

Exotic pine forestry in the Southern Hemisphere: A brief history of establishment and quarantine practices

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SYNOPSIS

Afforestation with exotic softwoods commenced in the Southern Hemisphere at the end of the 19th century. Initially the areas under afforestation were small, but today, exotic plantation species are the basis of huge forestry industries, forming a crucial component of the economies of many countries. Early plantations were relatively free of pests and diseases. However, as the industry expanded, so did pest and disease problems. Initially, quarantine regulations were non-existent or poorly enforced, but in the later part of the 20th century rigorous quarantine regulations were implemented. More recently, the opening of global markets and the increase in trade has increased the risk of introducing new pests and pathogens. The potential losses to the forestry industry are immeasurable and vigilance is required from importers, exporters and even tree breeders moving germplasm, to prevent the spread of pathogens around the world. This review considers the history of softwood forestry and quarantine in some of the most important producers of forest products in the Southern Hemisphere, namely South Africa, Australia and New Zealand.

AFFORESTATION WITH EXOTIC CONIFERS IN THE SOUTHERN HEMISPHERE

European colonisation of the Southern Hemisphere was generally accompanied with an utilisation, and often the destruction, of the natural resources. However, as the populations of the colonies grew, immigrants began to prepare for the future, and the preservation of the land, waters and forests commenced. In Australia, South Africa and New Zealand, the first forest laws were concerned with preserving existing indigenous forests. This was followed by the establishment of Forestry departments charged with providing a continual source of timber to supply future demand. Afforestation with exotic tree species was a logical result, and today plantations of exotics dominate the forest industries in the Southern Hemisphere.

South Africa; first to get started

The first colony was established in Cape Town in 1649 and by 1714 a number of European pine species were well established in gardens and farms around the

Cape region. The first commercial plantation of 30 ha was established with *P. pinaster* at Genadendal in 1825 (Legat, 1930). During the mid 1800's, administrators were appointed in the Knysna, Tzitzikama and Keiskama Hoek regions of the Eastern Cape, to control and prevent the destruction of the indigenous forests in these areas (King, 1938). Public afforestation commenced with the planting of *Acacia cyclops* and *A. saligna* for the stabilisation of drift sands in the Cape in 1877. By 1881, the Government had established a Forests Department and appointed Conservators in the Western and Eastern Cape regions. The first Government plantations were established at Tokai near Cape Town in 1883 (Lister, 1957). At this time there was less than 100 ha under afforestation in South Africa (Legat, 1930). The Cape Forests Act was passed in 1888, after which afforestation in the Cape Province began in earnest. Many species trials were established and initially *P. radiata* was seen as the most favourable species in the Cape and Natal regions (Legat, 1930).

In 1902, at the end of the Boer War, Conservators were sent to assess the forests in Natal, Transvaal and the Orange Free State. Plantations of exotic pines were recommended in all these areas (Legat, 1930; King, 1938). Sir David Hutchins foresaw the importance of matching tree species with specific sites and suggested sub-tropical Mexican pines would be well suited for planting in Northern Natal and Transvaal. He thus introduced *P. patula* to South

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Africa in 1907 (Legat, 1930; Poynton, 1977). *P. elliottii* was also planted on his recommendation, although not until 1916. In 1913, the Forests Act 16 replaced the Cape Forests Act. This Act was later amended to give the Government tighter control over the preservation of indigenous forests and the expansion of afforestation with exotics.

From 1910-1920, *P. radiata* was extensively planted throughout South Africa. Planting of *P. radiata* was later restricted to winter rainfall areas due to losses in summer rainfall areas from hail-associated outbreaks of *Sphaeropsis sapinea* die-back (Laughton, 1937; Swart *et al.*, 1985). By 1922 there were 30 000 ha afforested with softwoods (Legat, 1930). This increased to 100 000 ha of softwoods in 1938 (Poynton, 1977) and approximately 600 000 ha today (Anonymous, 2001). *P. radiata* and *P. pinaster* predominated until 1950, with the majority of plantations being in the Western and Eastern Cape Provenances. Today *P. patula* and *P. elliottii*, planted in Kwa-Zulu Natal and Mpumalunga (former Transvaal), dominate the softwood industry in South Africa (Anonymous, 2001).

New Zealand; forged on after a slow start

New Zealand was first colonised in 1792 and during the first 100 years of colonisation, indigenous forests were rapidly cleared for agriculture and timber production. In 1874 and again in 1885, Forest Acts were proclaimed aimed at reducing the cutting and subsequent loss of the indigenous forests. These Acts, however, were poorly administered. It was not until 1886 that a Conservator of Forests was appointed and a more comprehensive Forest Act proclaimed with regulations on the management of the existing forests (Turner, 1932). Afforestation officially commenced in 1896 when special officers were appointed on both the North and South Islands to promote afforestation of poor lands, using exotics from Europe and the Americas. Many species trials were established and by 1913, *P. radiata* had been identified as the species of choice for afforestation in New Zealand (Turner, 1932).

The New Zealand Forestry Department was established in 1919. At this time about 700 ha were being planted annually and the total area of plantations was about 15 000 ha, predominantly *P. radiata*. In 1922, the Forests Act was again revised and private afforestation with *P. radiata* commenced. Afforestation began to grow almost exponentially and by 1927, 15 000 ha were being planted annually. This resulted in a total area under afforestation, both public and private, of about 300 000 ha by 1930 (Turner, 1932). The annual planting rate increased during the depression and today New Zealand has approximately 1.6 million ha of pine plantations.

Australia; diverse land, diverse needs

New South Wales was settled in 1788, followed by Tasmania in 1804, Western Australia in 1829 and South Australia in 1836. The forests in each State of

Australia are controlled by separate Forest Acts and as such the introduction of exotics and management differs between regions. Today Australia has approximately 1 million ha of exotic soft wood plantations, with over 50% of this area in Victoria and New South Wales (Love *et al.*, 1999). This paper is, however, confined to South and Western Australia, which were the first and last States respectively, to commence afforestation.

South Australia was the only Australian State not to have a supply of indigenous timber for saw milling. It is, therefore, not surprising this was the first State to proclaim a Forests Act in 1873, less than 40 years after the region was first settled. It was also the first State to commence afforestation in 1876. The Act was amended in 1875 and again in 1882 when it was changed to the Woods and Forests Act (Commonwealth Forestry Association, 1971). The Act has been amended several times recently to accommodate modern conservation and forestry principles. The species of choice in South Australia was *P. radiata* and extensive plantations had been established by early in the 20th century, with 60 000 ha afforested by 1946 (Rodger, 1946). The planted area has increased steadily and today there are approximately 120 000 ha afforested in South Australia (Lavery, 1986)

Western Australia, by comparison, was richly endowed with indigenous forests and these met local timber requirements for some time. The first laws governing the use of indigenous forests in this state were proclaimed in 1898 under the Crown Lands Act. The first Forest Act was in 1918 and this was revised in 1954. As with all other Australian states having considerable areas of native forest, there have been recent changes to policy due to the Regional Forest Agreements. The Regional Forest Agreements are 20 year agreements between Federal and State governments on the use and management of Australia's native forest, aimed at ensuring the future supply of timber (Commonwealth of Australia, 1999). Sustainable cuts from indigenous forests are balanced with conservation and biodiversity considerations. This has driven a recent increase in both softwood and hardwood plantations in Western Australia (Love *et al.*, 1999).

Forestry in Western Australia was mainly involved in the management of indigenous forests, but in the 1920's the need for softwoods drove the commencement of afforestation. This was predominantly with *P. pinaster*, because *P. radiata* had performed poorly in earlier species trials. Land suitable for the growth of pines was scarce in Western Australia and it was only after considerable research that pines were grown successfully. In 1946, there were only 5 000 ha of softwood plantations (Rodger, 1946), but these have increased steadily to approximately 100 000 ha today. By the 1960's, extensive research and breeding with *P. radiata* to produce trees suitable for Western Australia ensured that planting of this species now exceeds those of *P. pinaster* (Love *et al.*, 1999).

FORESTRY AND QUARANTINE

The commencement of commercial afforestation with softwoods in the Southern Hemisphere at the turn of the 20th Century was followed by a 30-year period during which few losses and no major outbreaks of pests and diseases were experienced (Laughton, 1937; Old and Dudzinski, 1998; Wingfield, 1999). Geographic isolation provided a natural barrier in Australia and New Zealand and, prior to the 1950's, the long duration of sea travel is thought to have acted as an effective quarantine period (Eldridge and Simpson, 1987). However, today, the rapid movement and increased volume of people and cargo is eroding these former barriers to the movement of pests and pathogens (Palm, 1999; Wingfield, 1999). South Africa, having many borders with other countries, is dependent not only on its own quarantine strategies, but also those of other African countries. Experience indicates that human intervention is fruitless when attempting to restrict the natural dispersal of pests and pathogens between neighbouring countries (Schumann, 1991).

The first quarantine laws were proclaimed at the turn of the 20th Century. The Australian Quarantine Act of 1908 is a good example. The Act aimed to 'provide measures for the inspection, exclusion, detention, observation, segregation, isolation, protection, treatment, sanitary regulation and disinfection of vessels, installations, persons, goods, things, animals or plants and having as their object the prevention of the introduction or spread of diseases or pests affecting human beings, animals and plants' (Tanner and Nunn, 1998). However, although the means to regulate imports were available, prior to the 1950's quarantine of plants, both in agriculture and forestry, was very poor (Empire Forestry Association, 1948a; Eldridge and Simpson, 1987; Walker, 1987; Wylie, 1989; Old and Dudzinski, 1998).

During the course of the last century, quarantine has evolved from virtually non-existent during the Second World War, to exclusion policies in the 1950-70's and ultimately to modern quarantine practices based on manageable risk concepts (Wylie, 1989; Tanner and Nunn, 1998). Today, quarantine involves not only Government regulations, but also public education. Perhaps more importantly, the responsibility for failure to adhere to quarantine regulations now lies with the importers (Tanner and Nunn, 1998; AQIS, 1999).

In Forestry, one of the most serious limitations lies in the identification and detection of pest and pathogen incursions. Even with strict quarantine regulations, there have been numerous incursions of exotic forest pests and diseases throughout the Southern Hemisphere, particularly in the last 25 years (Old and Dudzinski, 1998; Wingfield, 1999). This is because forest estates are vast and often not effectively monitored. Thus, new pest or pathogen incursions may not be recognised immediately. Exclusion of pests and diseases at points of entry into a country may be effective, but this process is expensive to administer.

Most modern quarantine strategies are based on manageable risk. This involves targeting important species for strict quarantine. One possible oversight of this approach is that the most destructive pest and pathogens of forestry in the Southern Hemisphere were not recognised as a problem in their natural environment. Good examples of this are Sirex wood wasp (*Sirex noctilio*) and *Dothistroma septospora*, the causal agent of Dothistroma needle blight (Eldridge and Simpson, 1987; Old and Dudzinski, 1998)

INDUSTRY RESPONSE TO PESTS AND PATHOGENS

Recognition of the importance of pests and diseases to exotic plantation forestry in the Southern Hemisphere is well illustrated in the records of the British Commonwealth Forest Conferences. At the 3rd British Commonwealth Forest Conference in 1928, there was a call for research into pests and diseases and warnings were issued to avoid importing these agents of destruction, along with planting stock (Empire Forestry Association, 1929). The main proponent in this discussion was New Zealand, who at this time had the largest area of land under afforestation with exotic softwoods. At the 4th British Commonwealth Forest Conference in 1935, some progress in the study of forest diseases was reported (Empire Forestry Association, 1936). By the time of the 5th Conference in 1947, dangers associated with the lack of formal systems for seed testing and certification in the Southern Hemisphere was recognised. Consequently, a call was made by New Zealand for an 'Empire'-wide adoption of regulations regarding seed supplies (Empire Forestry Association, 1948b). In response, phytosanitary requirements for seed were implemented.

When the 7th British Commonwealth Conference was held in 1957, the danger of pests and diseases, especially in unintended exotic forests, was recognised. All countries in the Commonwealth were urged to intensify precautionary and preventative measures (Empire Forestry Association, 1957). The driving factor behind this increased interest in quarantine was the Sirex wood wasp, *Sirex noctilio*, and its associated symbiotic fungus *Amylostereum areolatum*, which had caused huge losses in pine plantations in New Zealand and Australia. Sirex wood wasp is endemic to North Africa and Eurasia, where it is rarely considered a pest. It was present in New Zealand from about 1900, but it was only after severe droughts in 1946 that it caused severe losses (Eldridge and Simpson, 1987). Following these droughts, 30% of *P. radiata* stands were lost to the ravages of the Sirex wood wasp. After its introduction into Tasmania in the early 1950's, the Australian Government's response was immediate. Affected areas were placed under quarantine and infested trees destroyed. However, this did not prevent the movement of *S. noctilio* to mainland Australia and the subsequent loss of large quantities of timber. It was only through biological control using a parasitic

nematode, *Deladenus siricidicola*, that this problem was finally controlled by the mid-1970's (Eldridge and Simpson, 1987).

A pathogen of considerable interest and concern to exotic plantation forestry was *D. septospora*, the causal agent of Dothistroma needle blight. This disease was first recorded in Kenya in 1950. By 1975 it had spread to all the major *P. radiata* growing areas of the world. This fungus had a wide distribution in North America and Europe, but was not associated with major disease problems in its natural environment. In contrast, its impact on exotic softwood plantations in the Southern Hemisphere was profound. For example between 1962, when it was first recorded in New Zealand, and 1966, 40 000 ha were infected, 11 000 severely (Eldridge and Simpson, 1987). Once again, strict quarantine laws were implemented, and movements of nursery stock from infected areas were banned. This did not prevent the spread of Dothistroma needle blight, but understanding the epidemiology of the pathogen has made it possible to predict outbreaks and control them by aerial spraying of fungicide (Eldridge and Simpson, 1987).

At the 8th British Commonwealth Forest Conference in 1962, entire sessions were devoted to forest pests and diseases (Commonwealth Forestry Association, 1962). During this meeting, it was noted that the scant attention previously given to forest diseases, both potential and actual, gave the appearance that there was not a problem. This was ironic given the fact that diseases in forestry had already resulted in losses surpassing those in agriculture. In agriculture a serious pest or pathogen could result in the loss of a short-term investment, whereas in forestry, a serious pathogen could decimate plantations and destroy decades of investment.

CONCLUSION

Exotic pines form a major component of the large forestry plantation industries in the Southern Hemisphere. A century of experience and tree breeding has enabled foresters to match species with sites. However, the forest estate is vast and continual surveillance of all areas under cultivation is impossible. Thus, there is a risk of introducing new pests and pathogens. Seed and seed chaff are potential sources of fungal infection, but budwood and scion material, exchanged for breeding material, is perhaps a more dangerous source. Tree breeders should exercise caution when exchanging breeding material. Quarantine regulations exist to help prevent new incursions. However, it is important that quarantine regulations are enforced with the Government and Forestry companies collaborating to ensure continued forest health.

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