



January - June 2017 kew.org/msbp/samara ISSN 1475-8245

Issue: 31

Evaluating extinction risk of the Hawaiian flora using the IUCN Red List

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Samara

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The Hawaiian Islands are home to 1,191 native vascular plant species (Wood et al., 2016), most of which are found nowhere else on Earth.

A staggering number of these are exceptionally rare. Over 230 taxa have fewer than 50 individuals remaining in the wild and over 100 taxa are thought to be extinct. For these reasons, botanists in Hawai'i are applying the International Union for Conservation of Nature (IUCN) Red List criteria to assess the extinction risk of the flora, starting with the species of highest conservation concern.

This effort will garner international attention for Hawai'i's unique flora and invite more support for the conservation efforts taking place in the Islands today, including habitat protection and securing *ex situ* collections of seeds at facilities in the Hawai'i Seed Bank Partnership (HSBP). The HSBP was established in 2013, by staff from the Lyon Arboretum Hawaiian Rare Plant Program, the National Tropical Botanical Garden (NTBG), O'ahu Army Natural Resources Program, and the Hawai'i Island Seed Bank to standardize protocols, share research results, identify knowledge gaps, and improve access to seed banking services in Hawai'i. Since then, the HSBP has grown to include botanists from several other entities. The Millennium Seed Bank of the Royal Botanical Gardens, Kew has been a technical associate since 2014, and a formal partnership is currently under development.

Gouania meyenii Steud. and *Phyllostegia electra* C.N.Forbes are examples of species that have been added to the Red List during these recent efforts and are targets for *ex situ* storage by the HSBP. Both species are threatened by non-native plant taxa, feral pigs





and goats, rats, introduced slugs and snails, and stochastic events such as landslides, fire, and drought. Further research is needed on general ecology, life history, population size, distribution, and population genetics of these endemic species.

The rugged cliffs of Oʻahu's Wai'anae Mountains are inhabited by *Gouania meyenii*, a rare species of the Rhamnaceae family. It was known from the islands of Kaua'i and Oʻahu, but is now extirpated from Kaua'i. Categorised as Critically Endangered on the IUCN Red List (Keir et al., 2016), there are a total of 15 wild individuals in two subpopulations remaining on Oʻahu, most of which can only be accessed by rappelling down the cliffs.

The species produces septicidal schizocarps that are typically collected using mesh bags that are left on the wild plants while the seeds mature. A noteworthy threat in recent years is an unknown insect predator that damages seeds. The problem has become so severe that only three healthy seeds were secured from a wild plant in 2015. The Plant Extinction Prevention Program (PEPP) and Hawai'i's Division of Forestry and Wildlife have been exploring other methods to protect the seeds during maturation. Research on optimal seed storage conditions for G. meyenii are still being developed by the HSBP, but seeds have remained viable after desiccation and refrigeration. Fifteen accessions totaling around 400 seeds of G. meyenii are currently stored at NTBG on Kaua'i and the Lyon Arboretum on O'ahu.

The wild plants are currently not protected in a fenced area, but there has been some success with a small outplanting of six plants into a fenced area that was completed in 2014 by PEPP. These individuals are thriving and have been producing healthy seed without predation and six more individuals were outplanted in 2017.

In Hawai'i, the mint family (Lamiaceae) has the second highest number of species extinctions outside of Campanulaceae and many subpopulations are declining at a rapid rate. *Phyllostegia electra*, is a beautiful mint species endemic to mesic and wet forests on the island of Kaua'i. It has



Phyllostegia electra



small, white flowers and fruits that are dark greenish-black and shiny when ripe. *Phyllostegia* has the fourth largest number of endemic species of any Hawaiian flowering plant genus (Ziegler, 2002). From just a single colonist, the genus radiated into 35 endemic taxa (Wagner et al., 2005).

With less than 50 individuals remaining in 15 subpopulations, *P. electra* is ranked as Critically Endangered on the IUCN Red List (Clark, 2016) and is one of NTBG's focal species for reaching objectives outlined in the Hawai'i Strategy for Plant Conservation (HSPC) - modeled after the Global Strategy for Plant Conservation. The HSPC is administered by Laukahi: The Hawai'i Plant Conservation Network.

Optimal seed storage conditions for this species are unknown and, in general, storage potential for *Phyllostegia* is poorly understood. There is limited data available for five other *Phyllostegia* taxa, which were found to be desiccation tolerant. Seed banks in Hawai'i are researching existing seed banking methods, including cryopreservation that would be optimal for Hawaiian *Phyllostegia*. Cryopreservation could be a promising method to increase longevity, but is not currently available in Hawai'i.

Like many other island floras, Hawai'i's native plants are highly imperiled. The conservation methods being developed to rescue these species can be used in other regions with similar threats. Until recently, Hawaiian plants have been underrepresented on the IUCN Red List. The assessments will help to support their conservation and raise global awareness of the need for plant conservation in Hawai'i. A partnership with the Kew MSBP will provide more expertise in completing the research needed to determine optimal seed storage methods and more support for ongoing conservation efforts.

ACKNOWLEDGEMENTS

Susan Ching Harbin, Marian Chau, Tim Kroessig, Nellie Sugii and Dustin Wolkis.

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Message from Colin Clubbe

Head of Department, Conservation Science, RBG Kew

Plants across the globe are under threat from habitat loss and fragmentation, invasive species, pollution, unsustainable use and the increasing impacts of global climate change. Data published in the 2016 State of the World's Plants Report estimated that one in five plants are threatened with extinction. During this United Nations Decade on Biodiversity (2011-2020) it's never been more important that we actively work to conserve plants. The global botanical community is responding positively and this issue of Samara highlights the many ways that our Millennium Seed Bank Partners are addressing this serious issue which has the potential to affect all humankind given the very many ways we rely on plants.

Accurate and robust data are vital for planning conservation actions. The IUCN Red List of Threatened Species is the global standard for identifying those species at greatest risk of extinction and threatened species are identified as Critically Endangered, Endangered or Vulnerable. The production of the Red List is made possible by the active participation of the 11 Red List Partners and their respective networks. Kew has been a Red List Partner since 2010 and we signed the new Red List Partnership Agreement at the World Conservation Congress in Hawai'i in September 2016. This Agreement, which runs for 10 years, will help to guide red list activity globally and by providing



robust data will help direct conservation action where it is needed most and ultimately improve the long term outlook for plants and the goods and services they provide for humanity. The Millennium Seed Bank Partnership has a significant and continuing role to play in this.

A message from Jonas Mueller

Senior Research Leader, Seed Conservation, RBG Kew



Last month, I read an article (Ceballos et al., 2015) that showed that we are currently in the sixth mass extinction (the fifth one, 65 million years ago, wiping out 50% of all plants and animals including the dinosaurs, marked the end of the Cretaceous and the beginning of the Tertiary geological period). Over the last 114 years, the cautiously estimated extinction rate has been, depending on the taxonomic group, between 8 and 100 times higher than the background rate. Whilst interesting to read, I felt this article had one major weakness – plant species are mentioned nowhere. And there is a simple reason for it – the global dataset of up-to-date conservation assessments for plant species is too weak in order to include plants in those calculations. Globally, only 22,200 plant species have been assessed (about half of which are threatened), compared to complete assessments of, for example, all known amphibians.

The good news is, as Colin Clubbe points out above, a lot is currently happening to address these knowledge gaps. The conservation status of more and more plant species is being assessed, and more and more regional and national red list assessments are published. This is a truly global effort. Conservation assessments are a great example to illustrate how research and applied conservation actions interact; they are integral parts in many of the seed conservation projects, managed by you, the partners in the Millennium Seed Bank Partnership. Indeed for many years, 'Endangered' species have been one of our seed collecting priorities. Let's find inspiration in the examples presented in this issue of Samara. Let's continue and expand our efforts, and be proud of what we do!

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The East African Plant Red List Authority

HENK BEENTJE (Botanist -Flora Zambesiaca-, RBG Kew) and QUENTIN LUKE (Honorary. Kew Associate, National Museums of Kenya)

The East African Plant Red List Authority (EAPRLA) started in 2005, when a group of Kenyan, Tanzanian, English and American botanists met in Dar es Salaam to assess species restricted to the coastal forests and Eastern Arc Mountains of Kenya and

Tanzania. The mixture of field botanists and taxonomists worked well, with colleagues from Missouri Botanical Garden providing the geo-referenced specimen data as well as the maps and Occurrence/ Occupancy data gathered from specimens. By the end of the first

workshop we had assessed 178 taxa.

Gradually the project broadened in scope

and expertise; as we started to assess

species from the broader East African

region, we were joined by colleagues from

Uganda, Rwanda, Burundi, Ethiopia, South

Sudan (briefly) and Congo. We have now

held thirteen workshops (in places like

Arusha, Nairobi, Kampala and Huye) and

have a core group of 15 members. Univer-

sity students can also attend to get an

As a result we have completed 2448 assessments – of which 688 are Endangered, and 126 are Critically Endangered!

overview on how the Red listing process works. We have successfully trained dozens of people from seven East African countries in assessing; we have also built a strong network and developed friendships. As a result we have completed

2448 assessments – of which 688 are Endangered, and 126 are Critically Endangered! We use the category LC (CD) for those plants that fall under least concern (LC) but are conservation dependent (CD). This is not an official category, but we believe an important one; we

hope to see it officially recognised. This category (with 219 assessments so far) covers species such as *Impatiens nyungwensis*, only found in Nyungwe Forest in Rwanda, a well-protected National Park. Any change in the status of such a protected area would immediately change the assessment from LC to something much worse.

While all our data have been made available to IUCN, only a small percentage of our assessments have been published on the official Red List. This means many of our assessments are not available to be used in practical conservation; there is a strong link between development projects and the Red List. For large projects, particularly those on infrastructure that need public money to go forward, species and habitats can be conserved/protected by using International Finance Corporation Performance Standard 6 and the Equator Principles to highlight Species of Conservation Concern (SCC) and Critical Habitat. Thus either offsets or avoidance can be sought at the planning stage.

Funding has been a problem – the first three workshops were funded by the Critical Ecosystem Partnership Fund, and the last three by the MacArthur Foundation. Our Chair was supported for several years by the Fairchild Tropical Botanic Garden in Miami. To date we have received no permanent funding but the Mohamed bin Zayed Species Conservation Fund has been a stalwart supporter.

Our future plans? Keep on assessing, and, if we can get the funds, do some fieldwork. Some of the data we work with are old, and need field-checking; this goes for our 66 data deficient species, but for many other taxa as well.



Next steps for Plant Extinction Risk assessments on the IUCN Red List

DR SERENE HARGREAVES (Plant Assessment Unit Coordinator, RBG Kew)

lant species are significantly under-represented on the IUCN Red List of Threatened Species (www.iucnredlist.org) which includes extinction risk assessments for only 6 per cent of known plant species. The IUCN's plant assessment targets for 2020 focus on a number of priority groups including economically valuable plants, ebonies, carnivorous plants and aloes. Selected endemic plants from many geographic regions have also been targeted, with New Caledonia and Mozambique having the ambitious target of completing extinction risk assessments for all their endemic plant species (see 😑 All endemic plants image).

With funding from Toyota and in partnership with IUCN, RBG Kew is playing a key part in the drive to increase the number of plant assessments published on the Red List by establishing a new Plant Assessment Unit. This unit is working with Kew's scientists to streamline the process of assessing species and to create a step change in the number of Red List assessments produced by Kew. In the first years of this project we will be focussing particularly on the island of New Guinea, and the genera *Myrcia* s.l., *Cola* and *Coffea*.

Technological developments also play a role in streamlining the publication of Red List assessments. RBG Kew has worked with IUCN to support the development of a tool to rapidly import multiple assessments via spreadsheets. 'SIS Connect' is now operational and assessments are already being transferred to the Red List via this route: (http://connect.iucnredlist.org).

A second development has seen the Biodiversity Data Journal (BDJ) and IUCN members working together to

nificantly the IUCN I Species ncludes only 6 The ts f of Selected plants All endemic plants

Priority areas for IUCN Red List plant assessment activity.

create Species Conservation Profiles. These act as a template that allows for the easy transfer of information between the IUCN system and the journal, concurrently generating both a published Red List assessment and an open access citable journal article.

The Green List is based on the understanding that conservation should not just focus on preventing extinction, but also on driving species recovery programmes to stabilise and protect the world's wildlife.

To complement the Red List of Threatened Species, IUCN is in the process of formulating guidelines for the

adoption of a new "Green List". While the Red List can track a species' risk of extinction over time, this may only be a small step in the conservation action required for a given species. The Green List is based on the understanding that conservation should not just focus on preventing extinction, but also on driving species recovery programmes to stabilise and protect the world's wildlife. Rather than documenting the losses that have already occurred, the Green List will seek to highlight conservation success stories, hoping to incentivise action towards recovery and preventing future declines. In the past the messages from the conservation community have often been negative, but with the new Green List it is hoped that these success stories can shed a positive light on conservation progress, highlighting the vital work being done by environmental organisations worldwide, including the Millennium Seed Bank Partnership.

Red Lists and conservation actions: the CJB example in Geneva

CATHERINE LAMBELET-HAUETER (Curator, Conservatoire et Jardin botaniques de la Ville de Genève)

The Conservatoire et Jardin Botaniques (CJB) is based in Geneva, Switzerland, comprising a herbarium housing approximately 6,000,000 specimens, making it one of the largest in the world, a botanic garden, and an extensive botanical library of global significance. What is perhaps less well known is that since 2000 the institution has developed many nature conservation projects. The CJB signed the International Agenda for Botanic Gardens in Conservation in 2007 and since then staff at the gardens have been working on projects that focus on the objectives of the Global Strategy for Plant Conservation.

Land use change in particular is a challenge for plant conservation in Switzerland. The surface of the territory impacted by human pressure is constantly increasing: for example, during the period 1985-2009, housing and infrastructure areas have experienced the largest increase in size, with a gain of 584 km², a relative increase of a quarter, mainly at low altitude.

Due to the concentration of economic activities in lowland areas, the flora of the Central Plateau is more acutely threatened than the mountain flora. However, urbanization and sporting activities are also on the increase in Alpine areas popular with tourists, and as a consequence pressure on mountain flora is also increasing. In Geneva, however, the



The only population of *Inula helvetica* in Geneva is the subject of special management and reinforcements.

main threat is the pace of urbanization. In order to undertake targeted plant conservation actions and to provide Switzerland's threatened flora with legal protection, a series of 'red lists' were produced which also served to consolidate data from multiple sources. The first Red List of the vascular flora of Switzerland was published in 1991 and then updated in 2002 and 2016. The Swiss Red List for Lichens dates from 2002 and for Bryophytes from 2004. In collaboration with the Nature Conservancy Agency in Geneva, the CJB produced a Red List of the vascular flora in 2006, for bryophytes in 2014, and for lichens in 2015.

The Red List of vascular plants for Switzerland shows that 30 per cent of the flora is either endangered or is regionally extinct. The Red List of Geneva's vascular flora highlights that 327 species (25 per cent) are endangered and 158 (13 per cent) have presumably become extinct since the end of the 19th century. Given the local climate and the fact that the vast majority of species produce bankable seeds, developing ex situ conservation techniques seemed to be an appropriate response. With the help of the rockeries section of the botanic garden, it was possible to create a seed bank and to maintain an ex situ living collection as a way of conserving Switzerland's endangered indigenous flora.

A key goal of CJB is to maintain regional genetic variability of plants by collecting samples of many endangered populations. At the same time, collected seed has been used for species reintroductions or population reinforcements, mainly in Geneva, as well as for several research projects. The seed bank is proving to be a vital tool in the task of safeguarding seeds of threatened plant populations that are being closely monitored and whose future remains uncertain.

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CJB - Conservation activities incl. Red List of Geneva http://www.ville-ge.ch/cjb/conservation presentation.php

Red Listing the Trees and Aloes of the Arabian Peninsula and the Socotra Archipelago

DR SHAHINA A. GHAZANFAR (Honorary Research Associate, RBG Kew) & DR ALAN FORREST (Conservation & Biodiversity Research, Centre for Middle Eastern Plants, Royal Botanic Garden Edinburgh)

ince 2000, the Environment and Protected Areas Authority (EPAA) based in the United Arab Emirates has hosted the annual Sharjah International Conservation Forum for Arabian Biodiversity (#SICFAB), thanks to the generosity of His Highness Sheikh Dr Sultan bin Mohamed al Qasimi, Supreme Council Member and Ruler of Sharjah. For many years these workshops mostly focused on the conservation of Arabian fauna, however, at the 18th Forum in February 2017, Arabian flora took centre-stage for the first time. The forum has a number of different themes, one of which focuses on taxonomy. Discussions between the organisers and the Centre for Middle Eastern Plants (CMEP) (part of the Royal Botanic Garden Edinburgh), resulted in conservation assessments of all Arabian trees and aloes being the main activity within this taxonomy themed event.

A mix of Arabian, regional and international experts on Arabian plant conservation gathered in Shariah. includina representatives from CMEP, RBG Kew and the IUCN Red List Unit. A total of 308 taxa were considered for assessment. Aloes form part of a global Aloe assessment, which is already underway, coordinated by Craig Hilton-Taylor, Head of the Red List Unit, IUCN, part of the Cambridge Conservation Initiative. The assessment of Arabian aloes forms a major component to this global assessment, as all but one species present is endemic to the region. As one of the Arabian Peninsula's rarest groups and most threatened habitats, trees also form a significant and conspicuous component of the assessment, including the valley forests of the Southwestern Arabian escarpment in Saudi Arabia and Yemen. Their assessment is long overdue, and several are regionally threatened, some critically so, despite being relatively widespread in Africa. The endemic

trees of the Socotra Archipelago have also been re-assessed, with many being classified as globally threatened. As a result of this important activity, 19 per cent of the trees and 42 per cent of the aloes were assessed as threatened.

Networking was an important aspect of the forum, with plant taxonomists mingling with those involved in managing protected areas, and allowing plenty of time for the exchange of ideas. The scarcity of plant species distribution data was also highlighted, and in an attempt to enhance existing resources, an identification app for Arabian Trees (downloadable from: http://padme.rbge.org.uk/arabia/trees) was also launched during the event. Tentative plans for workshops bringing together animal, plant and habitat management experts bodes well for the future of biodiversity conservation and sustainable use across the Arabian Peninsula.



Participants present for the Red Listing workshop.

The Ex Situ Seed Conservation of Threatened *Aloe gerstneri*

LIVHUWANI AULDREAN NKUNA (Millennium Seed Bank Partnership Manager, South Africa)

Background

Monitoring and assessment of plant species provides evidence on species that continue to decline to very low population levels in the wild, which helps the development of conservation strategies. The Millennium Seed Bank Partnership (MSBP) and South African National Botanical Gardens, managed by the South African National Biodiversity Institute (SANBI), prioritise threatened species for ex situ conservation. In this way, SANBI significantly contributes to the achievement of South Africa's National Strategy for Plant Conservation (NSPC), which directly contributes to the Global Strategy for plant Conservation (GSPC).

Distribution and habitat of Aloe gerstneri

Aloe gerstneri occurs in Babanango district in the KwaZulu-Natal Province. It is known from only seven localities. The known range of this species is severely degraded by extreme overgrazing and subsistence farming.

According to National Land Cover (NLC) data of 1996, 65 per cent of the species' distribution has undergone extreme degradation, but this is quite possibly an underestimation.



A. gerstneri habitat

Taxonomy of A. gerstneri

Botanically, *A. gerstneri* is a succulent monocot endemic to South Africa in the Asphodelaceae family. It grows as a single rounded rosette with stems that are very short or absent. The leaves are long and relatively broad, wide at the base with upper and lower surfaces of matured plants without thorns. Young plants have a single inflorescence, but mature individuals may have two or three. The flowers are broadly tubular, long and bright orange.

Red Listing of A. gerstneri

South Africa has become the first megadiverse country to fully assess the status of its entire flora. The Threatened Species Programme (TSP), managed by SANBI, is responsible for species assessment in South Africa. The Red List of South African Plants Online provides up to date information on the national conservation status of plants Africa's indigenous South (http://redlist.sanbi.org). In order to improve species data for red listing, the TSP collaborates with plant specialist groups, including Custodians of Rare and Endangered Wildflowers (CREW), SANBI botanists, the MSBP, Provincial plant Specialist Groups (PSG), and botanists from various universities. The TSP uses the IUCN Red List categories and criteria to assess the extinction risk of a species. Currently, 2,800 South African plant species are listed as threatened, representing 13.7 per cent of the flora.



A. gerstneri among rocky outcrops.

Due to the increase of the human population within the area, more villages are encroaching towards populations of *A. gerstneri*. In 2004, Erich van Wyk, Gideon Smith and Janine Victor assessed the conservation status of *A. gerstneri* as Vulnerable B1ab (i,ii,iii,iv). The species qualifies as threatened under criteria B because the data meets the criteria (i.e. small geographic range and decline, fluctuation or fragmentation) where the available data of *A. gerstneri* showed an extent of occurrence less than 111 km², the species was found in less than 10 locations and demonstrated continuing decline in all of the following:

- Extent of occurrence
- Area of occupancy
- Area, extent, and/or quality of habitat
- Number of mature individuals

Although this species seems to withstand heavy grazing and historical population distributions still persist, overgrazing within the species localities are causing soil erosion in large areas. This is especially marked along the R68 road between Nqutu and Babanango, leading to the loss of individuals and whole populations (C.R. Scott-Shaw pers. comm.). According to Van Wyk and Smith (1996), there is an ongoing decline in the number of plants.

Seed collecting of A. gerstneri

In January 2005, the MSBP South African team composed of myself and a colleague, Steven Nevhutalu, went into the field with the aim of finding *A. gerstneri* populations and collecting seeds. The team went during the flowering period in order to accurately verify the targeted species. A population of over 100 individual plants was found at early stages of flowering along the road R68 between Babanango and Nqutu. We collected data, photos and herbarium specimens to confirm the identification of the species.

Many plants were found growing next to the main road, which made the plants vulnerable to illegal collections and being destroyed during road maintenance and expansion. There was also evidence of poorly managed grazing of goats and cattle.

The MSBP South African team returned to the same population in April 2005 to make a seed collection. To ensure a good seed collection, we targeted individuals with dry, already open capsules, as this meant that the seed is at the point of dispersal. Cotton bags were used and seeds were sent to the MSB for banking. A portion of the seed collection was donated to the Lowveld National Botanical Garden (NBG), one of SANBI's 10 NBGs, for their living plant collection. To date, over 200 individual plants of *A. gerstneri* are growing in the Lowveld NBG. Data collected by the field team is valuable in order to update the status of *A. gerstneri* in the future.

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Flowers and leaves of A. gerstneri.



The highly degraded land where A. gerstneri occurs in Babanango district.



Steven Nevhutalu standing next to *A. gerstneri* near the road from Nqutu-Babanango in KwaZulu-Natal Province.

GeoCAT: Geospatial Conservation Assessment Tool

GeoCAT

a tool has been

developed that uses

knowledge of plant

specimen

locations.

EVA MARTENS (MSBP Administrator), STEVEN BACHMAN (Research Leader - Species Conservation), JUSTIN MOAT (Research Leader - Spatial Analysis), TIM WILKINSON (Spatial Analyst); RBG Kew

he IUCN Red List has been a global standard to assess extinction risk of species for decades. Plants are

an underrepresented group of the published IUCN Red Listed species – only 5 per cent of known plants have been assessed on the latest version of the Red List. A recent estimate of the number of threatened

plant species puts the figure at 21 per cent (Brummitt et al., 2015).

In an effort to increase the number of assessments of plants, a tool has been

developed that uses knowledge of plant specimen locations. The Geospatial Conservation Assessment Tool (GeoCAT),

first released in 2014, is an evidence-based tool using primary biodiversity data for an indication of the geographic range of a species. Following data entry, GeoCAT automatically estimates both Extent of Occurrence and Area of Occupancy for the

species and produces a report of how these score against IUCN criteria. The tool does not provide a full Red List assessment but the data necessary to fulfil certain Red List categories. GeoCAT is feely available over the internet (geocat.kew.org). To date GeoCAT has been used for more than 2,000 species conservation assessments. Ongoing development of GeoCAT aims to provide further automation to the Red List assessment process, facilitating more assessments. A new version is expected to be released in 2017.

ACKNOWLEDGEMENTS

EU BON / UNEP WCMC; NERC; VIBRANT - EU FP7

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Looking after our own

DR TESFAYE AWAS (National Coordinator, Ethiopian Biodiversity Institute), PROF SEBSEBE DEMISSEW (Professor of Biodiversity and Systematics, Addis Ababa University) and TIM PEARCE (MSBP Africa Coordinator, RBG Kew)

The Ethiopian Biodiversity Institute (EBI) and the Botany Department and National Herbarium of Addis Ababa University (AAU) recognise their responsibility in securing the Ethiopian endemic flora as accessible and useable seed collections. Together with RBG Kew, this year we have launched a three-year project entitled "Conserving the Endemic Flora of Ethiopia".

Ten per cent of Ethiopia's c.6000 native plant species are thought to be endemic to the country. This project will target at least 250 of these species with a focus

on threatened woody and tree species. The "Red List of Endemic Trees and Shrubs of Ethiopia and Eritrea" (Vivero, JL., et al. 2005) lists 117 threatened endemic woody species in Ethiopia; none of these species are currently conserved as *ex situ* seed collections at EBI. The collecting programme will rely on the collections and expertise of the National Herbarium of Ethiopia. A series of updated Red Listing Assessments will be completed based on new data gathered during the seed collection missions.

Material will be stored in the EBI Forest Genetic Resources Seed Bank and duplicated

Ten per cent of Ethiopia's c.6000 native plant species are thought to be endemic to the country. to a recently constructed EBI-managed seed storage facility within the Fiche Biodiversity Gene Bank some 100km from Addis Ababa. Data associated with the collections

will be made available to the MSBP Data Warehouse and contribute to the MSBP global seed conservation target of "Securing 25 per cent of the world's bankable flora in participating seed banks of the MSBP by 2020".

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Ethiopia's endemic giant Lobelia, L. rhyncopetala growing with another endemic species, Euryops pinifolius in the Choke Mountains.

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Seed conservation and Red Listing in the UK Overseas Territories

THOMAS HELLER and SARA BARRIOS (Islands Conservation Partnership Co-ordinators, RBG Kew)



Agave missionum, Vulnerable Puerto Rican Bank endemic, killed by an infestation of agave snout weevil.

The 16 UKOTs are, for their size, very rich in endemic taxa, with at least 180 plant taxa found nowhere else. In common with islands globally, habitat loss, invasive alien species, and climate change are increasing the threat of extinction for these plants. Indeed, 11 species from the UKOTs are listed by IUCN as Extinct, Extinct in the Wild, or Probably Extinct, with four of these having been lost in the last 70 years. Many more – 50 Critically Endangered plant taxa – are known to be close to following them.

The number of UKOTs species that have had their extinction risk assessed is relatively high, with 21 per cent of the total flora of c. 1600 species having published



Endangered tree *Maytenus cymosa*, endemic to the Puerto Rican Bank, and a high priority for seed conservation.

assessments on the IUCN Red List of Threatened Species, compared to about 6 per cent globally. Additionally, the Falkland Islands and Cayman Islands have published National Red Lists (Broughton and McAdam, 2002; Burton, 2008). Such assessments are a valuable tool in prioritising collecting activities in the UKOTs, with 64 of 95 taxa assessed as globally threatened having now been banked as part of the MSBP to date.

However, important gaps in our knowledge of the status of plants in the UKOTs remain. Many of the current activities of the UKOTs team at Kew are focussed on plant conservation in the British Virgin Islands, which form part of the Puerto Rican Bank floristic province. They are one of the most diverse of the UKOTs, with an estimated 650 native plant species, only about 11 per cent of which have been assessed using IUCN Red List categories and criteria. However, several of the unassessed species are endemic to the Puerto Rican Bank, and are therefore strong candidates for detailed assessments. Suitable habitat for these species across the archipelago has been targeted for field surveys by teams from Kew and the National Parks Trust of the Virgin Islands. Data for all occurrences of these species have been gathered, in tandem with targeting species for seed banking.

Through this work, we are building a much clearer picture of how these species are faring in the wild, with significant discoveries of previously unknown populations, along with recognition of important threats, with introduced insect pests a serious and growing one. For example, *Agave missionum*, a Vulnerable species endemic to the Puerto Rican Bank, has in recent years been infested by the agave snout weevil (*Scyphophorus acupunctatus*). Recent fieldwork has revealed how seriously BVI populations have been impacted, and the species is being targeted for seed conservation.

Further to undertaking species conservation assessments, we are able to use the resulting data to identify areas of BVI particularly rich in threatened species and habitats, as part of a project to identify Tropical Important Plant Areas, an additional tool in prioritising *in situ* and *ex situ* conservation efforts.

Our current activities in the British Virgin Islands are supported by the Garfield Weston Foundation, Darwin Plus and HSBC.

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Conserving San Diego's Endemic Geophytes

JOE DAVITT (Research Assistant/Schlum Charitable Trust Fellow, San Diego Zoo Global)



Calochortus dunnii (Liliaceae) blooming in Southern San Diego County.

Mediterranean climate and he diverse habitats that typify the county of San Diego have resulted in both the highest number of plant taxa found in any county in the United States (Rebman and Simpson, 2006), and plants with adaptations that make species assessment challenging when working to conserve its diversity (Lesica and Steele, 1994). As with other Mediterranean biomes, San Diego experiences hot dry summers and cool wet winters. As a result the native plants have adapted to cope with this unique climate. Geophytes (i.e. plants with perennating storage structures underground, such as bulbs, corms, and rhizomes) are particularly common in these climates (Raunkiaer, 1934). These plants retreat underground in adverse conditions, allowing them to allocate resources for use

when conditions are more favorable (Reese, 1989).

Working as a part of the California Plant Rescue (CaPR), a statewide initiative to collect and store 75 percent of the rarest plant species in California by 2020, the Native Plant Seed Bank at San Diego Zoo Global has been targeting many of these elusive and endemic geophytes in an effort to prevent their extinction in San Diego County. Population counts of geophytes can vary greatly by year, as dormancy and death are indistinguishable. A decreasing number of individuals seen over time can be the result of genuine population decline or of continued dormancy due to unfavorable conditions. This has been especially true during the prolonged drought in Southern California, and is likely to continue



Dudleya brevifolia (Crassulaceae) on a sandstone plateau near the San Diego coast.

with the inherent unpredictability of future weather due to climate change. To gain a better understanding of the true conservation status of these species, we must take a wide view, looking across many seasons and effectively examining entire population ranges within the context of climate variability.

Of the 48 seed collections that have been made as a part of CaPR, 20 collections are from ephemeral geophyte populations. In 2016, we collected seed from three separate populations of Calochortus dunnii (Liliaceae) a beautiful rare mariposa lily. This geophyte is endemic to the southern San Diego County and northernmost Baja California, Mexico. The species may also be particularly sensitive to the timing and quantity of rainfall. For example, one land manager saw a population blooming for the first time in 20 years after good winter rains in 2015. Our 2016 seed collection exemplifies the scope of our seed banking efforts as we were able to both collect data on this rare blooming event and conserve unique genetic diversity from this seldomseen population in our seed bank.

Dudleya brevifolia (Crassulaceae) is another endemic geophyte known from just five populations, found only in the coastal San Diego County. Though the populations are confined to a relatively small area, their reactions to microclimatic differences are varied and it is difficult to predict how many individuals will break dormancy each spring. Furthermore, individuals within a population may have a differential response to climate variability. Genetic diversity may be hiding under our feet during any given season, emphasizing the need for both large scale collection efforts and effective monitoring over many years under different climatic conditions. Thus far, we have seed collections from three of the five known wild populations and have had great success in germination trials and propagation for seed bulking.

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Not Your Ordinary Buttercup

CHRIS COCKEL (Crop Wild Relatives Project Coordinator, RBG Kew)

Unlike the plant that most people in the UK call a 'Buttercup', *Ranunculus ophioglossifolius* (Adder's-tongue spearwort) is certainly no ordinary buttercup. Unlike its more common cousins, such as Creeping Buttercup (*Ranunculus repens*) and Meadow Buttercup (*Ranunclus acris*), *R. ophioglossifolius* in the UK could be regarded as particularly fussy in terms of its preferred habitat, and extremely vulnerable due to the fragility of that habitat.

While relatively abundant throughout much of its range in mainland Europe, in the UK, this annual species is now limited to just two sites in Gloucestershire, at Badgeworth and Inglestone Common. While the small population managed by the Gloucestershire Wildlife Trust at Badgeworth has remained relatively stable in recent years, the Inglestone population was on the edge of extinction in part due to a reduction in traditional cattle grazing that helped to open up areas of bare mud ideal for seed germination, reduce the abundance of competitor plants, such as *Glyceria* and *Agrostis*, and the encroachment of woodland scrub.

By 1993 only one plant was recorded growing on the edge of its pond habitat at Inglestone Common, with only occasional sitings made over the next twenty years. While the species has been known to persist in the soil seed bank, the chances of *R. ophioglossifolius* being seen again at Inglestone appeared to be receding.

So, in 2012 the Freshwater Habitats Trust and the Gloucestershire Wildlife Trust decided that action was needed if the species was not to be at risk of extinction in the UK. They approached the Millennium Seed Bank to see if we could help. Thankfully, a seed collection had been made by Plantlife in 2007 and donated to the Millennium Seed Bank in order to avert such an extinction.

In March 2015 145 seeds from the original 2007 collection were sown by the nursery team at Kew's Wakehurst Place under the umbrella of the UK Native Seed Hub Project. To our surprise, the plants grew so well under glasshouse conditions and produced so many seeds (124,926 to be precise), that tiny seedlings started to appear from the gravel around the seed trays, clearly demonstrating the weedy characteristic that some species of *Ranunculus* are renowned for. A second generation of plants was



Ranunculus ophioglossifolius in the Wakehurst nursery 27th May 2015.

grown to bulk up the number of plants. These were brought on at Wakehurst until late in 2015 when the first batch of 250 plants was moved to the nursery at Bristol Zoo Gardens in preparation for planting out in spring 2016.

Meanwhile, in autumn 2015, South Gloucestershire Council commissed the clearance of woody scrub from tracks at Inglestone traditionally used by grazing cattle. This enabled the animals to play their part in churning up muddy pools and creating the ideal germination conditions for *R. ophioglossifolius*.

Finally, in May 2016 representatives from the above mentioned organisations and others involved in the project from Natural England and South Gloucestershire Biodiversity Action Group, met at Inglestone to plant out the first 83 clumps of plants in and around some of the ephemeral pools dotting the common. This was done while the plants were in flower to kick-start the process of replenishing the depleted soil seed bank. Monitoring of the site over subesequent months revealed new seedlings germinating in October 2016, and by March this year as many as 200 young plants were recorded at Inglestone, thus demonstrating the success of the project so far.



Wetlands at Inglestone Common 25th November 2015.



Planting at Inglestone Common 24th May 2016.

NEWS Visiting the Oman Botanic Garden

AISYAH FARUK (Country Programme Officer [Caucasus], RBG Kew), DARACH LUPTON (Senior Researcher/Botanist, Oman Botanic Garden) and ANNETTE PATZELT (Director, Oman Botanic Garden)



Mountain Oasis in North Oman.

n February 2017, Aisyah Faruk took a break from her Caucasus adventures to visit the Oman Botanic Garden (OBG), situated on the outskirts of the capital Muscat in the north of the country. The aim of the trip was to seek a partnership with OBG and to discuss strategies for the ex situ conservation of Oman's flora.

Oman is essentially the place where

Africa meets Asia in terms of plant diversity. Towards the north, the flora resembles that found in Iran, Pakistan and Egypt, while in the south, the flora more closely resembles that found distributed across the Horn of Africa (e.g. Somalia and Ethiopia). Unfortunately, this amazing flora is under threat from rapid urban development, as well as a changing climate and over grazing.

OBG is the country's first major botanic garden and is increasingly expanding its activities towards studying the ecology and importance of its native flora. During her trip, Aisyah met with most of the OBG team, introducing them to the Millennium Seed Bank Partnership, as well as discussing the fundamentals of longterm ex situ conservation in the country. It is hoped that OBG will soon join the MSB partnership and ultimately establish a conservation programme for Oman's threatened flora.



Aisyah Faruk meeting with Darach Lupton.

Promoting the conservation and sustainable use of tree seeds in the Caribbean region

EFISIO MATTANA, KEITH MANGER, DANIEL BALLESTEROS, THOMAS HELLER and TIZIANA ULIAN (RBG, Kew)

uring our last visit to the Dominican Republic a group of Kew scientists attended the IX Congress on Caribbean Biodiversity held from January 31st to February 3rd 2017 in Santo Domingo. As part of the congress we organised a very productive symposium, Seed Conservation entitled and Sustainable Use of Native Trees in Mesoamerica and the Caribbean, under the auspices of the Global Tree Seed Bank Project, and in collaboration with the Jardín Botánico Nacional Dr. Rafael Ma. Moscoso (JBN), the Universidad National de Santo Domingo, and the University of Puerto Rico. The key objective was to share project experiences and research results with institutions working in the Caribbean and Mesoamerican region, including Kew's partners from Puerto Rico and the Turks and Caicos Islands.

The symposium was followed by the inauguration of the JBN's new seed bank. This new facility is the result of Kew's long term

collaboration with the JBN which started in 2007 under Kew's Millennium Seed Bank partnership, and which is now flourishing through the Global Tree Seed Bank Project: Saving threatened forests of Hispaniola. The project, funded by the Garfield Weston Foundation, has the purpose of preserving seeds of native trees, and encouraging research into the conservation of biodisupport for reforestation new JBN seed bank. activities in the region.



versity and promoting Tiziana Ulian speaking at the inaugural ceremony of the

These events represented an excellent opportunity for Kew to promote its work and partnerships in the Dominican Republic and the wider Caribbean.

RELATED LINKS

http://www.jbn.gob.do/ http://www.congresobdc.org/

State of the World's Plants 2017

DR JAMES WEARN (Project Manager, RBG Kew)

n 18 May this year RBG Kew launched the State of the World's Plants 2017 report (see https://stateoftheworldsplants.com). The report highlighted emerging trends whilst building upon the important baseline information presented last year.

The report summarises new discoveries from 2016, which include those of horticultural interest, plants of economic importance, and country-based novelties. It provides an assessment of global threats to plants and identifies those plants that have traits which enable them to be more resilient to global climate change and those that are more prone to extinction. Advances in whole genome sequencing and the knowledge that this is providing for pure and applied botanical research are highlighted. The impact of burning on global land-cover change is considered, as are plant communities that are naturally adapted to wildfires and annual burning regimes. Finally, the report addresses the effectiveness of international policy frameworks for promoting sustainable use and conservation. The Madagascar



Fire burns through a coniferous forest.

regional focus provides a case study on how we might reduce threats to plant diversity.

The symposium engaged an international community including scientists and policy makers. The event was enriched by a strong lineup of speakers comprising 12 men and 12 women from 12 countries. Themed sessions addressed thought-provoking issues including 'The immediate risk of extinction: climate change won't matter if everything has already died out', 'Invasive plants: born to invade?' and 'Valuing nature: which plant species are most valuable?'.

Growing Nuphar pumila at Wakehurst Place

JOANNA WALMISLEY (Botanical Horticulturist Propagator, Wakehurst Place)

Wiphar pumila, or more commonly known as the Least Waterlily, is a scarce native UK species. Though occurring more frequently in Scotland, it is thought that high nutrient levels and too much shade threaten the habitat at its only remaining English site in Shropshire. Seeds and rhizomes were collected from this population in July 2016 by a team from the Millennium Seed Bank (MSB). The plant grows in sheltered bays of lakes and waterbodies that have low to medium nutrient levels, either alone or with the more widespread *N. lutea* with which it can hybridise.

Little is known about the cultivation of *N. pumila*. Therefore, as part of the Species Recovery Plan, Natural England commissioned and funded the MSB's UK team to conduct a post-harvest viability study of wild collected seeds and determine the conditions needed to germinate *N. pumila*. Tissue samples from various populations were also tested by Kew's Conservation Genetics team to investigate levels of hybridisation with *N. lutea*, and the extent to which the English plants are genetically distinct from Scottish populations.

To continue this research, work is underway in the nursery at Wake-



hurst, to grow on both the seedlings and rhizomes. The larger rhizomes have come through the winter of 2016/17 and are now being propagated by division. A new aquarium houses germinated seedlings, which were at first reluctant to grow. By reducing light levels, further seedlings are now underway. If these continue to maturity, knowledge of the cultivation requirements of *N. pumila* may be used in future conservation actions, helping to secure its future in an uncertain world.



Nuphar pumila seedlings growing in a tank at Wakehurst Place nursery.

New MSB Agreements

Country	Counterpart Name	Start Date	Duration (Years)
China	Guangxi Institute of Botany	December 2016	5
United Kingdom Overseas Territories	The Government of Montserrat	April	2
Ethiopia	Ethiopian Biodiversity Institute	February	4
Indonesia	Indonesian Institute of Sciences (LIPI)	December 2016	5
United Kingdom	True Harvest Seeds	April	2

Key science publications

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MSB Partnership Data Warehouse

The MSBP Data Warehouse (http://brahmsonline.kew.org/msbp) was established to give MSBP partners access to all data associated with their seed collections. The Data Warehouse can be used to plan target lists, identify seed collections available for research, look up X-ray and germination test conditions and results, and map collections via a Google maps interface. You can also download a complete, unique MSBP species base list to check for species not previously banked. Access is available to all MSB partnership organisations, you can register on the Data Warehouse website at http://brahmsonline.kew.org/msbp/Account/Register.

Please contact Naomi Carvey (N.Carvey@kew.org), the Data Warehouse Project Officer, to discuss data available, data training and with any questions or feedback.

Email: msbp.datawarehouse.access@kew.org



MILLENNIUM SEEDBANK PARTNERSHIP DATA WAREHOUSE

MSB dashboard

Date	27/04/17
Total Collections	82,896
Total Species	37,770
Total countries (including overseas territories)	189

Next issue

Issue 32 of Samara will be reporting on the work carried out across the MSBP on island flora. If you are an MSB Partner of an island nation working on your local flora, or you are an MSB Partner researching and/or conducting fieldwork on islands, and you would like to share it with the wider MSBP community and beyond, please contact our editorial team, we would love to hear from you.

TALES FROM THE FIELD

Fieldwork is an important part of the work that we all do. We'd love to hear about your fun, interesting and exciting field trips. Send your contributions to our editorial team!

Contact us

We want to hear from you! Samara is your newsletter so please send us any articles you feel would be of interest to the MSBP.

The Millennium Seed Bank Partnership is managed by Royal Botanic Gardens, Kew.

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Samara provides information and inspiration for MSBP partners and a flavour of the successes of the Partnership. It is available as a PDF from the MSBP website at www.kew.org/samara.

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