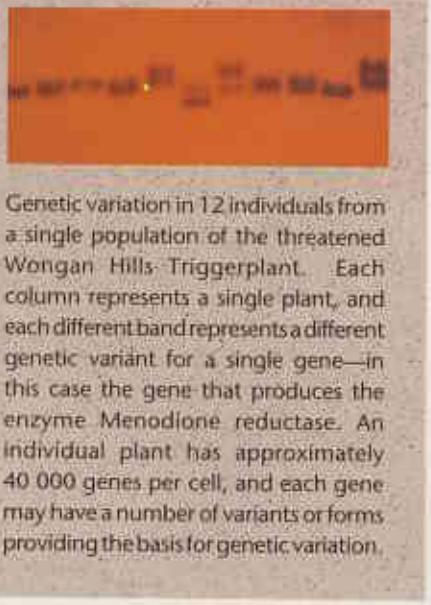
Banking FOR THE future

At a time when there is mounting international concern about the loss of genetic diversity, CALM's gene bank at the WA Herbarium is playing an increasingly important role in the conservation of threatened plant species.

BY ANNE COCHRANE, ANNE KELLY AND DAVID COATES

The unique and spectacular flora of Western Australia is facing an ongoing and worsening extinction crisis because of numerous threatening processes. Some 2 000 rare or threatened plants are currently recognised by the Department of Conservation and Land Management (CALM). Habitat destruction and degradation, weed invasion and dieback—a disease caused by species of *Phytophthora*—are some of the major threats to populations of these plants (see 'Threatened with Extinction', *LANDSCOPE*, Spring 1993). Natural populations of many rare and threatened flora face extinction, or at least a substantial reduction in size. These effects may not necessarily lead to immediate species extinction, but inevitably will result in loss of genetic diversity.



Genetic variation in 12 individuals from a single population of the threatened Wongan Hills Triggerplant. Each column represents a single plant, and each different band represents a different genetic variant for a single gene—in this case the gene that produces the enzyme Menodione reductase. An individual plant has approximately 40 000 genes per cell, and each gene may have a number of variants or forms providing the basis for genetic variation.

Species survival and continued evolution depend on the maintenance of genetic variation. This variation, or diversity within a species, refers to all the genes within a single individual and variants of those genes within populations of individuals. In the wild, this variation enables plants to adapt to changing environmental and ecological conditions, as well as providing resistance to pests and diseases. Where population extinction cannot be prevented, gene banks—or storage facilities for genetic material—can be used as an interim solution to prevent the loss of genetic diversity within a species range or, as a last resort, in preventing the extinction of the species. Capture of a sufficiently broad sample of genetic variation is essential if the stored material is to be effectively used in the long-term re-establishment of the species in the wild, following removal of the threats.

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Many populations of the feather-leaved banksia (*Banksia brownii*) are threatened by dieback. Seed from these populations is in long-term storage and may be used in re-introduction programs.
Photo – Babs & Bert Wells/CALM

Below: Collecting seed from plants such as this dieback-affected banksia is the primary focus of the work of the Threatened Flora Seed Centre (TFSC).
Photo – Jiri Lochman

THE CALM 'GENE BANK'

One of the most cost-effective methods for gene banking in plants is the long-term storage (ie. a minimum of 50 years) of seed at low (-20°C) or ultra-low (-196°C) temperatures. Recently, a low-temperature seed storage facility for plants critically threatened by dieback disease was set up at CALM's WA Herbarium as part of the Threatened Flora Seed Centre (TFSC). The principal aim of the TFSC is to maintain collections of seed from WA threatened plants for future recovery programs, where other avenues for saving a species have failed. To meet this conservation objective, seed collection has been carried out in areas of the south-west of the State, where the highest proportion of these plants can be found.

In relation to dieback, particular areas targeted include the beautiful species-rich heathlands of the Stirling Range, Fitzgerald River and Mt Lesueur National Parks. Research by CALM scientists has identified groups of plants that are most threatened by dieback (see 'Wildflower Killers', *LANDSCOPE*, Spring 1991; 'Endangered! Dieback-prone Plants of the Eastern Stirling Ranges', *LANDSCOPE*, Winter 1991; and 'Plants on the Edge', *LANDSCOPE*, Spring 1994). Banksias, dryandras, lambertias (native honeysuckles), *Adenanthos* (woolly bush), petrophiles and isopogons (cone flowers) in the Protea family, andersonias, astrolomas and leucopogons in the Epacrid or heath family, and some of the pea plants, are most susceptible to the disease. A range of plants from the family Myrtaceae—for example, verticordias (featherflowers), eucalypts and darwinias (mountain bells)—are variously threatened, depending on their site conditions. More than 200 presumed dieback-susceptible species have been targeted for collection, which represents about 10 per cent of flora on Western Australia's threatened and poorly known flora list. Occurrence in conservation reserves does not guarantee that these plants are safe, and many face at least localised extinction in the wild within the next 10 to 20 years.

While the initial aim of the TFSC was to focus on those plants threatened by dieback, collections have now expanded

to include other rare, threatened and critically endangered plants. Many of these are known only from a few small, isolated populations, particularly in the heavily cleared agricultural regions.

COLLECTING STRATEGY

The seed collection strategy of the TFSC attempts to capture 80–90 per cent of the genetic information of a threatened species throughout its geographic distribution. Protocols require that at least five populations be sampled, where possible. For any given population, seed should be collected from between 10 and 50 plants, depending on the size of the population. These individual plants should be distributed throughout the population and should contribute seed in equal quantities to avoid biasing the collection. Ideally, a healthy excess of 1 000 seeds per collection should be obtained to enable the extraction of representative sub-samples for germination testing, determination of moisture content and long-term monitoring of viability. This quantity of seed in long-term storage should adequately represent the genetic diversity found within a population.

Research has shown that the time of collection is critical, as the ripeness of the seed is important for maximum viability. Most species release their seed once they have ripened (for example, acacias and grevilleas). Some plants retain their seed for several months or even years (dryandras and banksias), and these fruits can be collected over an extended period. Plants with sporadic seed set (eg., *Adenanthos* spp.) often require several visits to a site to ensure that an adequate supply of seed is obtained. Techniques such as using shadecloth seed traps around the whole plant or muslin bags placed over a fruiting branch have proved to be successful.

Close contact is maintained with CALM district and research staff to ensure that field trips are planned to coincide with the peak fruiting times of targeted plants. Volunteers with expertise in the identification of special plant groups and knowledge of the locations of rare flora have provided a great deal of help in the field. Landowners have also been keen in their assistance with seed collection on their properties, and staff from local authorities have been of value in monitoring known populations and identifying new ones.

Top: Seed traps used for collecting seed from species such as *Adenthos* (woolly bush) that have low or sporadic fruit production.
Photo – Anne Cochrane

Top right: Small populations of endangered plants in heavily-cleared agricultural regions are a more recent focus of the TFSC.
Photo – Jiri Lochman

Above right: Laboratory work is an important aspect of the operation of the TFSC, and meticulous cleaning and counting of seed is required before storage.
Photo – Anne Cochrane

Right: Species-rich areas with major dieback infections, such as the Stirling Range National Park, are targetted for collecting work.
Photo – Anne Cochrane

Top left: Low seed set and small fragmented populations make collection of seed from *Banksia goodii* difficult.
Photo – Babs & Bert Wells/ CALM

Top: It is hard to obtain good collections of seed from plants such as *Darwinia meeboldii,* due to predation by insects.
Photo – Babs & Bert Wells/ CALM

Above left: Matchstick banksia follicles are burnt and soaked in water to release the seeds before germination testing.
Photo – Babs & Bert Wells/ CALM

Left: Seeds from threatened prickly honeysuckle plants, are safely in storage, but more discoveries are needed to supplement the genetic diversity.
Photo – Andrew Bown

COLLECTIONS SO FAR

The feather-leaved banksia (*Banksia brownii*) is one of the species most affected by dieback, and was one of the first plants to be targeted for collection by the TFSC. The seed store now holds seed from 12 of the 18 populations, including those that are suffering from dieback. It is envisaged that this seed will be used in the future to restock devastated populations, once an effective control for dieback has been found, or for establishing new populations in dieback-free areas.

The case of the prickly honeysuckle (*Lambertia echinata* subsp. *echinata*) highlights the importance of the TFSC's role in the conservation of endangered plants. This species has been almost destroyed by dieback, and the three surviving plants are isolated on an island of vegetation within a gravel pit. In addition to this seed being available for future reintroduction work, a small quantity of the material is being used to assess genetic differences between this and two other related subspecies.

Fortuitous collection of seed from a newly recognised species of *Jacksonia* (pea flower), found near Quairading, occurred only a few months before a wildfire devastated the only known population of the plant. If regeneration of the population is poor, it will be possible to use the stored seed to supplement plant numbers. Other populations of this species are unlikely to be found because of the paucity of remnant vegetation in the district.

As of March this year, 332 seedlots (or collections) from 145 different plant species have been incorporated into the Threatened Flora Seed Centre. Of these, 18 are categorised as critically endangered and 61 as endangered or vulnerable. In addition, seed from a further 53 plants on the priority flora list have been stored. Several of these are currently being recommended for declaration as threatened flora. A further 13 geographically restricted or otherwise 'interesting' plants are also represented in the gene bank.

Although only 28 per cent of the total number of declared rare flora for the State have seed represented in the TFSC, this still equates to approximately 63 per cent of species in dieback-susceptible genera that occur in known or likely dieback-prone sites. Many of the remaining plants have not been collected yet because of low or sporadic seed set, immaturity of populations, difficulty in accessing sites or simply because of lack of time and/or resources.

WHAT OF THE FUTURE?

While these may be impressive results for only three years' work, it is vital not to become complacent about the security of species represented in storage. The importance of the gene bank is obvious, but we must remember that long-term seed storage is not an alternative to conservation in the wild. Every effort must be made to protect populations in their natural habitat, and it is only with an integrated strategy involving on-site management and conservation off-site that this can be achieved. Work in the gene bank is contributing to this approach by providing the resource for future

FROM FIELD TO FREEZER

Collecting seed is only a small part of the operation of the Threatened Flora Seed Centre. For every day spent in the field there may be up to two weeks' work processing and testing that seed in the laboratory. All the seed that comes into the laboratory needs to be fumigated to kill any insect pests that may damage the seed. This is done by placing the seed for up to two weeks in laminated plastic bags that are strong enough to be heat sealed, and filling them with carbon dioxide. After fumigation, the seed is cleaned and counted before testing and eventual storage. Each collection of seed from a given location is assigned a unique number (a seedlot number) which is used to identify that collection throughout all subsequent handling. The initial viability of each seedlot is determined by removing a representative sample of seed and testing for germination. While some species, such as eucalypts and banksias, germinate readily, others require a more involved process that may warrant heat treatment (wattles), use of smoke (featherflowers) or growth hormones (triggerplants), scarification, and/or use of varying light and temperature.

Large woody fruits enable seed from many *Banksia* species to be stored in closed follicles on the cone, at room temperature and in airtight containers. Other genera, such as *Dryandra*, which retain their seed in individual follicles, can be stored in the fridge at 4°C. However, most seed is stored at low (-18°C) temperature conditions in 'standard' freezers. To avoid freezing injury, the moisture content of the seed must be reduced to between four and seven per cent. Past research on northern hemisphere crop species has shown that a reduction in moisture content and low temperature can increase the storage life of many types of seed. Moisture content is determined by an oven dry method, where the water in the seed is driven off by high temperatures or by an automatic titrator—as is used in the dairy and plastics industry. It is then reduced to the appropriate level by using silica gel in sealed desiccators. Within an individual species, the moisture content has been found to vary from year to year and may be dependent on the time of collection. Preliminary results have shown that seeds of native species of the south-west have moisture contents ranging from 3–13 per cent.

Before final storage, several additional samples are packaged separately from the main seedlot. All seed samples are placed in hermetically sealed foil packets filled with carbon dioxide. These are tested at yearly then five-yearly intervals to monitor the viability of the seed and its response to long-term storage. The long-term storage of seed from Australian plants is a relatively new field that requires further research and continued monitoring of techniques to ensure that that maximum longevity and viability of seeds are retained over time.

propagation material and increasing the knowledge of the seed biology of these threatened species. This knowledge will help CALM research and operations staff to prepare management and recovery plans for critically endangered populations of rare flora.

Right: Seeds of feather flowers, such as this *Verticordia staminosa*, are held within the flowers. Seed set varies greatly between the species.
Photo – Babs & Bert Wells/ CALM

Below: Mature *Acacia* pods split open to release seed, so timing of seed collection is important.
Photo – Jiri Lochman

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CALM is seeking corporate sponsorship for the Threatened Flora Seed Centre and would be pleased to hear from sponsors who would like to provide funds for staff to undertake specialised research on critically endangered plants.

LANDSCOPE

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The Perth Observatory celebrates its centenary this year, and during its 100 years' life it has played some major roles in the world of astronomy. Find out more on page 10.

John Forrest National Park has long been a popular picnicking spot for Perth residents, but this place of beauty has much more to offer. See page 16.

The Cape Range, in north-west WA, is known for its harsh environment. But if you look a little closer you'll discover the vast 'Range of Flowers' that live there. See page 28.

In 1961, the noisy scrub-bird was rediscovered at Two Peoples Bay. In 1994, the Gilbert's potoroo turned up unexpectedly. Find out more about this haven for the lost and found on page 35.

If all goes to plan, the Ord River area, will soon be known as a prime farming area for rare tropical timbers. Find out why on page 23.

FEATURES

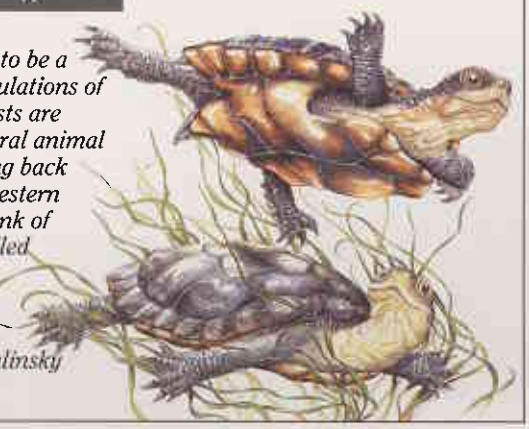
REGULARS

COVER

Fox-baiting has been shown to be a major tool in rebuilding populations of native animals. Now, scientists are embarking on a Statewide feral animal control program to help bring back native species, such as the western swamp tortoise, from the brink of extinction. The project is called 'Western Shield'.

The story is on page 41.

Illustration by Philippa Nikulinsky



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