached to the supply of this material which ensure the fair and equitable sharing of any subsequent benefits.

Subject to the terms of access and benefit sharing agreements signed with partners and of material

supply agreements with the recipient, the MSBP provides seed for researchers world-wide. For example *Hypericum* seeds (St John's wort) have been provided for research on anti-depressive activity and seeds of *Aloe* and *Agave* for research on anti-tumour activity.



The Millennium Seed Bank Project:

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The Millennium Seed Bank Project (MSBP) is an international plant conservation partnership, catalysed by the Royal Botanic Gardens, Kew (RBG Kew), in the UK. Bilateral research, training and capacity building relationships are supported world-wide in order to advance the conservation of wild plant species. These partnerships are formalised through Access and Benefit Sharing Agreements (ABSAs) inspired by the Convention on Biological Diversity (CBD). The MSBP aims to collect and conserve seeds from some 24 000 species, principally from the drylands, by 2010.

The MSBP is building capacity to facilitate banking of seeds from wild plant species in the countries of origin





The MSBP works with partners to facilitate seed banking of species in their country of origin. Duplicate collections are held for safety at the MSB in the UK. Combining partners' knowledge of their native floras and national sustainable development priorities with the wild plant seed conservation skills gained over 25 years by RBG Kew's Seed Conservation Department is the essence of the MSBP.

Through the MSBP, RBG Kew provides technical, scientific and financial support to help partners develop collecting, banking and research programmes and set up or improve their seed bank facilities. Procedures and techniques for collecting and banking seeds, seed germination and plant propagation are shared with partners. Skill development is supported throughout the Project, both in the UK and in partner countries, using formal and informal means.

Already the capacity building activities of the MSBP are producing results. For example three Kenyan partners successfully participated in the Kew International Diploma in Plant Conservation Techniques in 2001. In their project work one developed a list of priority species which is now being used to guide the Kenyan collecting programme. Another developed a project to involve local people in wild plant conservation. A third developed a standard operating procedure for the x-ray examination of seeds in their own institute.

MSBP Partners

W. Australia	Department of Conservation and Land Management, The Botanic Gardens and Parks Authority
S. Australia	Botanic Gardens of Adelaide
New South Wales	Royal Botanic Gardens, Sydney
Botswana	National Plant Genetic Resources Centre, National Herbarium and Botanical Garden, Veld Products Research and Development
Burkina Faso	Centre National de Semences Forestières
Chile	Instituto de Investigaciones Agropecuarias
Egypt	Desert Research Center
Jordan	National Center for Agricultural Research and Technology Transfer
Kenya	National Museums of Kenya, Kenya Agricultural Research Institute, Kenya Forestry Research Institute, Forestry Department, Kenya Wildlife Service
Lebanon	Lebanese Agricultural Research Institute
Madagascar	Silo National des Graines Forestières
Malawi	Forestry Research Institute of Malawi, National Plant Genetic Resource Centre, National Herbarium and Botanical Gardens, National Research Council of Malawi
Mali	L'Institut d'Economie Rurale
Mexico	National Autonomous University of Mexico
Namibia	National Plant Genetic Resources Centre
Saudi Arabia	National Commission for Wildlife Conservation and Development
South Africa	National Botanical Institute
USA	Bureau for Land Management, Chicago Botanic Garden, Lady Bird Johnson Wildflower Centre





Cylindrophyllum hallii



Seed collecting in the UK



Bromus interruptus
PHOTO: ROYAL BOTANIC GARDEN EDINBURGH

MSBP collections progress to date

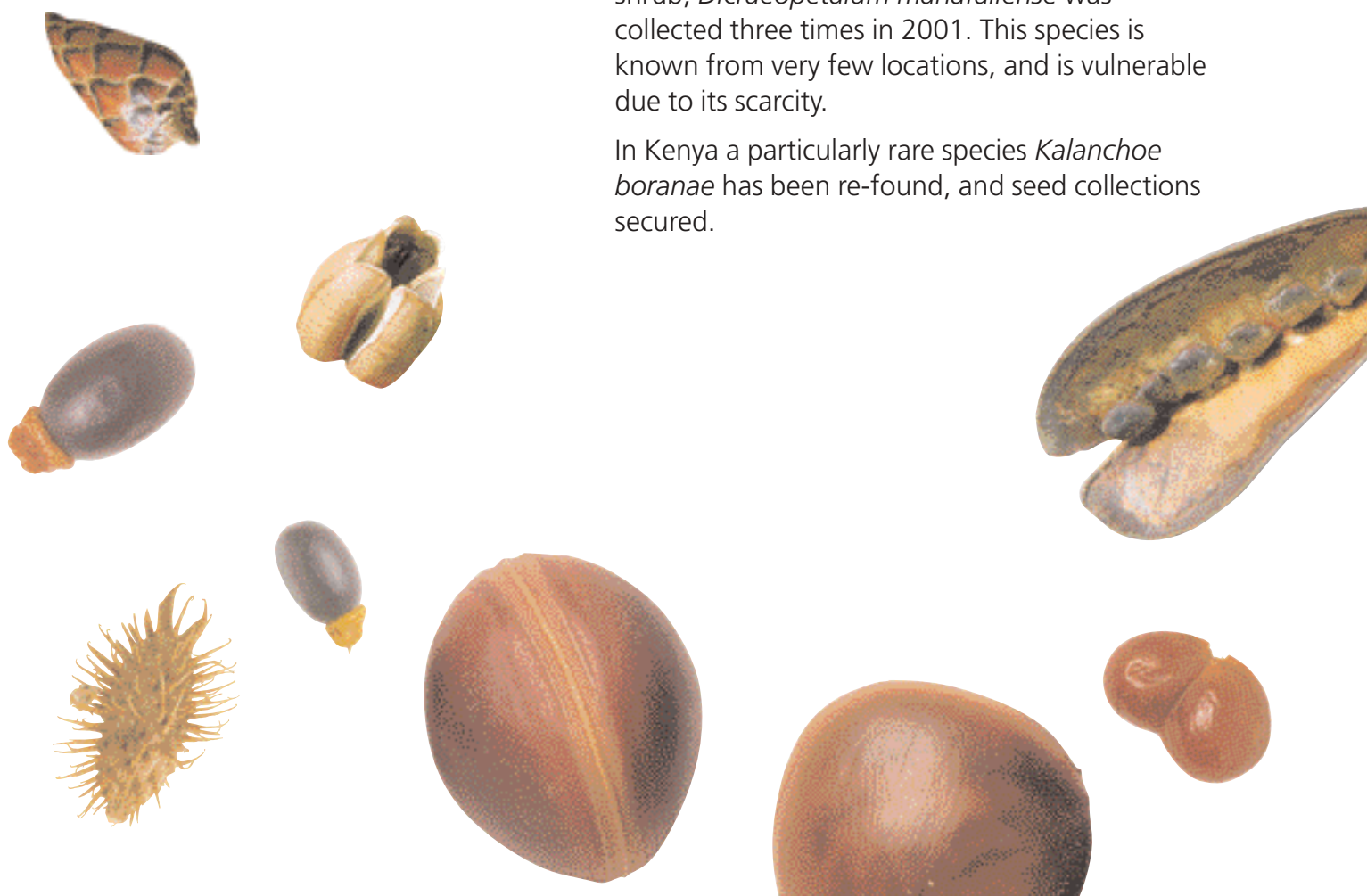
By 2003, the MSBP UK Programme had already banked seed from almost all the UK flora, including 229 species on the UK Red List. Some of the banked species are extinct in the wild – such as *Bromus interruptus* (Interrupted brome), a native UK species, which was last seen in 1972.

By late 2003, the International Programme had already collected over 3,700 species, including 71 IUCN-listed, globally threatened species and many more nationally threatened species.

In April 2001 MSBP seed collectors in South Africa found the only known population of *Cylindrophyllum hallii*. The population had not been documented since 1960. There were only about 200 individuals left and clear signs of drought and predation. Fortunately there were enough seeds to collect without endangering the population. The germination protocol for this species has since been established by RBG Kew, and more than 100 plants grown for repatriation to South Africa.

In Madagascar, the threatened leguminous shrub, *Dicraeopetalum mahafaliense* was collected three times in 2001. This species is known from very few locations, and is vulnerable due to its scarcity.

In Kenya a particularly rare species *Kalanchoe boranae* has been re-found, and seed collections secured.





Pressing plants to make herbarium vouchers



Seed research in the MSB laboratories



Examining *Albuca* seeds in South Africa



Public area at the MSB

Skills, knowledge and data from seed banks support wider plant conservation aims

Material accessioned into seed banks, including the MSB and its partner banks, is routinely accompanied by data gathered at the collection site. This data provides valuable information for plant conservationists. Data on size and location of populations *in situ* can help set conservation priorities; information on the ecology of populations is vital when developing *in situ* management plans. Herbarium vouchers are also made from the plant population whose seed is collected. Such vouchers verify the identity of species collected and enable taxonomists to better understand and document the diversity of plant species. Often, information is also gathered on the utilisation of the plants by local communities, which is essential for the development of sustainable use programmes.

Effective germination and propagation protocols are developed for species in seedbanks – knowledge and skills that are fundamental to the success of *in situ* conservation.

Research into seed storage behaviour maximises the application of seed banks, and can enable the sustainable use of

species that could otherwise be threatened by over-exploitation. For example, the bark of *Prunus africana* is highly valued and is used for the treatment of prostate cancer. In Burkina Faso the tree is becoming endangered *in situ* due to over-harvesting. A method for germinating its seeds has been developed by staff and partners of the MSBP. This will assist in the establishment of plantations in Burkina Faso, preventing over-harvesting of this and other wild species.

A project is being developed with MSBP partners in Mexico to link *in situ* and *ex situ* conservation with sustainable use activities.

Information generated from the MSBP is publicly available on the MSB 'Seed Information Database' (SID). SID includes taxon-based information on species' seed characteristics, including dormancy and germination protocols, storage biology, seed weights, chemical composition and physical characteristics. SID can be found at www.rbgekew.org.uk/data/SID.

Seed banks contribute to education and raising public awareness about plant conservation

Where they are open to the public, seed banks promote education and awareness about the importance of plant diversity and the need for its conservation. The Wellcome Trust Millennium Building (WTMB), which houses the MSB, includes a large public exhibition space. Over 330,000 visitors see the WTMB each year.

Visitors can see directly into the processing and research laboratories, which are designed so that interesting activities are both visible to the public audience and in a logical sequence. These activities are explained and illustrated further in a series of interactive displays.

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The benefits of seed banking are long term and achievable at relatively low cost

Of the 9,000 plant species whose seed storage characteristics are known, 92% are thought to have desiccation tolerant seeds and are expected to remain viable in storage for at least 200 years.¹³ Seedbanking has considerable advantages over other methods of *ex situ* conservation such as ease of storage, economy of space, relatively low labour demands, and consequently the capacity to maintain large samples, with wide genetic representation at an economically viable cost.¹⁴

Based on the known cost of existing seed banks, it is estimated that \$0.6–1 billion over 9 years would be enough to conserve 5 populations each of 90% of all threatened plants by 2010.