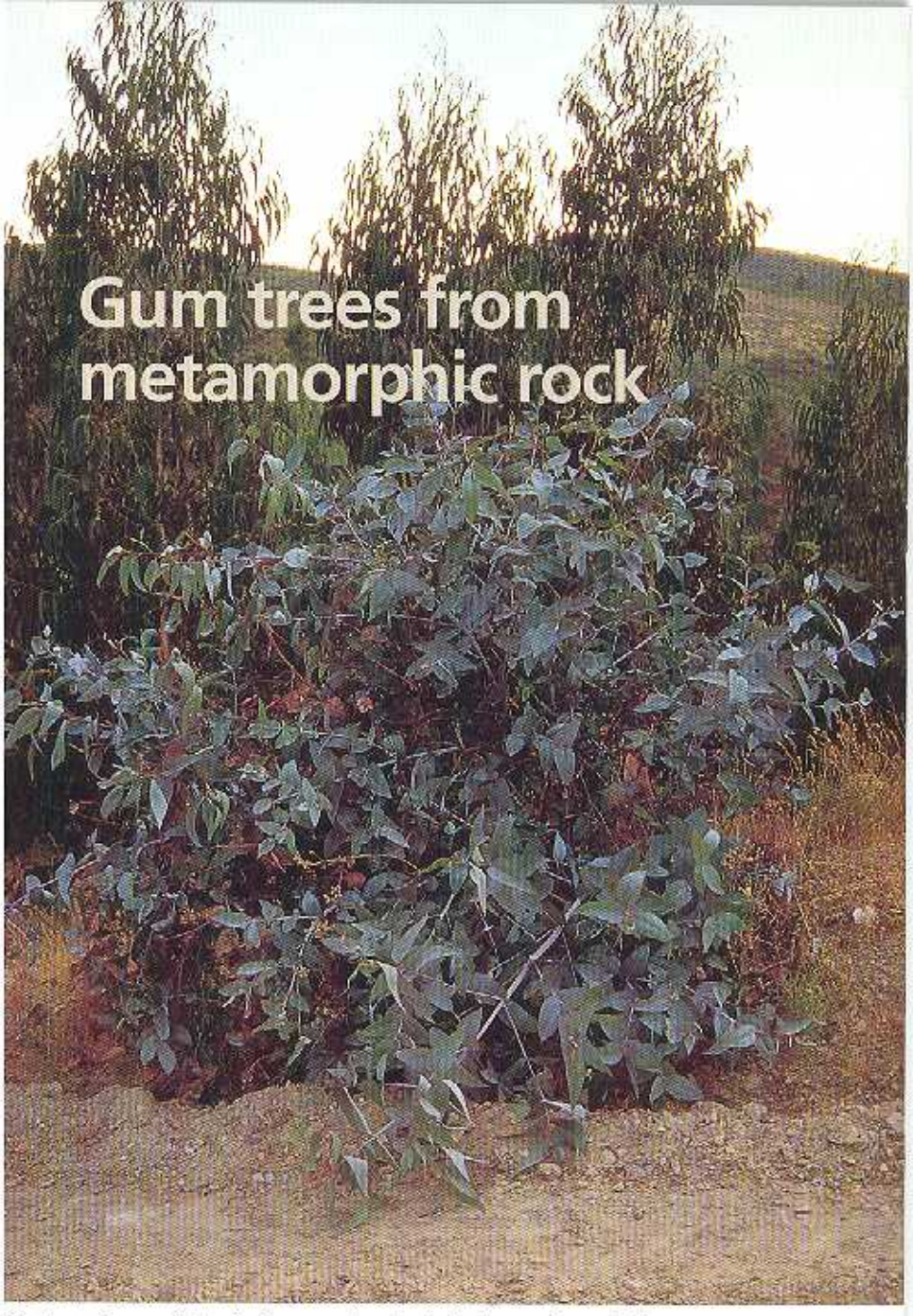
Gum trees from metamorphic rock

A classic lesson in boron deficiency

There are noble trees, semi-noble trees, and, well, ignoble trees. Eucalyptus is usually put into the third category, and in some countries is regarded as a rather undesirable Australian immigrant. Yet it is an ideal source of cellulose for the pulp and paper-making industry, and perhaps nature's most efficient converter of solar energy, water, and nutrients into timber biomass.

For eucalyptus grows very quickly. In good, warm conditions, *Eucalyptus globulus*, for example, will grow to over 12 meters (nearly 40 ft) in eight to ten years, and be ready for harvesting. After felling, it will then regenerate from the stump, and the best shoots will produce a second, equally viable crop in another eight to ten years, and yet a third crop in the third eight/ten year period. Thus in less than 30 years, eucalyptus will produce almost 200 tonnes of wood per hectare, as compared with spruce which yields about 120 tonnes per hectare in the same period, or pine which gives about 100 tonnes in 40 years. For pulp and paper, eucalyptus is at least as good as slower-growing softwoods.

However, if allowed to go on growing, *Eucalyptus globulus* can rise to well over 100 meters (330 ft), while its cousin, *Eucalyptus amagdalena*, can attain 160 meters (525 ft) thus challenging in height the Californian sequoia. Not bad for an ignoble genus. Yet in common with much (European) forestry, their status is such that frequently eucalyptus are relegated to poor or marginal land. They can grow where few other trees will survive.



Squat, useless eucalyptus in foreground, untreated by boron, is exactly the same age as healthy, boron-treated trees behind.

Some years ago, Portuguese papermakers attempted to grow *Eucalyptus globulus* on the bare slopes of Tras-os-Montes, eastward of Oporto. Torrid in summer, freezing in winter, these mountains' 'soil' consists mainly of metamorphic rock (or schist), and virtually nothing grows there naturally. Sure enough eucalyptus trees took root in the schist, but instead of growing straight and tall, they developed into round, semi-prostrate bushes with excessive branching - useless for pulping. They also appeared to be excessively vulnerable to frost

damage. After a promising start, the papermakers' experiment seemed to have foundered, but the soil science department at the University of Tras-os-Montes e Alto Douro (UTAD) in Vila Real had other ideas, and began a series of tests on its own account.

Professors Coutinho, Vale, and Bento theorized that it might be some micronutrient deficiency in the schist which was responsible for the trees' deformity, and considered boron the most likely candidate. In his first experiment, several hundred semi-prostrate eucalypti three or four years of age were cut back to their stumps so that they could regenerate. They were divided into sections and the surrounding schist was then treated with 20 grams, 40 grams, or 80 grams of boron per tree - or with no boron at all. Boron was given in the form of *Fertibor®* fertilizer borate which is 14.7 percent boron. No other nutrient or fertilizer was applied. That was in the spring of 1993, four different eucalyptus populations within the interior of Portugal being selected for the experiment, Vila Flor, Castelo Branco, Oliveira do Hospital, and Baiao.

Some six months later, eucalyptus leaves from each section were analyzed for boron content. Those from the untreated sections had boron contents of less than nine milligrams per kilogram whereas those from the treated sections had from 46 to 106 mg/kg boron. Clearly boron applied to the schist was being taken up by the trees - but was it having any effect on their growth?

The regenerated shoots were measured and compared in the spring of 1994 and again one year later. Their height, their diameter at breast height (1.3 meters/4.2 ft), and the basal area, that is the area of the shoots at stump level, were the main parameters for assessing biomass production. At once it became apparent that the boron-treated trees were significantly taller and thicker than the untreated trees. They were also straight and free of the deformities and 'frost damage' previously experienced. The untreated trees, however, were beginning to exhibit all the bad old symptoms including apparent damage by frost.

Boron deficiency in close-up

Professor Coutinho and colleagues do not consider that boron induces frost resistance *per se*, but rather that boron deficient trees become particularly sensitive to adverse environmental conditions, including frost.

By 1995 the differences were even more marked, particularly in Castelo Branco. Here the trees that had received the smallest dose of boron were 53 percent wider at breast height and 60 percent taller than the trees which had received no boron. And they were more than twice as large at the base. Interestingly, however, trees which had received higher doses of boron back in 1993 were not significantly bigger than those which had only received 20 grams. They did, however, retain higher levels of leaf boron. This implied the possibility that later in the crop cycle they might outgrow the 20 gram trees.

During 1994 and 1995, tests were also carried out in four other plantations. The purpose of this research - which was sponsored by Soporcel, a Portuguese paper-making company, and by the RTZ Borax company responsible for Iberian affairs, Borax España - was to corroborate initial conclusions about the benefits of boron supplementation, and to investigate the relative advantages not only of different dosages but also of different sources of boron.

In general, the same pattern of fast, straight growth yielding higher volumes of biomass was confirmed. Nowhere, however, was the beneficial boron effect so pronounced as at Castelo Branco. The obvious conclusion is that Castelo Branco's soil is the most boron deficient of the eight plantations tested.

The latest 1996 measurements show that trees which were given only 20 grams of boron in 1993 are now beginning to exhibit some of the deficiency signs again, while the trees which received 40 and 80 grams continue to grow tall and straight. They seem likely to produce significantly more wood at the end of the experiment.

Professor Coutinho and his UTAD team are currently investigating whether any beneficial effect is produced by boron in plantations believed to be boron-sufficient. In the spring of 1996, they also began an experiment on the effects of boron supplementation on pine *(Pinus pinea)* in the Tras-os-Montes region.

The experiments continue, yielding fresh evidence season by season. It is not too early to conclude that many rain-fed, seemingly barren areas in the Mediterranean region and elsewhere, which are distant from the sea and have sandy soils poor in organic matter, may well be able to grow healthy, profitable crops of eucalyptus, given a little help from boron fertilizers.