CHAPTER 5 - SEED, GENETICS and CLONAL PROPAGATION

Seed source

Genetic Variation in blackwood

Blackwood shows a high degree of genetic variation. This is present both within and between provenances.

Variation between Seedlots

In its natural distribution, blackwood is found from latitude 15° in Queensland, to 43° in Tasmania (Fig 15). It occurs in very diverse site conditions. Not surprisingly, differences are seen between provenances which reflect adaptations to climate, soils, exposure and competition. Examples are variations in frost tolerance, and in phyllode structure.

Site selection for blackwood in New Zealand is now well understood, and silvicultural systems allow reasonably straight butt logs to be produced. The possibility of exploiting the wide genetic variability of blackwood will therefore become increasingly important. This will need to be examined at two levels:

Provenance selection

- Provenance trials have been established in Tasmania, Queensland, Victoria, South Africa, China and New Zealand (see box over page). In Tasmania, trials with Tasmanian and mainland seedlots showed that soon after planting the Victorian and NSW seedlots were similar in performance to local seedlots. The Queensland seedlots were inferior in both growth and survival.

- In Victoria, two trial series with approximately 20 seedlots have shown a similar pattern. Some Tasmanian seedlots, and a South Australian seedlot, were ranked higher than Victorian seedlots for both form and diameter. In some of these trials, other Tasmanian, New South Wales and Queensland seedlots varied in performance, but generally Victorian seedlots were better than New South Wales and Queensland seedlots.

- In Queensland, provenance performance has varied, with local sources performing better than Tasmanian or Victorian seedlots, but not consistently so.

- In South Africa, some Tasmanian, Victorian and South African seedlots were consistently better than a New South Wales seedlot and other Tasmanian and Victorian seedlots, but performance varied with site.

Individual tree selection

This is supported by the wide variation between trees within provenances. This shows promise, but there are pitfalls:

- A selected tree will have been strongly influenced by microsite factors, including moisture, shelter, soil, adjacent vegetation, and insects.
- The relative influence of genes and environment can only be assessed by an examination of the progenies of selected trees, or their vegetatively-propagated clones, across a range of sites.

Trials of limited numbers of Australian provenances in New Zealand have indicated that Tasmanian and Victorian provenances perform best in our conditions (See box below).

Variation within Seedlots

Variation between trees in the same seedlot is equally striking, (heartwood colour variation will be obvious to anyone who has thinned a blackwood plantation) suggesting that there is genetic variation. Individual tree selection, establishment of seed orchards and/or clonal forestry are likely to result in genetic improvement.

Forest Research 1984 Genetic Trials

This trial series was established on 10 sites and 29 seedlots were tested: 6 provenances from Tasmania, 2 from Victoria, 1 from New South Wales, as well as seedlots from exotic plantations, 14 from South Africa, 5 from New Zealand, and 1 from Chile.

The results from an evaluation of three North Island sites in 1992 at age 8 years showed that Victorian and Tasmanian (Smithton) provenances and a New Zealand (Waipoua) seedlot had the best growth and form of the seedlots tested. South African seedlots have on average performed poorly with only a few seedlots proving superior.

Recent measurement of one of the trials (Whakarewarewa) in 2002 at age 18 years indicated that a Victorian, a Tasmanian (Smithton) provenance, a New Zealand (Waipoua) and a South African seedlot were the better performers.

Scion 2003 Genetic Trials

In 2003 a provenance trial testing 65 seedlots of blackwood was planted. Funding from the New Zealand Lotteries Grant Board assisted with the project. The seedlots were sourced from Scion Genetics, the Tasmanian Seed Centre and from the CSIRO Tree Seed Centre in Canberra. Additional Victorian seedlots were obtained from NRE at Hamilton, Victoria and Clinton Tepper of Wollybutt, Victoria.

The seedlots were grouped into 13 broad regional sets, with four replications of each group. The objective of this grouping was to place seedlots that may have a similar growth pattern together. This reduces the opportunity for suppression by fast growing seedlots and provides a longer opportunity for slower growing lots to fully express themselves. Fifty two plots were established with 40 seedlings per set comprised of 8 seedlings of five seedlots randomly allocated within the set. Each seedlot was represented by 32 individuals across the 4 replications.

Trials were established in the Waikato and South-Westland, complemented by a step-out planting of 19 seedlots near Auckland. A number of individual seedlots were also planted by Farm Forestry members in the North Island and the top of the South Island.

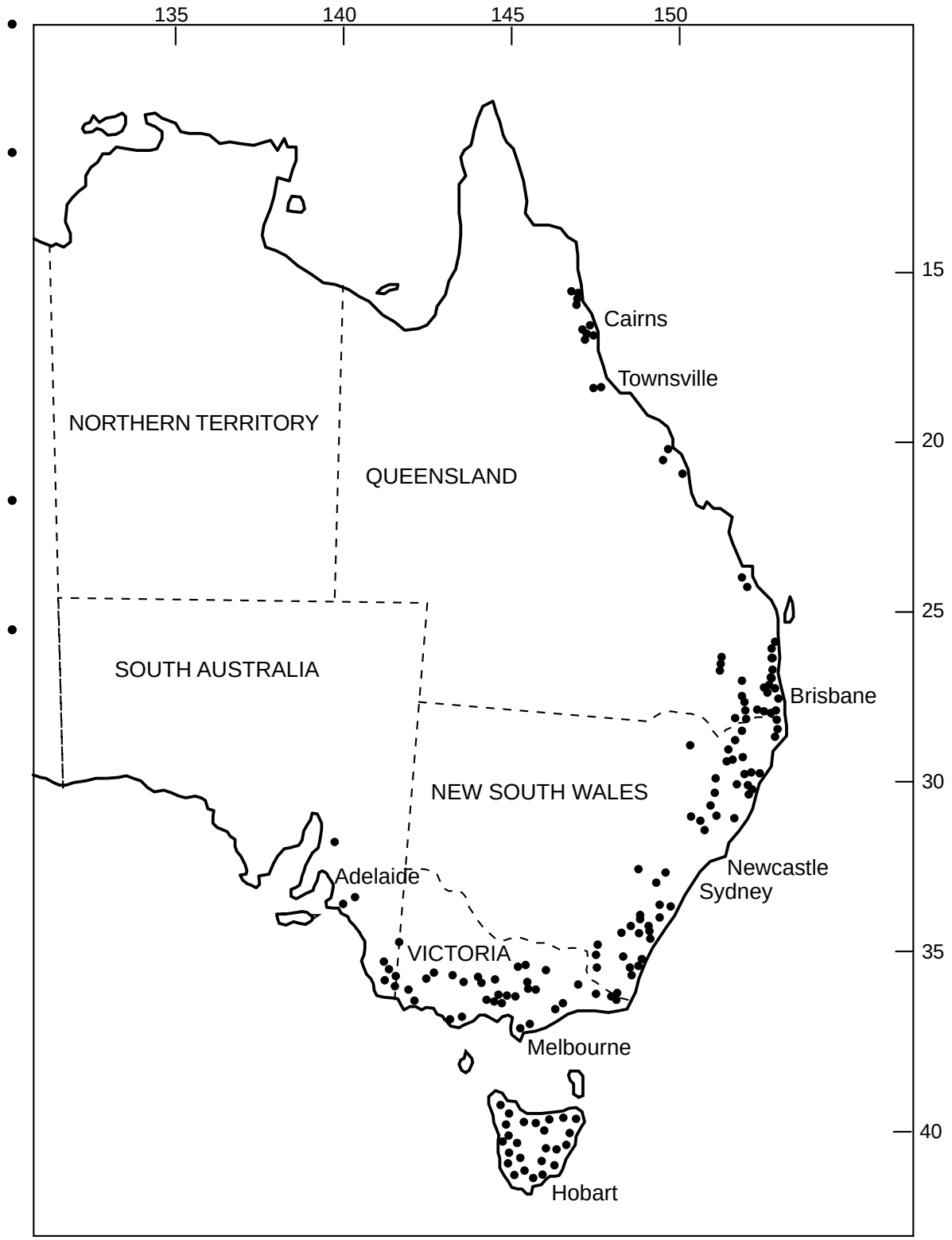

Figure15: Map of natural distribution of blackwood in Australia (Adapted from Stehbens 1992).

Genetic Evaluations

In 1959 Forest Research tested seed from 10 superior trees near Smithton on several New Zealand trial sites. Their form was no better than trees from unselected sources.

In 1988 Forest Research identified 74 good form trees from North Island plantations and collected root cuttings. Of the 35 clones that were successfully rooted 26 were archived on two sites north of Auckland in 1991. Measurements at age 6 years showed considerable variation in stem form amongst individual clones within sites. Although they were selected for form these clones were neither uniform nor of good form.

Heartwood Colour

An evaluation of two Tasmanian and two South African seedlots in a trial by Forest Research in 1983 showed no significant difference in heartwood colour between seedlots. In contrast there was an extreme range of colour within each seedlot. Several Australian reports suggest some association between colour and provenance.

Form

Selections have been made in South Africa for better form types. When assessed in New Zealand these showed no better form than other seedlots and poorer growth than Tasmanian seedlots.

Frost

Studies in Australia and New Zealand have shown genetic variation in frost tolerance. Frost tolerance and growth performance appear to be inversely related. Trees grown from seed collected from central Tasmania are quite frost tolerant, but the parent trees are described as having little timber value.

A South Island study showed wide variation in frost tolerance by individual trees within provenances, as well as between provenances.

Genetics

Genes or Environment?

In all the characteristics of blackwood there is a strong interplay between genetic and environmental factors. They can only be separated by planting progeny or clonal tests. Many studies have addressed the genetic influence in blackwood. They have often been limited in scope, and have often shown conflicting results. At the risk of grossly oversimplifying a complex issue, the likely genetic influence on some of the attributes of blackwood can be summarised:

- heartwood colour - mainly genetic; possible site influence.
- basic density - some genetic control.
- frost tolerance - genetic.
- vigour - both site and genetic, but strongly influenced by site.
- stem form - both site and genetic, but strongly influenced by site and insects.

Forest Research investigations

Cuttings

A series of experiments was conducted at Forest Research from 1987-1992 to develop techniques for vegetative propagation of blackwood. A total of five small studies were undertaken. These showed that:

- For repropagation from nursery stools, exposure of stumps and/or roots to light was necessary for the production of large numbers of shoots (roots were the best method).
- Root cuttings were more successful than stem cuttings.
- There was variation between clones in rooting success.
- Health of root material was very important. All healthy root material survived.
- Semi-hardwood cuttings were better than softwood cuttings.

Issues in root collection are:

- Care is required to ensure the root material collected belongs to the identified tree.
- Root material collected must be healthy.
- Root cuttings of 30-40 cm should be collected, approximately 10-20 mm in diameter. These can then be cut into 2-4 cm lengths and set. (While cuttings have been placed in the same orientation as naturally occurred in ground, the importance of this aspect is unknown).
- Cuttings have been collected in June, July and September with no time period preferred from Forest Research's limited experience.
- From successful rooted cuttings, stool beds can be set up for future propagation; the initial propagation is likely to be the hardest part.

Micropropagation

Plants have been regenerated from dissected embryos using tissue culture techniques. Shoots excised from seedlings grown *in vitro* formed roots in a non-sterile environment following an *in vitro* auxin/cytokinin treatment. The Quorin-Le Poivre medium used for the *in vitro* culture was not optimal; addition of activated charcoal resulted in clones with less foliage abscission, larger shoots, more leaves, and higher leaflet numbers.

Subsequent trial work showed that tissue-cultured planting stock (originating from dissected embryos) had a similar growth rate to seedlings. Although the tissue-cultured plants were not considered to have as good a root-shoot ratio as the seedlings at time of lifting, a preliminary trial showed that three randomly selected clones were not inferior to seedlings in the critical first year following field planting.

Clonal propagation

Clonal material selected for form, heartwood colour and heartwood percentage is available commercially in New Zealand. Although numbers are limited, it will provide a valuable resource for future evaluation.

The variation in blackwood growth habit and wood properties lends itself to a clonal programme, but this requires a successful propagation system. However, the influence of site on inherent properties and consistency of selected attributes are unknown.

Clonal selections will require assessment of their performance before they can be considered more than experimental.

Background research has identified the technology required for micropropagation. However the success of root cuttings has meant that this method is likely to be the preferred method of bulking up selections in the future, largely because it will be a cheaper option. Research in Australia showed that provenance, potting media, hormone and season all influenced the number of viable shoots produced.

In isolating the various contributions of genetic and environmental influences in blackwood performance, a study of clonally-produced replicates of individual trees, planted across different sites, would provide valuable information.

Our knowledge of genetic variation in blackwood has been based on subjective assessment of provenance trials for tree form, height and diameter. There have recently been one or two studies of the genetic structure of blackwood. Allozyme analysis has confirmed the high degree of genetic variation within and between provenances. It has also demonstrated what appears to be a significant genetic disjunction, which is emerging within the natural population of blackwood. This disjunction occurs in the Great Dividing Range at the Hunter River region with northern and southern populations identified.

Key Points

- We have reached a stage where we can be reasonably confident about site selection for blackwood in New Zealand and we have silvicultural systems which will allow us to grow straight trees. The opportunity to exploit the wide genetic variability of blackwood will become increasingly important.
- Blackwood shows considerable genetic variation, both between and within provenances.
- There is a lack of research results to guide the establishment of plantations and breeding programmes. Studies conducted have often been limited in scope, particularly with regard to the number of representative provenances. A recent initiative by Forest Research, NZ Lotteries Commission and Amigo aimed to address some of these issues.
- Propagation systems for clonal material are available.
- The variation in blackwood growth habit and wood properties lends itself to a clonal propagation system. However, the heritability of important selection traits, and the influence of site are also unknown.
- Clonal selections will require assessment of their performance before they can be considered more than experimental.

Suggested reading:

Cornell 1996.

Farrell and Ashton 1978.

Jones 1986.

Jones and Smith 1988.

Jones, Smith, Gifford and Nicholas 1991.

Harrison 1975.

Nicholas, Young, and Gifford 1994.

Playford, Bell and Moran 1993.

Searle 2000.

Stehbens 1992.