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Ensuring the survival of rare and endangered plants

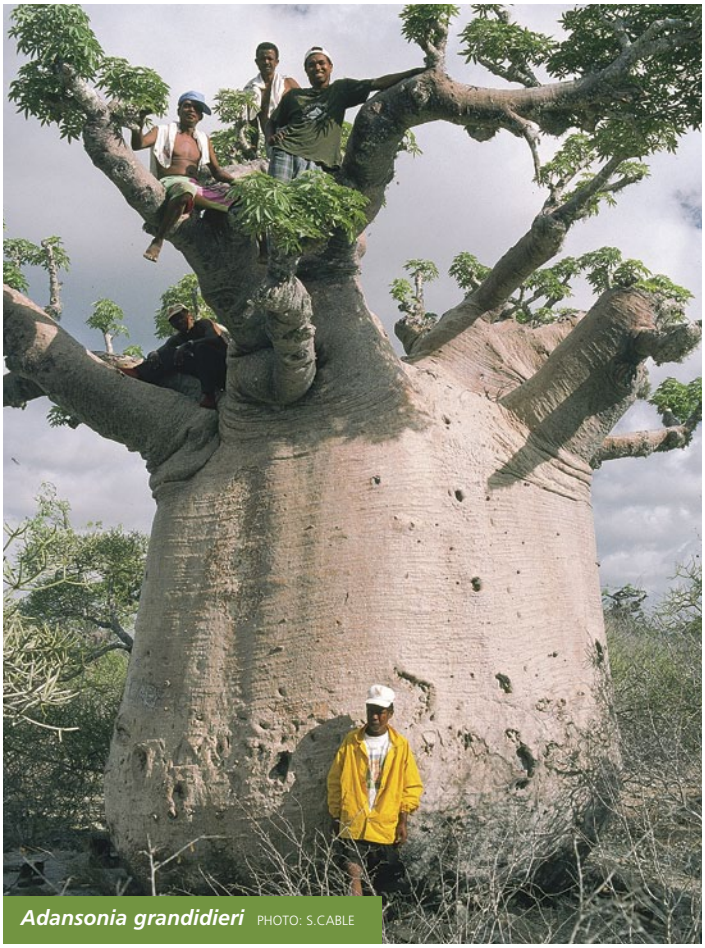
By Sara Oldfield (Botanic Gardens Conservation International)

One of the most charismatic globally threatened plant species is the Madagascan baobab *Adansonia grandidieri*, a giant, long-lived tree that is highly valued by local people for its edible fruits and seeds, medicinal products and its bark which is used in rope making. This extraordinary endangered tree, one of six baobab species found only in Madagascar, is an important part of local culture but without action could become extinct in the wild.

This is just one of thousands of plant species that are close to extinction and may be pushed to the edge by climate change. The need for action is well known but much more needs to be done. Governments around the world have signed up to the Global Strategy for Plant Conservation (GSPC) pledging to take action to prevent the loss of plant diversity. The GSPC has 16 ambitious targets to be met by 2020. A new report on progress towards these targets, prepared by Botanic Gardens Conservation International (BGCI) notes that significant achievements have been made in plant conservation around the world but that few of the targets are likely to be met (Sharrock et al., 2014).

Unfortunately we do not yet have the firm evidence base to use in calling for increased plant conservation action. Botanists need to act quickly to assess how many plant species are under threat around the world. This is called for by Target 2 of the GSPC. The IUCN Red List of Threatened Species™ is the most objective global approach for evaluating the extinction risk of species and it provides the basis for monitoring progress towards the achievement of other GSPC Targets. Unfortunately the number of plant assessments on the IUCN Red List has increased very slowly compared to other taxonomic groups. By the end of 2013, only 6% of plant species had been assessed at the global level using the IUCN Red List system. As an interim measure the work of Kew in producing a list of plant conservation assessments by adding data from national Red Lists and other published sources to plant data from the IUCN Red List is extremely important and is highlighted in the BGCI report. The interim list of plant assessments (for 2013) includes 58,494 unique plant assessments (approximately 16% of all plants). Of these, 43% of plants assessed are categorised as Threatened with extinction.

Assessing which plant species are under threat and where they occur is essential to guide priority action. GSPC Target 5 calls for *the protection of at least 75% of the most important areas for plant diversity within each ecological region* (Secretariat of the Convention on Biological Diversity, 2003). At the global level, the areas of highest plant diversity have been identified (Barthlott et al., 2007). Twenty areas have been identified where vascular plant species richness exceeds 3,000 species per 10,000km^2. The island of Madagascar is one of these areas. Currently less than 10% of the combined land of the 20 most globally important plant areas is protected. At the national level, over 60 countries have made significant efforts to



Adansonia grandidieri PHOTO: S.CABLE

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ROYAL BOTANIC GARDENS

MILLENNIUM SEED BANK PARTNERSHIP
Kew

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Adansonia grandidieri PHOTO: S.CABLE

identify important areas for plant diversity, but it is not yet clear how many of these are being effectively managed or how well these are distributed across ecological regions.

Conservation of plants in their natural habitats is of vital importance in maintaining the so-called ecosystem services that they provide and allowing evolutionary processes to continue. At the same time *ex situ* conservation of threatened plants in living collections and seed banks is an invaluable insurance policy. GSPC Target 8 calls for 'at least 75% of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20% available for recovery and restoration programmes'.

A recent analysis has identified 29% of globally threatened species (as included on the IUCN 2013 Red List) in cultivation and/or seed banks. The endangered *Adansonia grandidieri* is currently recorded in 29 botanic gardens worldwide and, at the very least, plants in cultivation can be used to highlight the plight of this species in the wild.

While the focus of conservation work by botanic gardens traditionally has been mainly through their living collections, there is increasing recognition that such collections do not include sufficient intra-specific genetic diversity. Where possible, seedbanking provides a desirable and cost-effective alternative. According to BGCI's GardenSearch database (www.bgci.org/garden_search.php), 275 botanic gardens in 66 countries now record having a seed bank. Of course, The Millennium Seed Bank Partnership (MSBP) coordinated by Kew, leads the way, working in over 80 countries to conserve 25% of the world's orthodox seed-bearing species. By August 2014, over 35,000 verified taxa had been stored in the MSB. Of these, at least 4,666 are threatened taxa, according to the various threatened species lists available. Efforts to assess the quality of these collections are ongoing.

This year two exciting new projects have been launched in a partnership between BGCI and the MSBP to boost progress toward the GSPC targets. One is the Global Seed Conservation Challenge which will encourage more botanic gardens around the world to establish local seed banks to conserve plant species under threat. The other is the Global Tree Seed Bank which specifically aims to boost the number of globally threatened tree species that are conserved within the MSB by working with local partners of the Global Trees Campaign (www.globaltrees.org).

Once in a seed bank under conditions of low humidity and temperature, most seeds can survive for centuries. More importantly, material is available to researchers and conservationists for study and use. For example, collections held at the MSB and by its partners are available for restoration, and are frequently used for this purpose (see previous issues of *Samara*).

Progress towards the second part of GSPC Target 8 (recovery and restoration) remains challenging. However, there is an increasing understanding of the importance of linking *in situ* and *ex situ* conservation and using collections for restoration activities – both at species and ecosystem levels. This is exemplified by the establishment in 2012 of the Ecological Restoration Alliance of Botanic Gardens in response to both Target 4 and 8 of the GSPC. Botanic gardens hold a huge amount of valuable knowledge for ecological restoration as well as plant material for propagation and use in restoration schemes. Members of the Alliance have agreed to support efforts to scale up the restoration of damaged, degraded and destroyed ecosystems around the world, with the goal of restoring 100 places by 2020.

So is there hope for globally threatened plant species like *Adansonia grandidieri*? The answer must be yes if we can compile the underlying data on threatened plants quickly and use it to prioritise local action with international support provided where necessary. Fortunately *Adansonia grandidieri* is receiving specific attention through the Global Trees Campaign working with local partner Madagasikara Voakajy and its future prospects for enhanced survival are looking good.

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www.iucnredlist.org
www.bgci.org/garden_search.php

A message from Paul Smith

After 18 years at Kew and nearly 15 years at the Millennium Seed Bank, this will be my last contribution to *Samara*. I leave with mixed feelings, of course, but mainly a feeling of great pride in what the Millennium Seed Bank Partnership has achieved since its inception in 2000. By my estimate, we have banked seeds from around 40,000 plant species, many of them rare and threatened as illustrated so well in this edition of *Samara*.

The future of these species, if not completely assured, is far brighter than it was. We can store the vast majority safely for centuries; we know how to germinate most of them; and we are growing an increasing proportion of them in the landscape.

Just as important as the seed collections themselves is the idea of seed conservation, an idea that has caught on globally. Large seed banks, designed specifically for wild species, have been built in Asia, Australasia and Latin America in the past decade, and elsewhere the agriculture and forestry sectors are waking up to the importance of wild species as the means to innovate and adapt.

Although my career has taken me from microbiology to plant ecology to seed banking, I am a conservationist at heart and to me the challenge that faces all of us privileged enough to work in conservation is how better to conserve and manage species diversity for the benefit of future generations. Our working premise is that there is no technological reason why any plant species should become extinct, and I look forward to continuing to work with you in the future to ensure that this hypothesis becomes a reality.

A message from Colin Clubbe

Head of the Conservation Science Department

As *Samara* goes to press Kew is in the middle of a major review of its science and science funding. In the face of declining government budgets, a challenge we share with many institutions around the world, we are looking at how we can secure the resources we need to continue our core science activities and maintain our hugely successful global partnerships. We are developing a new science strategy which we will launch in early 2015. The first phase of the science restructure has established six new departments: Collections, Identification & Naming, Conservation, Natural Capital, Comparative Plant & Fungal Biology, and Biodiversity Informatics & Spatial Analysis.

I have the great honour of being appointed as head of the Conservation Science Department and I am looking forward to working with the Millennium Seed Bank Partnership to continue to facilitate the many successful conservation outcomes already achieved since 2000. Collectively we have the challenging target of banking 25% of the world's bankable plant species by 2020. This target is important for the future of the world's plants and with all of your help we can achieve this target, improve the outlook for plants globally and continue to provide plant-based solutions for some of our greatest global challenges. I have worked in plant conservation for most of my professional life and I have seen habitats and species

Collecting seed of the endemic St Helena scrubwood (*Commidendrum rugosum*) PHOTO: V. THOMAS

decline in the wild. I was part of an unsuccessful attempt to prevent one species going extinct. Had the Millennium Seed Bank Partnership been as active then as it is now, I'm sure that the St Helena olive, *Nesiota eliptica*, would be more than just a herbarium specimen and an aliquot of DNA in Kew's collections. By focussing our collective efforts we can prevent species extinction and genetic erosion. The MSBP is central to achieving this.

Hermas pillansii PHOTO: S.-L. HUTCHINSON

The search for *Hermas pillansii* on Table Mountain

By Sarah-Leigh Hutchinson, (SANBI – South Africa National Biodiversity Institute)

Hermas pillansii* **(Apiaceae) was one of the first plants to be discovered from the Cape of Good Hope, South Africa, and was illustrated in 1685 by Hendrik Claudius. Such an early discovery suggests that this plant was a relatively common species… or does it?**

The first published habitat description for *Hermas pillansii* indicates its preference for growing on damp ledges of 'scarcely approachable rocks' on vertical cliff faces of the Cape Peninsula. Until very recently the last sighting and herbarium specimen collected was in 1938, not surprisingly perhaps, by that famously fearless mountaineer and botanist, T. P. Stokoe. After that,

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Chris Browne scaling the cliffs PHOTO: S.-L. HUTCHINSON

Escaping the mist PHOTO: S.-L. HUTCHINSON

seven decades went by without a trace of this very special Table Mountain endemic, despite persistent searches by local botanists. Consequently, *H.pillansii* was feared extinct, due perhaps to disturbance from recreational rock climbing across the mountain.

In 2011, SANBI's Red List scientist, Lize von Staden, posted a challenge on the citizen science website, iSpot, asking any climbers and those 'without fear of heights' to try and help relocate this elusive plant. A year later, a group of botanists led by Dr. Anthony Magee (Apiaceae expert at Compton Herbarium) found a total of six plants of *H. pillansii* on the shaded, west-facing kloof, Fountain Ledge. A few months later, Chris Browne, of the local botanical group CREW (Custodians of Rare and Endangered Wildflowers) found another *H. pillansii* plant, but this time in a locality last recorded in 1928. Despite only finding one plant, Mr Browne was certain he could spot a few more individuals on the cliffs below. All that was needed to prove his assumption was some artful rock climbing and a touch of bravery. News of these fortuitous rediscoveries reached our MSB team at Kirstenbosch and arrangements were made to collect seed of this species which was, in all respects of the word, living on the edge.

It was a perfect summer morning in February as we set out for the cable car station at the foot of that great South African icon, Table Mountain, the 'mountain in the sea' or 'Hoerikwaggo' as its earliest inhabitants the Khoi'san first named it. Accompanying our seed collecting team were Mr Browne and three CREW members. We were grateful for the extra pairs of eyes and especially Mr Browne's firsthand knowledge of the mountain paths. To maximise our search time, we decided to take the cable car to the summit, albeit not without feeling we had cheated somewhat! Little did we realise, however, what a good decision this would turn out to be…

At the top was a breathtaking sight. We were the same height as a massive expanse of clouds resting on the horizon. We took a moment to drink in the view and then followed Mr Browne's lead across that magnificent 'table top'. Before long we had found his site and the small *H.pillansii* perched at the edge of the plateau. We carefully collected the mature seeds, snapped some photographs, and braced ourselves for the real hunt that lay steeply below us. After an adrenaline-filled hour of careful manoeuvres along the cliffs, peeking into all the shaded crevices and overhangs, we were extremely chuffed to return to the top, all limbs intact, and to add ten more plants to the global population list! Strangely enough, all ten plants we had found were without flowering stems, just a handful of basal leaves, and thus we were unable to make more seed collections. We puzzled this over a quick lunch and then debated whether to call it a day or tackle a different cliff section. The cloud bank we had admired earlier was now resting on the city and every now and then a wispy cloud fragment rushed past. Unperturbed, we decided to risk it. This time, heights got dizzier and some of our team members stayed behind. Making our way along a very overgrown, forgotten contour, the rest of us came across a gorgeously robust *H.pillansii* dripping with seed. Suddenly we noticed the cliff above us was punctuated with *H.pillansii*, all of them in seed and in full sun! Overjoyed, we gathered the seed which could be safely reached and counted as many as thirty individuals. The answer to our lunchtime question seemed evident – *H.pillansii* must prefer the sunny, north-facing cliffs, as all our previous ten plants had been hidden in the shadows. Just then we realised the mist and clouds were almost upon us. Making haste, we reached the top but the thick white tablecloth was already firmly in place and within seconds our hair and eyelashes were dripping with water droplets and visibility was minimal. Thankfully, Mr Browne knew the way, and we hurried on in single file, hoping not to miss the last cable car. Looking like exhausted, drowned rats we must have made for a humorous sight that afternoon crammed together with all the tourists inside the last cable car, but we didn't mind, for our hearts were full from the day's adventure, and the success of helping to conserve and solve the mystery of the no-longer elusive *Hermas pillansii*.

*A new taxonomic revision of the genus *Hermas* by Dr. Anthony Magee is currently in press and as a result the name *Hermas pillansii* will soon change to *Hermas lanata*.

For further information contact Sarah-Leigh Hutchinson (S.Hutchinson@sanbi.org.za)

A seed conservation network for islands of the Mediterranean Basin

By Sarah Hanson (Mediterranean Projects Support Officer, MSBP)

Participants on a joint field trip to Cyprus PHOTO: A.KYRATZIS

Seeds of *Astragalus siculus*, an endemic plant of Sicily, have been collected for the project PHOTO: G. P. GIUSSO

The Mediterranean Basin is a biodiversity hotspot with nearly 25,000 plant species – one in ten of all known plants, of which over half are endemic to the region. It is however amongst the four most significantly altered biodiversity hotspots on Earth with less than 5% of its total land area protected in nature reserves. This means that, as well as being vulnerable to changes in climate, the majority of plant species are unprotected from changes in land use caused by activities like tourism and agriculture. Nowhere is this threat felt more than on islands where high levels of biodiversity and endemic richness are combined with a wide range of habitats within a small but restricted area, reducing the opportunities for species migration when conditions change.

The 'Ensuring the survival of endangered plants in the Mediterranean' project, funded by the MAVA Foundation, is an initiative led by seven conservation organisations from Sicily, Sardinia, Cyprus, Corsica, Crete, Mallorca and the UK working together to protect the endangered flora of the six islands through *ex situ* seed conservation. The first phase of the project ran for three years between October 2011 and September 2014 and has seen many successes:

- Seeds have been collected from mainly endemic, rare, threatened or protected taxa, stored in local seed bank facilities on the six islands and backed up at the MSB. This has resulted in the protection of over 900 endangered plant taxa.
- Germination tests continue to be carried out to assess the viability of the seed material and to ensure regeneration is possible. Data from this research, including germination protocols, is available to aid in conservation and restoration activities.
- The project has enabled a network of seed conservationists in the Mediterranean Basin to be developed. This has improved local conservation initiatives, built relationships and facilitated resource sharing between institutions and staff working in seed conservation across the Mediterranean linking, for example, seed banks with universities and other research facilities.
- A programme of joint seed collecting trips has forged relationships as well as improved local knowledge about the ecology and taxonomy of the flora of all six Mediterranean islands.
- The project has included higher-level training with MSc and PhD support as well as a number of publications. Research projects include:
  - An ecophysiological study of germination and dormancy in eight native plant species from Crete.
  - Taxonomical investigations on the endemic species of the Sicilian flora.
  - Molecular characterisation of secondary dormancy in the annual *Silene integripetala* subsp. *greuteri*. Seed dormancy and germination niches of Mediterranean species along an altitudinal gradient in Sardinia.
  - There have been three PhD summer schools, organised by the Sardinian partner.
  - The project has also been widely publicised and helped to increase public awareness of the value and vulnerability of the local flora.

There have been a few unexpected pleasant surprises along the way, including the discovery in a gorge in Crete of a population of *Hypericum aegypticum* subsp. *webbii*, previously thought to be extinct, and the discovery of populations of *Bellium artrutxensis* in Mallorca and Ibiza, previously only recorded in Minorca.

The first phase of this vital project has been a success on a number of levels and should pave the way for future plant conservation activities in this fragile region.

Project partners:

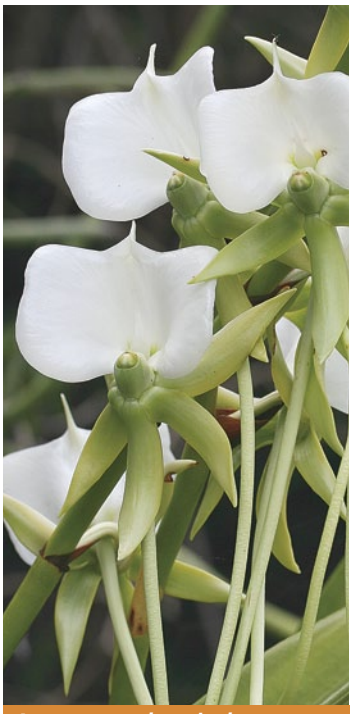
- Royal Botanic Gardens, Kew, UK
- Jardí Botànic de Sóller, Mallorca
- Mediterranean Agronomic Institute Chania, Crete
- Conservatoire Botanique National de la Corse, Corsica
- The Agricultural Research Institute , Nicosia, Cyprus
- Centro Conservazione Biodiversità, University of Cagliari, Sardinia
- Dipartimento di Scienze Biologiche, Geologiche e Ambientali, University of Catania, Sicily

For further information contact Sarah Hanson (s.hanson@kew.org)
Web: www.medislandplant.eu

The KMCC Orchid Conservation Project – working to conserve Madagascar's most endangered orchids

Landy Rajaovelona (KMCC Orchid Conservation Officer)

Landy Rajaovelona inspecting young plants in the Kew Conservation Biotechnology Unit
PHOTO: S.CABLE



***Angraecum longicalcar*, Critically Endangered**
PHOTO: S.CABLE

***Angraecum protensum*, Critically Endangered** PHOTO: S.CABLE

The Orchidaceae family in Madagascar is represented by over 1000 species (8% of the flora) and 90% of these are endemic. Since 2012, the Kew Madagascar Conservation Centre (KMCC) has worked with the Millennium Seed Bank (MSB) and the Kew Conservation Biotechnology Unit (CBU) to conserve the endangered orchids of Madagascar. The seed collections are duplicated at the MSB and the Silo National des Graines Forestières in Madagascar. Seeds are also provided to Kew's CBU for research on cryopreservation and propagation to facilitate the reintroduction of the most critically endangered species. Our current focus is on conservation of the seeds of epiphytic species (standard storage at -20 °C) and on conservation of the protocorms (embryonic seedlings) of terrestrial species through cryopreservation (at -196 °C) with their associated ectomycorrhizal fungi. We also aim to build conservation living collections of the most threatened species.

In 2012, a joint expedition with Kew's CBU made collections of seeds of the threatened species *Angraecum longicalcar*, *A. protensum* and *A. magdalenae* as well many other orchid species from the new Itremo Massif Protected Area in the Central Highlands, managed by Kew. In June 2013, we returned to develop an in-vitro methodology, collecting mature fruit capsules and root fragments of 19 species of orchids belonging to the genera Angraecum, Bulbophyllum, Cynorkis, Eulophia, Jumellea and Polystachya. In-vitro collecting allowed us to keep the fruit capsules intact in a nutrient gel with the seeds maturing inside. The root fragments allowed us to collect and isolate the ectomycorrhizal fungi and to test the feasibility of storing seeds and fungi together.

Propagation was greatly accelerated when seeds of *Angraecum protensum* and *A. coutrixii* were germinated with their associated fungi. Ten plants of the critically endangered *A. protensum* resulting from the experiments were reintroduced into the wild at the Itremo Massif to strengthen its population.

Three sites have been visited for the MSBP recently: the Itremo Massif, the humid forest corridor of Fandriana-Marolambo and Antanifotsy near Antananarivo. These trips have yielded seeds of 30 species belonging to the genera *Angraecum*, *Aerangis*, *Bulbophyllum*, *Cynorkis*, *Eulophia*, *Habenaria*, *Jumellea*, *Liparis*, *Microcoelia*, *Oeonia* and *Polystachya*. Identification of orchids is a difficult task when they are sterile, so we have planted living plants in the shade house at KMCC for subsequent identification when they flower.

Preliminary IUCN Red-List assessments of 700 out of the 1000 known orchid species have been carried out so far. These use the full IUCN criteria, but have not been submitted yet as we hope to refine them further with more field surveys of populations. The analysis was based on more than 6,000 herbarium records from the herbaria of the National Museum of Natural History in Paris, the Tsimbazaza Botanical and Zoological Park in Madagascar and the British Museum and Royal Botanic Gardens Kew in the UK. We found that 72% of Madagascar's orchids are threatened with extinction and only 22% are of least concern. The extinction categories are: Critically Endangered 26%, Endangered 37%, Vulnerable 9%, Near Threatened 6% and Least Concern 22%. Less than 1% were classified as Data Deficient, but many species have not been observed in the wild for many years or are only known from a few records and have very small distributions (often single patches of forest).

Targeting species for conservation is increasingly important as not all species are adequately covered by the protected area system. Orchids are a high profile plant group in Madagascar and it is the largest plant family. Many are threatened by illegal collecting and habitat loss from agriculture and charcoal production. We are developing a pipeline for conservation: systematic preliminary IUCN conservation assessments, prioritisation of species, full IUCN assessments of priority species, conservation action plans, seed banking, cryopreservation and rescue projects for critically endangered species.

For further information contact Stuart Cable (s.cable@kew.org)

Successful germination in rare or threatened species

By Alice Di Sacco (Germination Specialist, MSBP)
and Sharon Balding (Information Project Development Manager, MSBP)

Ensuring that collections stored at the MSB can be successfully germinated is an important step in the management of the collections. Rare and threatened species are the focus of particular attention regarding their germination requirements. If collections fail the initial germination tests, research is carried out into the taxonomy and ecology of the species and the habitat and climate of the area of collection. Using this information, germination treatments can then be more closely matched to the natural conditions. Literature searches are also carried out to check for successful germination protocols. In addition, seed dormancy mechanisms are considered and specific treatments are applied.

Here are a few examples of priority collections for which successful germination conditions have been found after a few failed attempts.

***Bulbostylis lichtensteiniana*, endemic to St Helena** PHOTO: T.HELLER

***Cistanthe amarantoides*, endemic to Chile** PHOTO: M.ROSAS, INIA

***Ochagavia litoralis*, endemic to Chile** PHOTO: M.ROSAS, INIA

Species	Family	Conservation Status	Distribution and Collection Location	Conditions	Germination; Viability (%)
Abies fraseri (Pursh) Poir.	PINACEAE	Endangered	Endemic to USA (North Carolina, Tennessee, Virginia); collected from North Carolina[3]	Cold stratification at 0°C; 56 days. Then 20°C; 56 days. Agar 1%	67; 67
Austrobryonia argillicola I.Telford	CUCURBITACEAE	Listed as Vulnerable in Northern Territory and Endangered in Queensland	Endemic to Northern Territory and Queensland, Australia; collected in Northern Territory[5]	Scarification (seed coat partially removed to expose radicle) with scalpel. Then 30/15°C (Thermo-photoperiod 8/16); 48 days. Agar 1%	90; 90
Bulbostylis lichtensteiniana (Kunth) C.B.Clarke	CYPERACEAE		Endemic to St. Helena[9]	20°C; 168 days. Agar 1% with Gibberellic Acid (GA3) solution 250mg/l	77; 85
Chironia jasminoides L.	GENTIANACEAE	Least Concern	Endemic to the Cape, South Africa; collected in Western Cape[4,6]	20/10°C (Thermo-photoperiod 8/16); 97 days. Agar 1%	88; 88
Cistanthe amarantoides (Phil.) Carolin ex Hershk.	PORTULACACEAE		Endemic to Chile; collected from Antofagasta[2]	Pierce seed coat in centre with a needle. Then 20°C; 56 days. Agar 1%	94; 96
Eucalyptus mitchelliana Cambage	MYRTACEAE	Rare	Endemic to Victoria, Australia[9]	Cold stratification at 0°C; 84 days. Then 15°C; 77 days. Agar 1%	62; 66
Ochagavia litoralis (Phil.) Zizka, Trumpler & Zöllner	BROMELIACEAE	Vulnerable[10]	Endemic to Chile; collected in Valparaiso[9]	15°C; 77 days. Agar 1%	90; 90
Phylica oleaefolia Vent.	RHAMNACEAE	Least Concern	Endemic to the Cape, South Africa; Collected from Northern Cape[4,6]	15°C; 63 days. Agar 1%	100; 100
Phylica rigidifolia Sond.	RHAMNACEAE	Least Concern	Endemic to the Cape, South Africa; collected in Western Cape[4,6]	15°C; 14 days. Then scarification (seed coat partially removed) with scalpel. Then 15°C; 49 days. Agar 1%	100; 100
Pinus cubensis Griseb.	PINACEAE	Least Concern	Endemic to Cuba; Collected in Guantanamo[3]	20°C; 35 days. Agar 1%	41; 59
Protea witzenbergiana E.Phillips	PROTEACEAE	Least Concern	Endemic to Western Cape, South Africa[6,7]	25/10°C (Thermo-photoperiod 8/16); 84 days. Agar 1%	67; 67
Solanum pyracanthos Lam.	SOLANACEAE		Endemic to South East Madagascar; collected from Tuléar Province[8]	30/15°C (Thermo-photoperiod 12/12); 63 days. Agar 1%	86; 100
Solanum remyanum Phil.	SOLANACEAE		Endemic to Chile; collected from Antofagasta[1]	30/15°C (Thermo-photoperiod 12/12); 70 days. Agar 1%	86; 86

Notes:

The germination result is calculated as the percentage of germinated seeds out of full seeds sown. The viability result is calculated as percentage of germinated plus fresh seeds at cut test, out of full seeds sown. Empty and insect infested seeds are excluded from the calculations.

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UK Overseas Territories: *ex situ* collections

By Thomas Heller (MSBP) **& Marcella Corcoran** (Kew UKOTs team)

***Nastanthus falklandicus* in the wild** PHOTO: T.HELLER

UKOTs conservationist Marcella Corcoran with *Vachellia anegadensis* PHOTO: T.HELLER

***Plantago moorei* in the Alpine nursery at Kew**
PHOTO: T.HELLER

Kew has a well-developed programme of research and conservation of plants from the UK Overseas Territories (UKOTs). Mostly islands, the 16 UKOTs are found at a wide range of latitudes, from within the Antarctic Circle to close to the equator. Consequently, they support a wide range of habitats, home to the majority of the UK's biodiversity. Being often very remote islands, the level of endemism is high, with over 180 endemic plant species in a land area (excluding the British Antarctic Territory) roughly the size of Wales. Their insular nature also means that the many threats to the biodiversity are all the more acute, with habitat loss, invasive alien species and climate change all taking their toll.

Kew has banked seeds from the UKOTs since before the Millennium Seed Bank Partnership began, most notably collections made in St Helena, home to some of the world's most threatened plant species. These include the St Helena boxwood (*Mellissia begoniifolia*), once thought extinct in the wild until a fragile population was discovered in the late 1990s.

During the first phase of the MSBP (2001–2010), banking of the UKOTs seeds was stepped up, and collecting continues today with the help of additional funds from the Darwin Initiative, for example, which is funding seed conservation in the Caribbean UKOTs. To date, over 500 taxa from the UKOTs have been banked, including almost 80 of their endemic species. Examples of endemics and threatened species banked include the Bermuda palmetto (*Sabal bermudana*, Endangered), Montserrat orchid (*Epidendrum montserratense*, Critically Endangered), false plantain from the Falklands (*Nastanthus falklandicus*, Endangered), Ascension spurge (*Euphorbia origanioides*, Critically Endangered), ironwood (*Chionanthus caymanensis*, Endangered), *Cotula moseleyi* (from Tristan da Cunha, Vulnerable) and wild shallot (*Encyclia caicensis*, Endangered).

Of course, seed conservation does not stop at the long-term banking of seed. Like many MSBP accessions, those from the UKOTs are helping to further research and conservation of these plants. A major component of Kew's work on plants of the UKOTs is the development of horticultural *ex situ* conservation collections both in-territory and at Kew. These collections fulfill a number of purposes: to secure threatened species in *ex situ* collections (in parallel with banked seed); as part of garden displays to raise awareness of the biodiversity of the UKOTs; and to develop horticultural protocols for growing threatened species.

Seedlings from MSB germination tests are routinely sent to Kew's nurseries for growing on and seeds are also used to develop horticulture protocols (best practice for the germination, growing-on and multiplying collections).

Vachellia anegadensis (formerly *Acacia*), is a species endemic to Anegada and Fallen Jerusalem in the British Virgin Islands (BVI). It is a very spiny small tree, known locally as 'poke-me-boy'. Critically Endangered according to IUCN Red List criteria, it faces threats from housing and hotel developments, invasive plants such as *Cryptostegia madagascariensis*, as well as incursion of its low-lying habitats under rising sea-level scenarios. Seeds were collected from Anegada and stored at the MSB in 2004, and used to develop a full horticultural protocol for this species. The results of these trials have subsequently been made available in a detailed report for the benefit of others working on this and related species. 'Low-tech' methods that can easily be reproduced in-country by partners are an important output of such work. Similarly, seed from the MSB has been used in horticultural trials for many other UKOT species such as *Rondeletia buxifolia* (Critically Endangered) and *Limonium bahamense* (Endangered).

Plants raised from germinated MSBP seeds are also valuable for systematic studies, providing material for morphological, genetic and cytogenetic analysis and comparison with close relatives, such as the Falklands threatened endemic *Plantago moorei* and *Varronia rupicola*,endemic to BVI and Puerto Rico.

Seeds banked at the MSB have also been repatriated to UKOTs for conservation work, including *Mellissia begoniifolia*, as well as a range of species native to the Falkland Islands, for propagation for local gardens and habitat restoration. Partners in the Caribbean UKOTs are now able to bank seeds locally thanks to funding from Darwin Plus, which has helped to establish small seed banking facilities in Montserrat, Cayman, Turks and Caicos Islands, Anguilla and British Virgin Islands.

For further information contact Thomas Heller (t.heller@kew.org) or Marcella Corcoran (m.corcoran@kew.org)

Threatened status of *Jatropha* species endemic to Mexico

By Cecilie Christensen (former MSc student at the University of Copenhagen, Denmark)

Herbarium specimen of *J. bullockii* from Kew PHOTO: RBG KEW

The genus *Jatropha* is distributed worldwide throughout the sub-tropical regions, and Mexico is believed to be the centre of origin. Of the 25% of species found in Mexico, 80% are endemics (Dehgan, 2012). The socio-economic potential of several neglected and underutilised species of *Jatropha* is well documented, including as sources of food, raw materials, medicine and ornamental value. For example, *J. platyphylla* is cultivated for medicinal purposes in Huitzontla, grown as an ornamental and the seeds are consumed by descendants of the Lacapaxa tribe in Sinaloa (Makkar et al., 2011), whereas *J. gaumeri* was used by the Mayans of Tixpeual and Tixcacaltuyub, Yucatán, in traditional medicine, handicraft, soap production and the extraction of toxins (Rico-Gray et al., 1991), and the root and latex also have medicinal properties (Ankli et al., 2002). The seeds of many species are also high in oil, with potential as a source of biofuel (see article on page 9 of *Samara* issue 25). But despite the economic importance of *Jatropha* species, little is known about their conservation status.

Working with Kew scientists at the Millennium Seed Bank (Hugh Pritchard, Charlotte Seal and Tiziana Ulian) and the Herbarium (Lulu Rico and Gill Challen), an assessment of the conservation of species in the genus *Jatropha* subgenus *Curcas* was made using herbarium specimens from the Natural History Museum Copenhagen (C), the Natural History Museum London

Preparing herbarium specimens during a field trip to Mexico PHOTO: C. CHRISTENSEN

(BM), the Royal Botanic Gardens, Kew (K), Herbario Nacional (MEXU) in the Instituto de Biología – Universidad Nacional Autónoma de México and Izta Herbarium (IZTA) in FES Iztacala – Universidad Nacional Autónoma de México and data from CONABIO (Mexico). We applied the IUCN Red List categories and criteria to 24 species (using a total of 994 herbarium specimens) of the genus *Jatropha* subgenus *Curcas* section *Curcas* and section *Platyphyllae* in Mexico and two species from the adjoining regions of Central America.

We found 11 species are Threatened; two Critically Endangered, five as Endangered and four as Vulnerable. Five species were assessed as Near Threatened, four as Least Concern and four as Data Deficient. The major threats are declining habitat quality due to changes of land use favouring livestock, plantations, expansion of infrastructure to accommodate human population growth, logging and tourism (Trejo and Dirzo, 2000). Eight of the eleven threatened species also have a narrow altitude range, indicating specialised growth habitats (Holdridge, 1947). All but two of the species evaluated as threatened are restricted to dry deciduous forest to which is threatened by a decline in area and quality (Trejo and Dirzo, 2000). With a growing emphasis on the unregulated exploitation of many species due to their medicinal properties and nutritional qualities (Devappa et al., 2010), it is important to establish systematic collections of *Jatropha* for the assessment of their threat status and to develop management strategies for their conservation to ensure that these neglected and underutilised species are available for the future.

Seeds of (from left to right) *J. oaxacana*, *J. curcas*, *J. rzedowskii*, *J. elbae*, *J. sympetala* and *J. pseudocurcas* collected in the Mexican states Oaxaca and Puebla PHOTO: C. CHRISTENSEN

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NEWS

The MGU-Useful Plants Project Workshop: reflecting on 6 years of livelihoods improvement

Workshop participants PHOTO: W.STUPPY

A vibrant mix of experts from ethnobotanists, taxonomists, plant physiologists and agricultural scientists met at the MGU-Useful Plants Project (UPP) workshop (22 to 24 July 2014), hosted at Kew. As the UPP's second phase draws to a close the workshop provided an opportunity to review the project activities and to formulate a plan for future initiatives. It also presented a range of Kew's global projects which support *ex situ* and *in situ* conservation through research on useful plants to improve community livelihoods.

During the first day of the workshop, representatives from the five partnership countries of the UPP delivered presentations about their project activities: Dr Khola Mogotsi, Botswana College of Agriculture; William Omondi, Kenyan Forestry Research Institute; Prof. Rokia Sanogo, Institut d'Economie Rurale, Mali; Dr Rafael Lira, Universidad Nacional Autónoma de México and Taki Mamatsharaga, SANBI – Lowveld National Botanic Garden, South Africa. Their presentations highlighted project successes but also included honest discussions of the obstacles they encountered working on livelihoods projects such as political barriers to working with communities. The day was completed with two presentations by Kew staff on the use of pesticidal plants in Africa (Prof. Phil Stevenson) and the challenges and opportunities of sustainable plant use (Prof. Monique Simmonds).

The second day of the workshop showcased other Kew livelihoods projects from around the world, adding to the variety of experience at the workshop. The presentations included: the Great Green Wall project in Africa (Dr Moctar Sacandé); restoring soil fertility in the Bolivian Amazon (Dr Alex Monro); forest and agricultural adaptation to global change in Peru (Oliver Whaley); bridging the knowledge gap between Indonesian weavers and botanists (Dr Rogier de Kok); Madagascan agroforestry for livelihoods (Stuart Cable) and seed science and neglected and underutilised species (Prof. Hugh Pritchard).

Three guest speakers gave additional insights into useful plants projects with Dr Milagre Nuvunga (Micaia, Mozambique) presenting on the Chimanimani TransFronteer Conservation Area, Dr Stefano Padulosi (Biodiversity International, Italy) on enhancing the use of neglected and underutilised species in Latin America and Asia and Dr Chikelu Mba (Food and Agriculture Organisation, Italy) on harnessing the potential of plant genetic resources for food and agriculture.

On the final day a lively discussion and exchange of ideas was generated during a 'strengths, weaknesses, opportunities, threats' (SWOT) analysis session as all the workshop participants evaluated project successes, challenges and future opportunities. The analysis results were presented to the group including the two external reviewers (Catherine Mackenzie a consultant in forestry, conservation and social development and Dr Paolo Ceci from the University Consortium for Socioeconomic and Environmental Research).

The workshop provided an invaluable opportunity for all participants to mix and to share experiences. The connections made should provide fruitful ideas and create further opportunities for collaborative work in the future.

PhD congratulations to Dr Angelino Carta

Angelino Carta from the University of Pisa recently completed a PhD in Biology entitled 'An integrated approach to the conservation of peripheral isolated plant populations'. Angelino was supervised by Gianni Bedini and Lorenzo Peruzzi, from the University of Pisa and Robin Probert from the MSBP.

Angelino writes about his research:

'Peripheral isolated plant populations (PIPPs) found at the margin of a species range may be exposed to ecological and evolutionary processes that differ from central populations. Peripheral populations may have either a high evolutionary potential or be prone to extinction and therefore, they are considered an important source of biodiversity and included in conservation actions.

This work addresses the identification of the main biological and ecological processes which allow PIPPs to survive. I collected and integrated data of all plant life stages, including seedling recruitment, adult survival and actual, past and potential distribution into an evolutionary framework. My research included a range of experimental approaches such as manipulation in the field to measure reproductive fitness, simulation of regeneration strategies by seeds in the laboratory and computation of potential habitat by GIS techniques. This combination of different approaches has significantly improved the knowledge of PIPPs, however, further studies are required to assess genetic drift and genetic divergence for narrow endemic species to understand adaptation processes.'

Crop wild relatives training course in Uganda

Course participants outside the Uganda National Genebank PHOTO: L. SALAZARA

In August the MSBP, Crop Diversity Trust and the Uganda National Agricultural Research Organisation (NARO) organised a five day training course in Kampala, Uganda for potential partners of the project, 'Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives' (CWR Project) which supports genebanks around the world in collecting and safeguarding priority crop wild relatives.

The course entitled 'Collecting, handling and long term conservation of seed of wild species related to crops' brought together 15 seed scientists and botanists from 8 African countries. Their respective institutions are all potential partners for CWR projects in Africa. During the course participants improved their skills in collecting, processing and storing *ex situ* seed collections of crop wild relatives. They also had time to share experiences and knowledge from their own genebanks in conserving wild and crop species. NARO provided an informative tour of the Uganda National Genebank at Entebbe Botanic Garden and their biotechnology laboratories. At the end of the course all participants agreed they had improved their knowledge in handling wild species seeds and said they would share their new knowledge on seed conservation with their colleagues.

Plant conservation agreement in the Pacific region

Kew and the General of the Secretariat of the Pacific Community (SPC) have signed a 10 year agreement to work together in supporting and implementing plant conservation activities in the Pacific region.

With members from 22 Pacific Island countries and territories and four original founding countries, SPC is an international organisation that supports sustainable development in the Pacific region according to its vision "to help Pacific Island people position themselves to respond effectively to the challenges they face and make informed decisions about their future and the future they leave for the generations that follow".

Within the framework of this agreement, Kew will begin a technical partnership with SPC's Pacific Island Tree Seed Centre (PITSC) to conduct seed conservation activities in Fiji. This centre was created in 2012 to act as a regional focal point for coordination and implementation of priority germplasm collection, storage, distribution, research and training. In Fiji, SPC works closely with the Forestry Department, the Department of Environment and the University of the South Pacific. Fiji is part of the Polynesia-Micronesia biodiversity hotspot, one of 34 global biodiversity hotspots (Conservation International) with an exceptional level of plant endemism and serious level of habitat loss. Tropical dry forests in Fiji are among the most threatened ecosystems in the world (Keppel & Tuiwawa, 2007).

***Santalum yasi* a native species from Fiji. Trees from the *Santalum* genus are often harvested for their heartwood, from which highly-priced sandalwood oil is extracted** PHOTO: PITSC

This new partnership is part of the Pacific Programme of the MSBP, which aims to contribute to the MSBP's target of storing 25% of the global flora (i.e. 75,000 species), Target 8 of the Global Strategy for Plant Conservation 2010-2020 (75% of threatened species in ex situ collections) and to support plant conservation in the Pacific region.

References:

Conservation International - www.conservation.org/hotspots

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For further information contact Peter Giovannini (p.giovannini@kew.org)

MSBP Global Tree Seed Bank Project

***Eligmocarpus cynometroides*, a Critically Endangered legume from Madagascar, with only 21 individuals left in the wild. Targeted for seed conservation** PHOTO: S.CABLE

There are an estimated 80,000 species of tree in the world, all have potential uses for humans and could provide options for innovation and adaptation in the future. However, only around 450 species are used today in commercial forestry and are stored in forestry seed banks leaving the remaining 79,550 species with uncertain representation in *ex situ* conservation. Over 8,000 tree species are currently assessed as threatened with extinction and over 1,100 species are listed on IUCN red lists as Critically Endangered – they are likely to become extinct unless urgent action is taken now.

The MSBP has already collected seeds from 3,900 tree species during the last 14 years but we plan to accelerate this in the next four years to collect a further 3000 species. Thanks to £5 million of generous funding from the Garfield Weston Foundation we are launching the new 'Global Tree Seed Bank Project'. We will work with existing and new MSB partners across the world to target seed collection of the rarest, most threatened and useful trees.

Alongside seed collecting, a research programme will be undertaken to improve our knowledge of tree species leading to improved conservation. Propagation protocols will be established for key species and used for forest restoration projects. A DNA fingerprint library of important timber species will be assembled to enable us to pinpoint the geographical origin of timber exports. Storage protocols for recalcitrant tree species like oak (*Quercus*) and chestnut (*Aesculus*) will be developed. Genetic studies on rare trees will be carried out to help design species recovery programmes in island habitats. Methodologies will be established to study tree species traits and their resilience to environmental threats, leading to better prioritisation of species for seed banking.

The funding will also allow the MSBP to support the Global Trees Campaign (GTC), a joint initiative launched in 1999 between Botanic Gardens Conservation International (BGCI) and Fauna and Flora International (FFI). The GTC has supported tree conservation in 25 countries, drawing on BGCI's global network of botanic gardens and FFI's network of *in situ* forest conservation projects.

The Global Tree Seed Bank project will run for the next four years involving many MSB partners.

Key science publications
(May – September 2014)

De Vitis, M., Seal, C. E., Ulian, T., Pritchard, H. W., Magrini, S., Fabrini, G. & Mattana, E. (2014) Rapid adaptation of seed germination requirements of the threatened Mediterranean species Malcolmia littorea (Brassicaceae) and implications for its reintroduction. *South African Journal of Botany* 94 (September): 46-50.

Eldarov, M., Aminov, N. & Van Slageren, M. W. (2014) Distribution and ecological diversity of *Aegilops* L. in the Greater and Lesser Caucasus regions of Azerbaijan. *Genetic Resources and Crop Evolution*. DOI: 10.1007/s10722-014-0151-0

Griffiths, K. E., Balding, S. T., Dickie, J., Lewis, G. P., Pearce, T. R. & Grenyer, R. (2014) Maximizing the phylogenetic diversity of seed banks. *Conservation Biology*. DOI: 10.1111/cobi.12390

Marks, T. R., Seaton, P. T. & Pritchard, H. W. (2014) Desiccation tolerance, longevity and seed-siring ability of entomophilous pollen from UK native orchid species. *Annals of Botany* 114 (3): 561-569.

Pritchard, H. W., Moat, J., Ferraz, J. B. S., Marks, T. R., Camargo, J. L. C., Nadarajan, J. & Ferraz, I. (2014) Innovative approaches to the preservation of forest trees. *Forest Ecology and Management*. DOI: 10.1016/j.foreco.2014.08.012

Millennium Seed Bank Collection Figures November 2014

Total collections	72,188
Number of species	35,039
Number of genera	5,581
Number of families	332

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Contact the editors **Kay Pennick, Thomas Heller & Emma Williams**
Royal Botanic Gardens, Kew
Wakehurst Place, Ardingly, West Sussex, RH17 6TN, UK
Tel: +44 1444 894178 Fax: +44 1444 894110
Email: samara@kew.org

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