oil in the leaves

The smell of eucalyptus oil is quintessentially Australian, yet the majority of the oil sold in Australia comes from overseas. Now, Western Australians are exploring new ways to revive this old industry - through research, experiment, and replanting the land.

BY LIZ BARBOUR AND JOHN BARTLE

PHOTOGRAPHS BY JIRI LOCHMAN

Since World War II the production of eucalyptus oil in Australia has declined as production costs increased, making it uncompetitive with imported eucalypt oil from in China, Chile, Spain, Portugal and South Africa.

Eucalyptus oil is presently used for perfumery, medicinal or industrial purposes. Perfumes accounts for only a small fraction of the total market, while medicinal and industrial oils are used in about equal proportions. Medicinal applications include antiseptics, liniments, gargles, lozenges and inhalants, while current industrial use is for scenting disinfectants and cleaners.

Although eucalyptus oil has long been recognised as an excellent solvent, its potential to break into industrial solvent markets has never been seriously investigated. The prospects, however, look very encouraging.

Most industrial solvents are derived from petroleum and subject to increasingly stringent health, safety and disposal regulations. One major solvent, trichloroethane, is likely to be withdrawn from use in Australia by 1996 (and internationally by 2000) under measures to combat ozone depletion. International consumption of this product is estimated to be one million tonnes - some 300 times the present world production of eucalyptus oil.

Providing that it can be competitively priced, the 'natural' credentials of eucalyptus oil, including low toxicity and biodegradability, should give it easy entry into solvent markets. The scale of tree planting required to supply these markets could also be a major force in the treatment of land degradation.

ORIGINS OF LOCAL INTEREST

Local interest in eucalyptus oil began in the early 1980s when Professor Allan Barton of Murdoch University in Western Australia investigated the use of cineole (the major constituent of eucalyptus oil) as a stabiliser for mixtures of petrol and ethanol ('gasohol'). Although that use did not develop, Professor Barton became convinced of the potential of eucalyptus oil for general industrial use. He screened and selected WA native mallees for oil content and extensively planted trial and demonstration plots throughout the Wheatbelt.

During the late 1980s the Department of Conservation and Land Management (CALM) investigated potential commercial tree crops for the Wheatbelt. The objective was to find economic tree crops that could increase the motivation for the large scale tree planting required to treat land degradation. The economic prospects for eucalyptus oil looked attractive and CALM joined with Professor Barton to continue development. Alcoa of Australia generously supported the investigation of industrial uses.

Several local mallee species have good potential as crop plants. They are native to the Wheatbelt and well adapted to the dry, tough conditions which exclude other commercial species such as bluegum and pine. There are enough species with high oil levels to allow a suitable tree to be found for every site. Additionally, the mallee's growth habit (to be able to resprout from the 'mallee root') permits a two year harvest cycle thus providing regular income. Being native plants they also serve an important nature conservation function.

At this stage the local mallee species are 'wild' in that they have not been subject to any deliberate selection or breeding to improve their performance as a crop.

Natural oil contents range from half a per cent to five per cent of the fresh weight of leaves. In their difficult natural environment these species tend to be conservative in leaf production, but in the more favourable farmland environment they could be selected to produce a bigger bulk of leaves, consequently there is great scope to increase the amount of oil production by selection and breeding.

Previous page
Main: Seedlings of *Eucalyptus horistes*.
Inset: Seedling of *Eucalyptus augustissima*.

Left: Degradation of Hermans Lake (near Narrogin) by saline groundwater.

Below: Testing the industrial degreasing value of eucalyptus oil in a workshop at Alcoa's Kwinana Refinery.

IMPROVING OIL YIELD

CALM has begun a program of genetic improvement of several oil mallee species. The first step in this process is to collect seed from across the natural distribution of the species. The initial collections, made by Professor Barton, have been added to over the past year by CALM staff Tim Birmingham, Wally Edgecombe and Peter White. They scoured the Wheatbelt identifying trees on Crown land and private property, marking their location, collecting leaf samples, and later collecting seed. The large natural variation in leaf oil content allows seed collecting to be biased to favour oil content. Before gathering the seed, the collectors took leaf samples from each of the trees, immediately placed them in alcohol and passed them on for cineole assessment. This was done by Professor Barton and Ben Tjandra at Murdoch University, using gas chromatography.

The seed from this collection will be sown this winter in specialised breeding trials and seed orchards, as well as in operational scale plantings stretching from Geraldton to Esperance.

GOING TO SEED

To supply tree farmers with seeds (or the resultant seedlings) which have an improved oil yield, seed production orchards will be established. Seed orchards provide several benefits. By having all the trees in one area, seed collecting costs will drop dramatically, they overcome the inbreeding inherent in the seed from wild populations, they permit easy selection of superior parent trees, and they can be designed to facilitate maximum crossbreeding. Two types of orchard can be established, an open-pollinated seedling orchard or a clonal orchard.

For an open-pollinated seedling orchard, the seedlings from high oil-yielding parents of the same species are planted together. When the orchard trees have reached harvest age, which in the case of the oil mallees is three years, the oil content of each tree is assessed and the

Below left: Preparing specimens for oil analysis at Murdoch University.

Below: Eucalyptus kochii, mature capsules.

Bottom right: Eucalyptus kochii, canopy of an early seed orchard at Murdoch University.

Bottom left: Eucalyptus kochii, flowers and buds.

poor producers culled from the orchard. This step ensures that all parent trees are superior oil producers.

The alternative method is to take clones of the very high oil-yielders and plant them together in an orchard. However, some difficulties in cloning remain to be solved before it can be used on the oil mallees. The most promising cloning technique is tissue culture.

A SLICE OF LIFE

Tissue culture, or micropropagation, is a method of growing material in a container under sterile conditions. Originally a research tool, it is now used extensively in horticulture and floriculture nurseries as a way of multiplying shoots.

Woody tree material has been difficult to adapt to this propagation system. For a number of years Murdoch University has been a major force in developing tissue culture techniques for the cloning of different eucalypt species in Australia (see LANDSCOPE, Winter 1990). One species that showed great potential, as a result of work by Professor Jen McComb and Dr Ian Bennett in the late 1980s, was the oil mallee Eucalyptus kochii subsp. kochii. Five clones were initiated into tissue culture by Murdoch University. These were taken over by CALM in 1992 and a further six high oil-yielding clones have since been added to the collection.

The process of cloning is complex. Young coppice shoots are collected from stumps and transported to the laboratory, where the leaves are removed. The stem is cut into sections, washed, sterilised and immediately placed in a decontaminated container holding a gelled mix of nutrients and plant hormones (called the medium). The most difficult part of culturing woody tissue is successful sterilisation. The decontamination procedure is a delicate balance between killing the stem tissue and killing the bacteria and fungi (either on the surface of the tissue or within the vascular system). If sterilisation is successful, the combination of nutrients in the gelled medium stimulate the tissue to grow, and shoots appear. These are placed in a special room where light and temperature are conducive to growth.

For continued growth the shoots have to be regularly transferred into new medium under sterile conditions. Once established, they are placed in a medium containing a rooting hormone, which stimulates root development. From here they are prepared for planting.

These 'plantlets' are very different from seedlings. Having existed in a perfect environment they rarely form the water-protective coating, or cuticle, vital for survival outside the laboratory. Additionally, the plantlets depend on the medium and need to become photosynthetically self-sufficient before they can be moved into the nursery.

If tissue culture of oil mallees turns out to be easy and efficient, it could be used to produce stock for full scale

Below: Cultured *Eucalyptus kochii* tissue with emerging shoots.

Bottom: Cultures in the growth chamber.

OIL-BEARING EUCALYPTS

Oil occurs in the leaves of all eucalypt species in differing amounts. Of the 700 species and varieties of eucalypts, fewer than 20 have enough oil to be commercially exploited.

The original eucalyptus oil industry was based on species from the eastern States of Australia - blue mallee (*Eucalyptus polybractea*) and the peppermints (*E. radiata* and *E. dives*).

Western Australia has its own oil mallees, which occur widely as remnants on farmland in the Wheatbelt and also in pastoral areas east of the agricultural zone. The species that are of greatest interest are *E. kochii* subsp. *kochii*, *E. kochii* subsp. *plenissima*, *E. horistes*, *E. angustissima*, York gum (*E. loxophleba*) and swamp mallet (*E. spathulata*).

Photo - Oil mallee leaf showing leaf glands

operational planting, not just stock for clonal seed orchards. However, there is an interesting complication. For operational planting the tissue cultured plantlet must be able to produce a 'lignotuber'. This is the well-known 'mallee root' which, when fully grown, is the underground root mass from which new shoots emerge after harvest (or fire). The tissue culture process may alter the development of the lignotuber. If so, the technique may need to be restricted to gathering the best material for future seed orchards. During this winter CALM will establish field trials to test the field performance of tissue cultured plantlets.

OIL FOR THE FUTURE

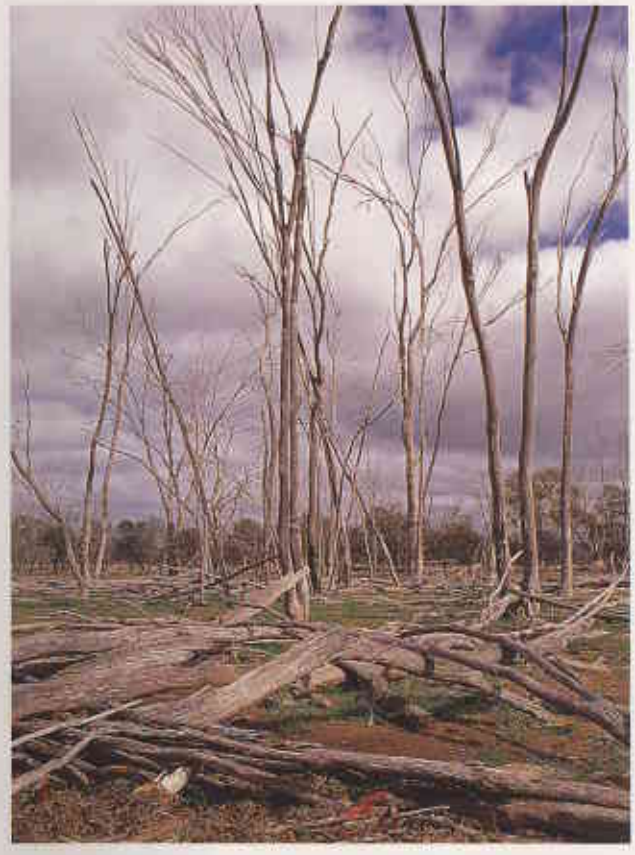
Breeding and propagation is just one part of developing a major new industry for rural Western Australia. If each of the parts are carefully researched and developed, Western Australia should be able to build an efficient eucalyptus oil industry based on providing new environmentally safe industrial solvents. Furthermore, the revival of this traditional industry would help to reduce, as well as prevent, land degradation.

Right: Saline groundwater inundation causing tree death in a valley bottom near Woodanilling.

Below right: Eucalyptus kochii showing mallee root with numerous shoots.

Below: Oil mallee species being raised for plantation in 1993 at CALM's Narrogin tree nursery.

Bottom: Initial field scale plantings in 1992 near Woodanilling.



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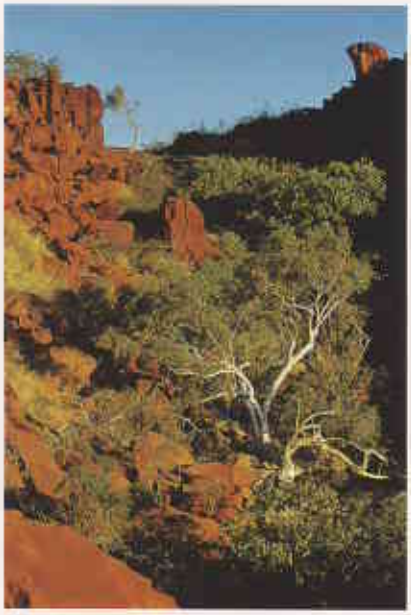

LANDSCOPE

VOLUME EIGHT NO. 4 WINTER ISSUE 1993

Nature-based tourism is a rapidly-growing industry and WA is poised to take a slice of that growth. See 'Our Natural Advantage' on page 10.

'Seagrass, Surf and Sea Lions' (page 21) are just some of the features of a string of islands that dot the WA coastline north of Lancelin.

Forrestdale Lake is an 'Outer City Sanctuary' for thousands of visiting and resident waterbirds. See page 35.

Frogs can be an interesting addition to any suburban native garden. Grant Wardell-Johnson describes how to attract them to your garden on page 16.

When is a flower not a flower? Neville Marchant, from CALM's WA Herbarium unravels the intricacies of the State's many 'False Flowers' on page 39.

FEATURES

REGULARS

COVER

*The bull frog (*Litoria moorei*) is very large and has a voracious appetite. It is a frequent visitor to gardens and may be found particularly in greenhouses, ferneries and wet areas such as streams and ponds.*

The illustration is by Philippa Nikulinsky, inspired by a Peter Marsack photograph, courtesy of Lochman Transparencies.

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