Wild Australian orchids, including these species *Caladenia stricta* (inset) and *Dendrobium vexillarius*, are a speciality of the herbarium.

From Banks t

Roger Beckmann discovers a botanical treasure trove at Australia's new National Herbarium.

Tucked away behind CSIRO's lab complex on the slopes of Canberra's Black Mountain is a new building that's home to more than a million plant specimens, and a whole new concept in biodiversity monitoring.

The building houses the Australian National Herbarium, a unique collaboration between CSIRO Plant Industry and the nearby Australian National Botanic Gardens (part of the Australian Nature Conservation Agency).

The herbarium is part of the Centre for Plant Biodiversity Research which plays a key role in monitoring, analysing and researching Australia's unique botanical richness. Director of the centre, Dr Judy West, says biodiversity is essential both for Australia's future economic prosperity and its environmental health.

Documenting Australia's botanical biodiversity, 80% of which is found nowhere else in the world, is the main function of the herbarium. This involves establishing the identity and relationships of native plants, as well as their geographical distribution and ecology.

Many native plants offer considerable commercial potential which in the past Australia has been slow to profit from. For example, macadamias are Australian, but the world production of macadamia nuts is centred in Hawaii. We import blackwood timber (of *Acacia melanoxylon*, one of our best-known trees) from Chile, and eucalyptus oil from China. Knowing the characteristics of our flora will help in identifying future commercial opportunities.

o biodiversity

Going out and searching for possible wealth from organisms is sometimes called 'bioprospecting'. Just as mineral prospectors need a rough idea of what's likely to be in an area (whether it's diamonds or iron ore) so bioprospectors need a good map of biodiversity. In Australia, that's easier said than done, largely because finding out what plants exist on the continent is a far from finished process.

About 20 000 different species of angiosperms (flowering plants) are known to exist in Australia, 10 times more than in Great Britain. Yet that country, with its larger population and history of formal botanical study, has many more plant taxonomists than Australia. As a result, Great Britain's flora has been thoroughly studied, while ours still needs more exploration. It's not surprising then, that many Northern Hemisphere specialists are keen to study Australia's plants.

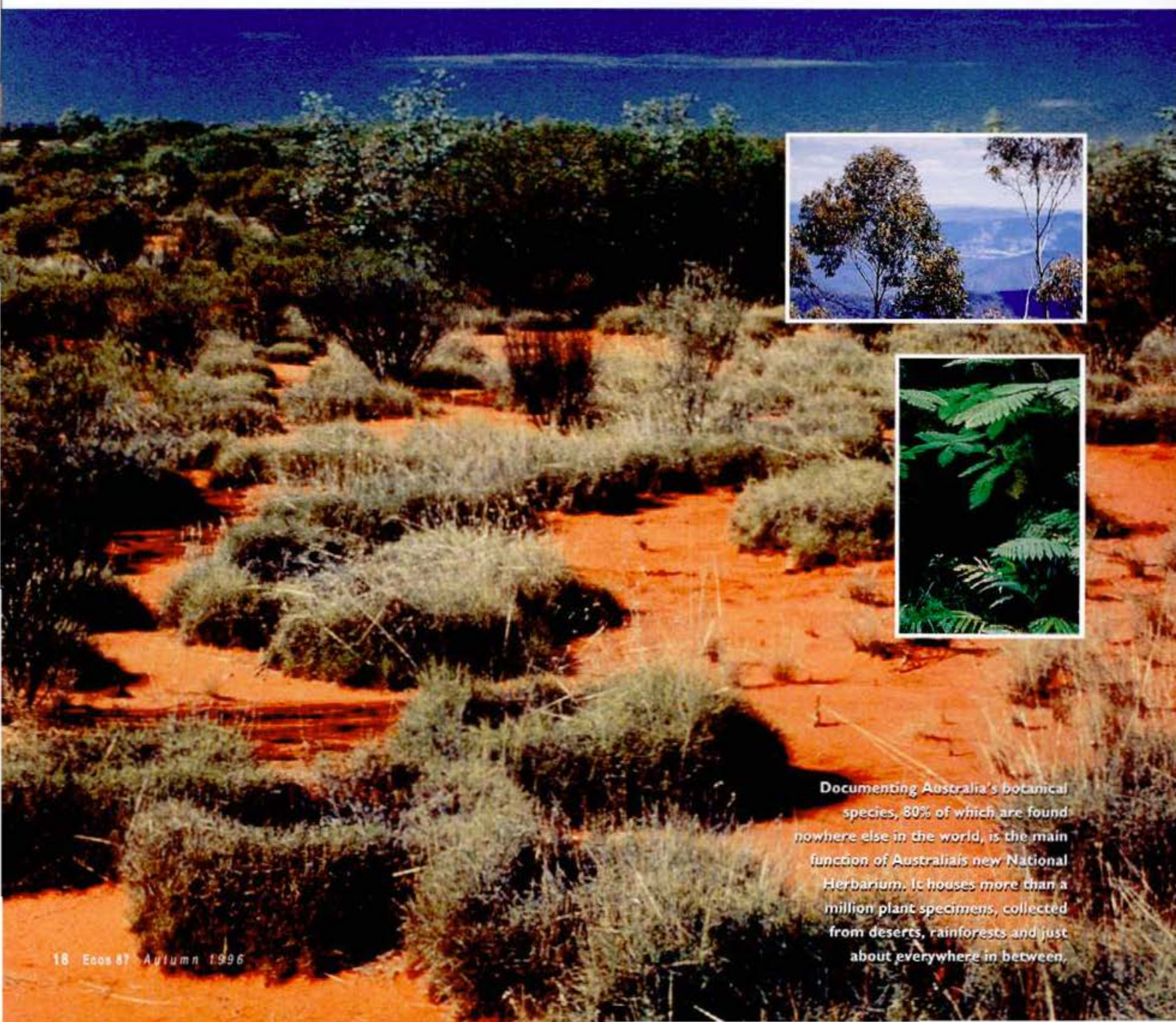
Making it grow

Staff from the herbarium do their own field collecting, during which they take leaves, flowers and, if possible, roots and seeds of a plant. Information about the plant's locale is also recorded. Especially important is the latitude and longitude, height above sea level, and the surrounding topography and features, including what else may be growing there.

The plant material is stored loosely in old newspaper, with loose fragments such as seeds of flower heads put in sealable plastic bags. Upon arrival at the herbarium all material is pressed and dried (see box story).

Not all specimens come to the collection through the indefatigable efforts of the herbarium's own staff. Plant material is also exchanged with other herbaria in many countries, as well as the various state herbaria. Of particular interest are plants from South America, New Zealand, South-

***Eucalyptus platyphylla*, a specimen collected by Joseph Banks during Captain Cook's first voyage, part of the treasure trove at Australia's National Herbarium.**



Documenting Australia's botanical species, 80% of which are found nowhere else in the world, is the main function of Australia's new National Herbarium. It houses more than a million plant specimens, collected from deserts, rainforests and just about everywhere in between.

East Asia, India and, southern Africa. This is because these land masses once adjoined the Australian continent. In the same way, the National Herbarium is expected to furnish material for others, and so collecting duplicates in the field is a regular practice.

Another reason for collecting more than one specimen of a given species is that wide variation within a plant species is common. Mulga (*Acacia aneura*), for example, can vary greatly in its shape, growth patterns and leaves. Therefore, to have more than one specimen is desirable. Specimens taken from locations with different characteristics, or taken many years apart, are also of value.

Old specimens may allow botanists to see whether changes have taken place in a species over time. This archival aspect of plant-collecting goes right back to Captain Cook's botanist Joseph Banks, some of whose collected plants are housed at the National Herbarium.

Banks' specimens are now of interest for their part in our heritage as much as for their scientific value. Since they have been well cared for, these old specimens look almost as fresh as specimens collected last year. Thus they are valuable in helping to study changes in plants over time such as the number and distribution of stomata in a leaf in relation to increasing CO_2 concentrations in the past 200 years, or the effects of introduced organisms on the characteristics of a plant species.

As befits a national herbarium, the collection concentrates on groups of plants that are particularly important for the national interest. These include eucalypts, native grasses, orchids and certain unique rainforest types.

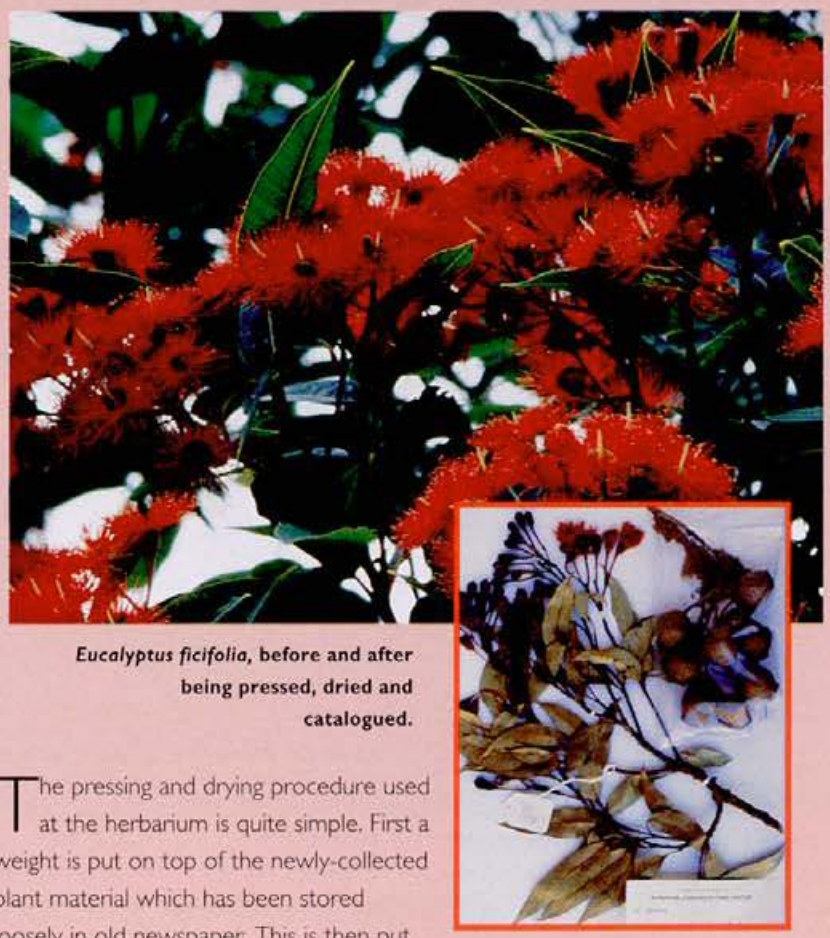
The eucalypt collection is the world's largest and is very comprehensive. It needs to be, as there are about 700 species in the genus *Eucalyptus*. But the collection is not confined to flowering plants. Mosses are a group of particular interest, and ferns, fungi and lichens are all sampled and stored as well. A large collection of algae is on long-term loan to the Sydney Herbarium, where an algologist studies them.

Wild desires

A herbarium's work is not simply a matter of collecting and storing bits of plants. It also carries out research on native flora. Knowing the characteristics of native plants that are related to valuable crop species is of particular importance.

Crops plants have been selected for desirable traits and come from a small genetic base. Wild relatives may possess qualities that could be incorporated into the cultivated varieties. Agricultural scientists are constantly seeking ways of improving their plant varieties, and knowledge of what exists in the wild types is vital (see box story on page 22).

Storing the treasure



***Eucalyptus ficifolia*, before and after being pressed, dried and catalogued.**

The pressing and drying procedure used at the herbarium is quite simple. First a weight is put on top of the newly-collected plant material which has been stored loosely in old newspaper. This is then put in a desiccator that produces warm, dry air.

After 24 hours, the specimens are 'decontaminated' in case any surviving insects or fungal spores are present. These could destroy the material or, worse still, spread out throughout the vast collection and spoil everything.

To accomplish the sterilisation, material from anywhere in Australia is kept at a cool and dry -18°C for at least two days, while that from overseas institutions is kept there for a whole week. At the end of that time, there should be no viable plant-eating animal life left, and probably few fungi either.

Most specimens are now ready for mounting. Special acid-free archival paper, designed for long life, is used for this. The dried material is carefully and often artistically laid out on the paper and stuck into place with strategically-placed strips of special long-lasting archival tape that won't lose its adhesiveness.

At this point high-technology enters into the age-old process. The paper is bar-coded (just like items from the supermarket), so that each specimen has a unique number and can be machine-read. All the information about the specimen is kept on computer, as well as on the specimen label. The specimens are then stored flat in labelled shelves (rather like books in a large library) in a large, climate-controlled room.

Some specimens can't be mounted for various reasons. For example, succulent plants, with their fleshy leaves, can't be dried and mounted because the leaf would lose its shape and you'd have a hard job knowing that the plant had ever been a succulent. Materials from these and other plants where the three-dimensional form is important are kept in alcohol in glass jars

Controlled pollination of the rare *Daviesia suaveolens* and the collection of its seed when they are released in the field allow staff at the Centre for Plant Biodiversity Research to compare its genetic variation with populations of common *Daviesia*.

Knowledge of plant systematics (the classification of plants and how they are related) is important in biodiversity monitoring, land cover assessment and land-use planning, agriculture, and, in the case of eucalypts, forestry. Recognising the relationships between organisms has long been specialised and highly technical work. Now it also relies on modern technology. Communicating about our flora, and finding out about the flora of the rest of the world is now done largely by computer.

The herbarium has a large specimen database, designed to be readily accessible and user-friendly. There are now roughly 3000 inquires to the National Herbarium's computer databases every day! The only check on this free flow is the need to protect plants, and so the location of rare or threatened species is not made explicit.

A computer identification system for rainforest trees has been designed, and the herbarium is now producing a special CD-ROM, for non-specialists, with information on the identification of eucalypts in south-eastern Australia. The CD uses clear colour photographs as well as diagrams and descriptions so that, with the help of the program and computer, anyone can identify the trees in their own backyard.

The Australian National Herbarium clearly plays a vital role in biological research in this country and, fortunately, it looks set to continue expanding to help us get to know better the flora with which we share this continent.

Better crops from Australian plants?

In Australia there are many wild relatives of some of the world's most important crop species. Plant geneticists are now realising that these wild species (often quite inconspicuous and little known compared with their famous, widely-grown relatives) could be a source of useful germplasm for the crop species.

For example, there are about 50 species of the genus *Gossypium* known in the world. This is the genus to which the cotton plant belongs. Seventeen of these 50 occur naturally in Australia, among them Sturt's Desert rose. Some of these wild species have very useful features that could be incorporated into commercial cotton species.

The desert rose (*Gossypium sturtianum*), one of many native *Gossypium* species being crossed with cotton cultivars and other wild species to generate improved hybrid stocks for commercial production.

For example, current cotton varieties may suffer damage to the cotton lint from rain after the 'cotton ball' (the plant's fruiting stage) has broken open. By contrast, the fruit of some Australian *Gossypium* species hangs such that the lint is no longer exposed after the ball has broken open.

Cotton plants, as well as providing us with fibre, also have useful seeds. The oil from these is a major product and, after the extraction of the oil, the seed meal is fed to stock and poultry. Unfortunately, commercial cotton species contain toxic terpenoids in their leaves, stems and seeds. These compounds are useful to the plant because they deter most predators, but are a nuisance to us in the seeds and so need to be removed.

Some wild Australian *Gossypium* strains, however, have functional terpenoid glands in their leaves, and non-functional ones in their seeds. Thus the terpenoid concentration in the seeds is low. It might be possible to transfer this characteristic of low-terpenoid seeds to commercial species, thus saving on the processing costs of the seed meal for animals.

Soybean (*Glycine* species) provides another example. A particular rust fungus to which it is prone can cause losses of 20-30% of the crop in Asia, and is a serious threat to world soybean production. Some wild Australian *Glycine* species were known to be resistant to Australian forms of the rust, and recent experimental research at the Australian National Herbarium has also revealed that Australia's species are in fact resistant to the Asian rust as well. This resistance would be most valuable if incorporated into the commercial varieties of *Glycine*.