



samara

The International Newsletter of the Partners of the Millennium Seed Bank Project

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Management and exchange of seed bank data – current practice and future opportunities

Data needs to be gathered throughout seed conservation activities; during planning, collecting, processing, testing and finally, supply of seed to other users. It is vital that this data is accurately compiled and efficiently managed to achieve greatest impact. Frequently we use data dictionaries or catalogues, including species lists, gazetteers, and habitat classifications. Procedures for calculating seed numbers or for scoring germination tests can also be listed in catalogues and published for wider reference. These are all elements of *data standards* which ensure the accuracy, consistency and wider relevance of a data set.

Data for programme planning

Herbaria play an important role in providing access to geo-referenced specimen data for programme planning. In combination with globally-relevant published data such as the IUCN red list or Kew's SEPASAL database, it is possible to prioritise areas of high botanical interest or conservation importance for targeted seed collection programmes. Regional collaboration allows for improved targeting of species across their distributional ranges.

Data gathering in the field

Field, or passport, data answers the important questions “who?”, “what?”, “when?”, and “where?” was the collection made. The majority of passport data fields are common to botanical database projects. The MSB partnership has also promoted the capture of data on the phenology, sampling and post harvest handling of seed which provides a useful insight into the nature of the resulting seed collection and the options for subsequent use. Seed collection teams are perfectly placed to ensure that other population data such as frequency of plants, evidence of establishment of seedlings, threats to the site, and land use can be recorded to assist future conservation assessments.

We have seen an increase in the use of electronic tools to record data in the field e.g. the portable data assistant. This has the added advantage of linking directly to data catalogues, and in some cases including direct access to digital maps.



Data sheet used in the field PHOTO BY JO WENHAM

Data gathering in the laboratory and seed bank

A seed bank carrying out its own seed research and providing seed samples, needs to compile comprehensive data from each activity, from seed cleaning, germination testing, and seed storage, to the supply of seed. As standard operating procedures are shared more widely within networks such as ENSCONET, data can be effectively compared with other organisations holding duplicates.

Story continues on page 2

Exchanging botanical data within networks

The ability to access and use botanical data created by others is essential to successful seed conservation projects. Increasingly, these external datasets are available online in some form, and we are witnessing rapid development of tools to access and integrate such data to provide users with the most complete information possible.

Although initially such information can be shared in an *ad hoc* manner, standards are necessary in order to lower the 'transaction costs' of sharing data. The forum for achieving best possible consensus on standards is the Taxonomic Database Working Group (TDWG) and the most relevant standard for data exchange within the MSB Partnership is the Darwin Core (sometimes abbreviated to Dwc).

In order to share data effectively using such standards, the following questions need to be considered at an early stage.

Do I have permission to exchange and use this data?

Check that your intended use of the data is allowed under existing agreements and any published conditions. Online botanical data is commonly disseminated for individual, non commercial use only and consent would be needed to place this on an institutional server, for example. Regular data exchanges detailing acknowledgement of the source can be agreed under a data supply agreement.

Do I need to modify my database fields in order to exchange data?

Although a new database project may choose to align closely to the data terms in the Darwin Core standard, for most partners the important step will be to 'map' or cross-reference existing database fields to the corresponding standard fields in which data will be exchanged. For example your database may store a collection latitude as north, zero degrees, 16 minutes and 57.50 seconds but this data will need to be simply transformed to decimal degrees (+0.282640 degrees) for exchange under the Darwin Core standard. You could run the opposite routine when receiving standard data for use in your database.

Do I need to incorporate the external data into my database?

The options include:

- simply copying an item of data from an external source and making a note of the source.
- matching ('resolving') the external data to an existing internal catalogue and making a note of the source.
- Identifying the permanent location of the unit of external data (e.g. including the URL of a specimen image or other data available on line).

How can I recognise a duplicate of a specimen already in my database?

The collector's name and number remains the key identifier for the original field collection. In addition, it is usual for each institution receiving specimens to assign an accession reference (usually a number) unique to their collection. It is useful to also track the identifiers, often termed 'donor reference' that the donor provides. This practice enables you to:

1. Recognise the specimen as existing or new to your database.
2. Decide whether to add a new record, to add to, or to modify an existing record, or to reject the new data.
3. Communicate clearly with the donor organisation about errors or inconsistencies in the data provided for that specimen.

We are following developments of Global Unique Identifiers (GUID) which prefix the accession number with standard institutional code (e.g. 'K' for RBG Kew) and also collection code (e.g. 'seedbank' or 'herbarium') to ensure uniqueness when multiple datasets are combined.



Resolving incoming geographical and species data to be catalogued in the Seed Bank database

Examples of current data sharing initiatives.

As several thousand new MSB seed collections are received each year, it has become increasingly important to create tools for electronic import of new specimen data into the Seed Bank Database (SBD) of Kew (see article by Rob Turner on page 8). Other examples of data sharing from the botanical community are the Plant Collections project in the USA, the Australian Virtual Herbarium, and the BRAHMS online groups. The portal provided by Germplasm Resources Information network (GRIN) allows a multi database query of participating seed banks, although each database returns results in a separate window. The most integrated example is perhaps that of the World Information Network on Biodiversity (REMIB) established by CONABIO Mexico. REMIB allows a distributed query across as many as 124 collections. Results are provided as comma delimited text files, and hyperlinks allow further linked queries within partners such as TROPICOS and USDA Plants database. The Inter-American Biodiversity Information Network IABIN has also allowed users the ability to configure the return data.

In the longer term, we anticipate that more powerful analytical queries will be provided for such combined data, and database managers will provide better tools to allow corrections or inconsistencies to be notified. The next phase of the MSB global partnership will need to compile, analyse and disseminate specimen data from a wide range of participating institutions. We intend to demonstrate a pilot 'data warehouse' later in 2009 which would meet these initial needs, and would facilitate the next generation of seed conservation partnerships worldwide.

Tim Pearce & Michael Way

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Resources and websites:

Follow the links at:
www.kew.org/msbp/data

Data transfer from a UK expedition to Chile

Efficient data capture and exchange was an important consideration during the planning of a collecting expedition to Chile in March 2009. The expedition was organised by staff from Kew's Wakehurst Place Horticulture Section with collaboration from UK Forestry Commission and several Chilean organisations including MSB partners INIA.

For convenience during each collection, data was written on specifically designed paper forms which correspond to a fieldwork database. A laptop was later used to capture the field data into Kew Collector, an Access-based database developed by Kew staff. Kew Collector outputs the data in a format which can be easily entered into Kew's Living Collections Database (LCD), and it can also prepare pre-formatted herbarium labels.

For those seed collections that have been provided to the MSB, the final stage is to transfer the data from the LCD into the matching fields of the Seed Bank Database (SBD) using the XML import tool described in Rob Turner's article. This transfer between Kew collection databases using XML has been effective for data from several horticultural expeditions.

Additional data generated after the horticultural and seed bank collections have been accessioned are entered into the corresponding databases, and the complete data set is available for repatriation to Chilean counterparts to assist in the study of the material in the country of origin.



Jo Wenham filling in a data sheet PHOTO BY DAN LUSCOMBE

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The Australian Seed Conservation and Research network: sharing data across seed banks

Through twelve organisations, in seven states and territories, Australia is making a major contribution to the Millennium Seed Bank Project. Collectively, our Australian partners operate as the Australian Seed Conservation and Research network ("AuSCaR").

One aim of the network is to ensure that state by state collection programmes are well co-ordinated and the best use of resources is made when designing and implementing collection programmes. One tool to assist in this is an online data portal for access to currently held accessions in the seven distributed seed banks within the network.

Australian herbaria are well resourced to deliver such a portal for herbarium vouchers through the Australian Virtual Herbarium <http://www.anbg.gov.au/chah/avh> where collections from all state herbaria are available either individually or collectively to query and view.

Now, a similar portal has been developed for AuSCaR as part of the BRAHMS OnLine database pages <http://dps.plants.ox.ac.uk/BolIMvc/auscar>. When used to its full capacity, database "groups" can be linked through one front page, allowing users to select those seed banks which they wish to include in their search. In this draft version, we have only used data from those collections currently duplicated in the MSB.

Users can search by taxon, geographical location, collector or seed bank. Results are displayed spreadsheet-style and a number of useful tools including the Google Maps mapping function are included. Downloads of data are offered in data or text formats and users can email the database "owners" (the seed bank of origin) with comments or corrections concerning individual records.

Tim Pearce

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Data transfer across networks; the BRAHMS Seed Manager module

Through the BRAHMS (Botanical Research and Herbarium Management System) project we are constantly challenged to ensure we provide users with sufficient inter-operability between database systems. For a number of years now, we have been working closely with the MSB team and some of its partners to ensure we provide just that sort of inter-operability between BRAHMS users and the MSB. We have significantly overhauled the BRAHMS Seed Management module which now not only emulates much of the data structure of the MSB database standards, but includes an import/export function to facilitate the transfer of electronic data files from the MSB Seed Bank Database into BRAHMS and vice versa.

This newly introduced flexibility uses the .xml file format and provides a mechanism for very efficient seed data transfer between MSBP partner databases and the MSB 'mothership' database at Wakehurst place. Prior to this development, data were being transferred to and from using a mixed bag of file formats. In most cases, data were being re-entered from printouts. Responding to this, BRAHMS has been developed to both receive and generate the MSB seed .xml files.

Results from seed data queries in BRAHMS, including germination test results, can be exported to an .xml file following the MSB XML schema (see the article by Rob Turner on page 8). These files can then be directly imported into the Kew system. Similarly, data provided by Kew can be uploaded to a seed RDE file and subsequently transferred into a BRAHMS project database.

The future has to accommodate this level of inter-operability, and the investment of resources in establishing data standards and then mapping data across database projects will inevitably pay dividends if we are to achieve global data sharing throughout the MSB network of seed bank partners.

These latest BRAHMS developments are documented on <http://dps.plants.ox.ac.uk/bol/documentation/Default.aspx> and then following the tree index through the "Seed Management Module > Kew MSB XML transfers"

Denis Filer

BRAHMS Project

University of Oxford Dept. of Plant Sciences

A selection of international programme activities

Slovakia

Approximately 4713 taxa of ferns and flowering plants occur in Slovakia. Out of these, 124 are critically endangered, 273 are endangered and 350 are vulnerable. More than 10% (488) taxa have been reported as endemic in the Western Carpathians, almost 5% (220) of them distributed only in Slovakia. This large biodiversity, concentrated in a relatively small area of Slovakia, can be explained by the fact that three bioregions (namely the Alpine, Continental and Pannonian) meet in this region. However, the Western Carpathians, which belong to the Alpine bioregion, have a crucial impact on species richness in Slovakia. Influence of the Pannonian region, is apparent in the southern most part of Slovakia only - many of the endemic Pannonian species reach their northern-most border of distribution here.

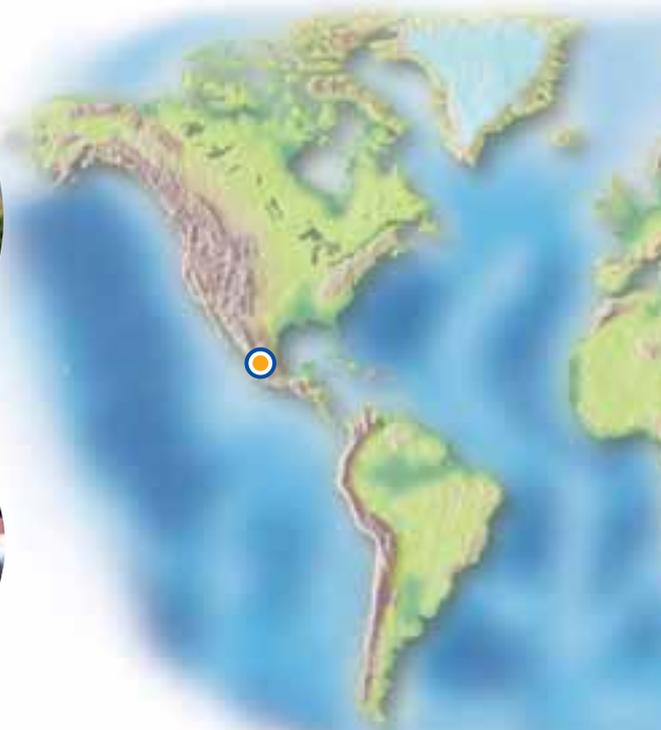
A Memorandum of Collaboration between RBG Kew and the Institute of Botany, Slovak Academy of Sciences was signed in December 2006. A "Seed Collecting for Conservation" course, including fieldwork, was delivered to all participants in the Slovak team by Janet Terry in June 2007. After this course, we established the "Slovak collection team". Members of the Slovak team come from following institutions: the Slovak University of Agriculture in Nitra, the Natural History Museum in Bratislava and the Administration of National Park of Slovensky kras Mts. In 2008 Clare Trivedi came to Slovakia to discuss working plans for the next years and the future. Our seed collecting is focussed on endemic and endangered species, and the collecting programme covers the whole area of Slovakia. During the 2007–2008 collecting seasons we collected 198 species, of which 26 are treated as endangered, 27 as vulnerable and 32 as critically endangered. Eighteen of the collected taxa are endemic to the Carpathians and 5 species are endemic to the Pannonian region. Almost all seed collections are stored at the Millenium Seed Bank, and also in the Gene Bank of the Slovak Republic in Piešťany.

By Jaromir Krucera



Burkina Faso

Burkina Faso is the main MSBP partner in West Africa, where seed collecting will have covered about 50% of the country's flora by December 2009. Over the last eight years, more than 1000 species have been collected and banked in duplicate at the *Centre National de Semences Forestieres* (CNSF), Burkina Faso and at the Millennium Seed Bank. These collections also include Mali species that are stored in trust at CNSF. The two countries have had regular annual joint collecting expeditions and this has been a great success and helped avoid a lot of duplication. Each of the six seed regions in Burkina was visited and the collection guides (including data contributions from the Museum National d'Histoire Naturelle Paris), have been used to better target species. The team now has acknowledged expertise on the country's flora and this has had a marked improvement on the effectiveness of the collecting programme. The herbarium at CNSF has also attained



Jordan

Desert plants rescued

Jordan suffered two consecutive years of dry conditions in 2008 and 2009; very low rainfall with extremely hot summers. We expected seed collecting to be very difficult in those years, so tried to orient our missions to small rivers and streams and the very high mountainous areas. What is amazing is that in those two years most of the collectable seed plants were found in unexpected areas of desert, in Wadi Araba. Here the sand dunes and the very low altitude make it a representative of tropical phytogeographic penetration. We managed to collect about seven species, and all were desert plants. Such achievements illustrate that when extreme conditions prevail, one should search for "hero" plants, and not underestimate such fighters!

By Khaled Abulaila

NCARE

Jordan

South Africa

The Western Cape has been hit hard with uncontrolled bush fires destroying thousands of hectares of natural vegetation. Prevailing winds and high temperatures fanned the flames which in turn affected the collecting season in many ways ...

MSB Cape Team made an exciting re-discovery in the Koue Bokkeveld region with a little known species called *Erica greyi*. It was last recorded in 1897 and 111 years later the Cape Team have successfully collected seeds and much needed herbarium vouchers. Following this exciting find, a bush fire swept through the area destroying the main population of this low growing, dusky pink flowered species. A thorough search has revealed two smaller unburnt populations in the area.

A healthy population of *Lachenalia salteri* (endangered) growing in a popular coastal village, was collected in January. The following week the

international standards with over 6000 specimens, and was registered on the Index Herbarium in 2008.

Community-based projects, enabling sustainable use of seed collections, are being implemented to restore damaged ecosystems and are also being used in agro-forestry farming systems. CNSF has been greatly involved in these communities' projects, providing state and NGO nurseries with seeds and training for seedling production. This enabling use of species is gradually improving farming systems and providing protection against desertification. Such thematic plantings will continue to be extended, so that important wild socio-economic species are used sustainably and protected in the wild.

By Moctar Sacandé
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Malawi

The collecting of Malawi flora has proved to be successful, as over 1000 species were collected and banked in duplicate in the country and at the Millennium Seed Bank. This represents over 25% of the flora. Each of the Malawi districts has been visited and specific collection guides for the Nyika Plateau and Mount Mulanje have been used to better target species. However, it has been noticed that Malawi presents a number of difficult problems for seed collecting, including plant identification and a high proportion of species with very restricted distributions.

The Malawi team has successfully hosted the second regional meeting of the southern Africa MSBP partners including South Africa, Namibia and Botswana. The meeting was a combination of training, information exchange and a consultation on the future of the MSBP project. It was followed by a memorable international expedition on Mount Mulanje where a great number of endemic species were collected.

A few pilot activities regarding enabling sustainable use of threatened plants have already been developing around Mulanje and provision of seedlings to communities. MSBP will increase such activities in the country, through government decentralised structures and NGOs, so that important socio-economic species are used sustainably and protected in the wild.

By Moctar Sacandé
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Team collecting field data
PHOTO: JIE CAI



Suessenguthiella caespitosa
PHOTO: HERTA KOLBERG

local council mowed the species to the ground whilst making fire breaks as a preventative measure to runaway fires.

Seed was collected from *Pillansia*

templemannii (rare) which flowers bright orange solely after fire - fire is not always a bad thing as it is needed for regeneration of many Fynbos species.

In KwaZulu-Natal, in the north, *Aloe inconspicua* (endangered) was collected near the town of Estcourt. Fifteen plants were found on a farm owned by the Green family. The number of plants is deteriorating each year and threats include trampling by livestock and climate change affecting reproduction (only 5 plants produced fruits). Another challenge is

to save the population because its locality has a land claim registered for human settlement. The population might disappear quicker than previously thought. Seed will be propagated for reintroduction purposes at secure sites.

Seed was also collected from three threatened species from the Blouberg Mountains in Limpopo province. These are *Streptocarpus longiflorus* (vulnerable), *Senecio hederiformis* (rare), and *Dicoma montana* (rare). They occur on unstable steep rocky faces. Threats to this habitat are trampling by livestock and human disturbance. The collected seed is currently their only hope for survival.

By Nicolette Stoll and Livhuwani Nkuna

Training in BRAHMS at the Botanical Garden and Institute of Botany, Tbilisi, Georgia

The MSBP has been collaborating with the Caucasus Regional Seed Bank (CRS) managed by the Tbilisi Botanical Garden and Institute of Botany, Georgia, since 2005. In April 2007 the Head of the Plant Conservation Department of the Tbilisi Botanical Garden and Institute of Botany, Tsira Mikatadze-Pantsulaia, and I had an excellent opportunity to visit the MSB for training in Seed Conservation Techniques. During the visit, we made an attempt (together with colleagues Janet Terry and Clare Trivedi from the MSB) to put in order the data pertinent to Georgian collections. The data were then held in the form of separate filled-in collector's forms or, as Word or Excel files. Re-typing hand-written collectors' forms caused numerous incorrect entries, especially in geo-referencing, collection dates, explanatory notes, etc.

In order to solve the problem, Clare Trivedi organised a meeting with Tim Pearce and Udayangani Liu, who are involved in the management of botanical and seed bank data at the MSB. They explained how data is managed at the MSB. Tim Pearce, who has experience of using BRAHMS, (Botanical Research and Herbarium Management System, developed at the Department of Plant Sciences, University of Oxford), in several MSBP partner gene banks, proposed to use this system to manage data at the Caucasus Regional Seed Bank.

During 2008, MSB staff worked with Denis Filer, (coordinator of the BRAHMS Project) to extend the BRAHMS Seed Bank module. It was agreed that this would be the best tool to manage the data of the Caucasus Regional Seed Bank. Tim Pearce, Denis Filer and Clare Trivedi developed and arranged a training course in Tbilisi in early February 2009, making the Georgian team the first to receive training with this new module. Space and facilities necessary for conducting the training were kindly provided by the director of the Tbilisi Botanical Garden and Institute of Botany, Shalva Sikharulidze.

The seed bank staff involved with the collections (Tsira Mikatadze-Pantsulaia, Lia Kobakhidze, Marina Eristavi, Manana Khutsishvili) attended the training to learn more about the database and to have a representation on how the data they are generating can be used. Staff members from the



other Departments of the Institute (Herbarium, Department of Cryptogamics, participants of the Red Data Listing Project) and interns from Kutaisi Botanical Garden (West Georgia) were included in the training.

All participants of the training were provided with copies of a comprehensive training guide to BRAHMS. In order to practise optimizing data entry, querying and reporting, the seed bank staff could immediately work on a draft database of the Caucasus Regional Seed Bank, editing records and linking with data files. Mapping to Diva GIS and Google Earth were amongst the most exciting and useful tools. Special stress was put on visual reporting for labels and lists and the process of connecting seed bank collections with associated herbarium vouchers was explained.

Together with Tim Pearce, we managed to configure the file with the collections of 2008 and the draft database was published using the BRAHMS on-line system. The home page portal was created and edited and the necessary data uploaded. The regional seed bank database will be accessible online after refining all data.

Managing data in BRAHMS will also allow direct transfer of digital data between the MSB and the Caucasus Regional Seed Bank. It could be used to plan seed collecting activities. In addition, BRAHMS is being successfully used for managing the data of the National Herbarium of Georgia (TBI), also overseen by the Tbilisi Botanical Garden and Institute of Botany. As a result of accomplishing the project, (funded by the Georgian National Science Foundation), 10,000 specimens of the National Herbarium have been imaged digitally so far and the data have also been imported to BRAHMS and published to BRAHMS online.

There is still much to do to improve the quality of data for the collections of the Caucasus Regional Seed Bank. Step by step we move forward and the working process shows how to make the data more accurate and the data management process more efficient.

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The Cactus Seed Biology Database

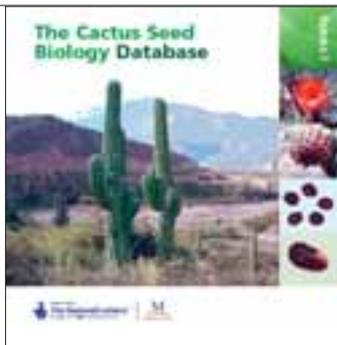
An international research project was started in June 2006, as part of the MSBP Americas programme, to produce a comprehensive summary of cactus seed biology. The project, led by Hugh Pritchard and Charlotte Seal in conjunction with MSBP colleagues Wolfgang Stuppy, Tiziana Ulian and Michael Way, worked with 11 institutes from Argentina, Chile, Mexico, Peru, and the USA. The project was funded from the UK's Millennium Commission as an Enhancement Grant to the MSBP.

There are approximately 1800 species of cacti, predominately located across North and South America in a range of habitats from arid deserts to tropical rainforests. Many species are of great importance in the daily life of local people as valuable sources of food and raw materials; for example, *Echinopsis chiloensis* ssp. *skottsbergii* is endemic to Chile and used locally as a raw material for construction, crafts and medicine. Globally, the ornamental use of cacti is a lucrative business.

However, as a result of over use, habitat destruction and life history (longer-lived perennials are at greater risk of extinction due to environmental changes), many species are judged to be of conservation concern. The International Union for Conservation of Nature (IUCN) and national conservation organisations consider several species at risk from extinction immediately, and many at risk in the near future, unless urgent action is taken. To ensure the most appropriate action, an understanding of the biology of both plants and seeds is needed. Seeds are particularly important, as germination, and development into a seedling, are the first steps in producing the next generation of plants.

Most published research on the plant and seed biology of cacti reports data for traits such as germination, dormancy, dispersal and morphology. However, species data is often incomplete for all traits. There also tends to be a bias in which species are studied and some data are not easily accessible, for example, that in institutional reports and student theses. Therefore, a more comprehensive summary of biology was needed, to include a review of the literature (both published and inaccessible 'grey' literature) and to generate new data from laboratory studies.

In partnership with the project collaborators, a review of the published literature, student theses (MSc and PhD) and institutional reports was conducted, in addition to collating plant images from the field. In parallel, laboratory studies were conducted for 86 species/sub-species collected from the wild, in order to study seed germination (temperature and light requirements) and seed mass. Laboratory experiments were carried out in-



The 'Cactus Seed Biology Database' is available as a CD for researchers and conservationists. PHOTOGRAPH BY C. SEAL

country or at the MSB. Project funding supported 1-3 month visits to the MSB by partner researchers. At the MSB, detailed germination studies were also conducted using the thermogradient plate to study a gradient of 14 different germinations temperatures simultaneously.

Co-author Dr Joel Flores (Instituto Potosino de Investigación Científica y Tecnológica, Mexico) donated his personal database in addition to spending three months at the MSB to conduct laboratory experiments and to assist with the literature review. He also helped create a database to consolidate the project data. The 'Cactus Seed Biology Database' (available as a CD) contains information on over 350 species of cacti with data on up to 15 traits including conservation status, distribution and habitat, seed germination, seed mass, seed oil content, plant physiology (including images), uses and taxonomy. The second version of the database will be released in 2010 and will include

new knowledge on cactus seed biology, scanning-electron microscope images of seed morphology and work with new collaborating groups.

The 'Cactus Seed Biology Database' is a unique summary of cactus seed biology. It is intended for use as a starting point for many people to appreciate cactus biodiversity and as vital background material to assist in the conservation of these special plants.

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Collaborating organisations:

Universidad Nacional de Salta, Argentina
Instituto Nacional de Tecnología Agropecuaria, Argentina
Universidad de Buenos Aires, Argentina
Instituto de Investigaciones Agropecuarias, Chile
Ex Situ and *In Situ* Cactaceae Conservation Project, Chile
Instituto Potosino de Investigación Científica y Tecnológica, Mexico
Universidad Nacional Autónoma de México, Mexico
Universidad Nacional Agraria La Molina, Peru
Jardín Botánico "Octavio Velarde Núñez" de la Universidad Nacional Agraria La Molina, Peru
Bureau of Land Management, USA
Lady Bird Johnson Wildflower Center, USA



Echinopsis chiloensis ssp. *skottsbergii* is endemic to Chile and an important raw material for local people. PHOTOGRAPH BY P. LEÓN-LOBOS



The ornamental use of cacti occurs throughout the world. Popular species that were studied in the project include *Cereus hankeanus* (Argentina) and *Melocactus peruvianus* (Peru). PHOTOGRAPHS BY P. ORTEGA-BAES AND N. RAMÍREZ BULLÓN



Natali Ramírez Bullón (Universidad Nacional Agraria La Molina, Peru), using a thermogradient plate to study seed germination at 14 different temperatures simultaneously at the MSB. PHOTOGRAPH BY N. RAMÍREZ BULLÓN



A message from Paul Smith

Many thanks to all of you who have corresponded with us here at the MSB on the subject of future activities.

We have made excellent progress in developing a plan for the next phase that will ensure that the momentum developed by the MSBP is not only maintained but accelerated. Our shared vision for the future is based on three main outcomes:

1. 25% of the world's plant taxa secured in safe storage by 2020.
2. The use of a wide range of plant diversity in critical areas such as habitat restoration and livelihood improvement.
3. Long term financial security is secured for the seeds, data and skills within the MSBP. Given the current global recession, and consistent with achieving long term financial security, a more diverse funding model will be required than in the current phase of the MSBP.

Within the partnership we will be approaching statutory funders, philanthropists, trusts, foundations, corporate sponsors and the general public. Our relationships with these sponsors will vary enormously, some founded on philanthropy and others based on the technical services we provide. This is not only a robust funding model that will enable us to survive financial turbulence, it is also the way in which we will connect with society as a whole.

Seed Bank Data Exchange: Kew's Technical Approach

After a seed bank data standard was produced in a tabular format with field names, descriptions and data types, we had to decide how the actual data should be transferred whilst preserving data type and readability.

We decided to use XML as our data exchange format. XML is database- and platform-independent and provides a readable transfer format which can be validated against a schema. XML files can be easily viewed by web browsers, and the contents can be modified with a text editor or managed with more powerful software such as XMLSpy.

The first stage was to express our data standard as an XML Schema Document (XSD). This enables us to describe allowable document content and to validate the correctness of data. It also allows us to resolve some 'one to many' relationships (e.g. a specimen can have many germination tests) using nested elements.

We then wrote a program to **export** data from the Seed Bank Database (SBD) into XML. This enables searching either by a defined set of criteria (e.g. donor organisation) or by supplying a list of keys (seed bank accession number) obtained from another query.

The next more complex phase was to produce a data **import** tool for SBD. This had to perform the following functions:

- 1) Check that the supplied XML document can be validated against the XSD
- 2) Check that we are not importing duplicate records (using donor reference as the key)
- 3) Check incoming data against any SBD data dictionaries, including geographical locations and plant names
- 4) Import the data and provide the user with a list of the seed bank accession numbers and imported donor references

Currently, both 'passport' and 'processing' data sets can be exported but only 'passport' data can be imported. This has been achieved from other Kew collection databases, and a dataset provided by Kenyan partners. Implementation of the 'processing' data import function is expected to be scheduled in the near future.

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Since its beginning in 2001, Seeds of Success (SOS), the U.S. national native seed collection program and U.S. partner in the Millennium Seed Bank Project, has grown from a handful of collecting teams in the western U.S. to over 65 teams nation-wide. SOS has made over 8,000 wildland native seed collections from more than 2,000 species. The Bureau of Land Management (BLM) uses collections management software, *BG-BASE*, to manage SOS collection data, target lists, and material transfers.

In 2007, SOS piloted an electronic field notes project to reduce the amount of time taken up by duplicate data entry. *BG-BASE*, Inc. developed specialized SOS software that allows SOS seed collectors to capture collection information at the collection site. The software has been installed on eight ruggedized laptops and is used to enter collection information which is then exported and e-mailed to the SOS National Co-ordinating Office at the BLM. After the collection information has been checked for accuracy and errors, it is directly incorporated into the SOS national database.

In 2009, additional SOS collecting teams will use *BG-BASE*. Plans have been made to develop an XML export that will allow collection information to be exported from the SOS national database and electronically incorporated into the Millennium Seed Bank Project database. This next phase will continue to streamline the flow of collection information throughout SOS.

Mary K. Byrne, Botanist, *Seeds of Success*
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Millennium Seed Bank Collection Figures June 2009

	total in MSB	since Phase III started
Collections:	48,011	36,584 (1,950 UK)
Species:	26,774	22,434 (610 UK)

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