INTRODUCTION OF POPLAR AND WILLOW PATHOGENS INTO NEW ZEALAND AND THEIR EFFECT

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(Received for publication 4 July 1989; revision 17 August 1989)

ABSTRACT

Since 1973, poplars in New Zealand have been attacked by five new pathogens: *Melampsora larici-populina* Kleb. (1973), *Melampsora medusae* Thum. (1973), *Marssonina brunnea* (Ell. & Ev.) Magn. (1976), *Marssonina castagnei* (Desm. & Mont.) Magn. (1985), and *Xanthomonas campestris* pv. *populi* de Kam (1985). The *Melampsora* rusts and *Marssonina* species have defoliated susceptible cultivars and killed mature trees whereas *X. campestris* pv. *populi* has caused little damage. During the same period tree and shrub willows have been defoliated by two newly introduced rusts, *Melampsora coleosporioides* Dietel (1978) and *Melampsora* sp. (1985) respectively. With the exception of *Marssonina brunnea* which was introduced into New Zealand on poplar seed, and *X. campestris* pv. *populi* whose time and mode of entry are unknown, the pathogens all entered New Zealand via trans-Tasman wind currents from Australia. The devastating effects of poplar rust and *Marssonina castagnei* on poplar plantings clearly demonstrate the dangers posed by extensive monoclonal propagation. To avoid future disease epidemics the genetic base of poplars and willows has been broadened considerably and the planting of genetically diverse clonal mixtures undertaken.

Keywords: quarantine; windborne pathogens; seedborne pathogens; monoclonal plantings; *Melampsora lacrici-populina; Melampsora medusae; Marssonina brunnea; Marssonina castagnei; Xanthomonas campestris* pv. *populi.*

INTRODUCTION

Poplars and willows belong to the family Salicaceae and originate from temperate regions of the Northern Hemisphere. Some 300 species of willows and 40 species of poplars are known. Both genera are readily propagated from cuttings or large poles and this can lead to extensive monoclonal plantings which are vulnerable to newly introduced pathogens.

Poplars and willows are an important component of the New Zealand landscape. Weeping willows (*Salix babylonica* L.) were first planted in Akaroa in 1840, the crack (*S. fragilis* L.), golden (*S. alba* L. var. *vitellina* (L.) Stokes, grey (*S. cinerea* L.), and osier (*S. viminalis* L.) willows were also planted before 1860. In 1937 the Christchurch Botanical Gardens imported over 60 species from Kew. Currently, some 200 species are held in the collection at Aokautere. Willows are used for horticultural shelter, soil conservation, firewood, river control, and amenity purposes. They are also used for bee fodder and roughage for deer and goats (Hathaway 1986).

Poplars were also introduced into New Zealand between 1840 and 1850; the lombardy (*Populus nigra* L. cv. Italica), American cottonwood (*P. deltoides* Marsh.), and silver poplars (*P. alba* L. cv. Nivea) were extensively planted. The New Zealand Forest Service imported a further 12 cultivars from Kew in 1930. Later, as interest in erosion control, shelter, and timber production increased, more selected cultivars were introduced from Europe, America, and Japan until by 1973 some 400 cultivars were held at Aokautere. Prior to 1973 when poplar rust invaded New Zealand, poplars and willows were free of growth-limiting diseases (Wilkinson 1987).

In this paper I will discuss in chronological order the introduction and influence of several serious pathogens on poplar and willow cultivation.

PATHOGENS

The *Melampsora* Poplar Rusts

In March 1973 the two poplar rusts, *M. larici-populina* and *M. medusae,* entered New Zealand via trans-Tasman wind currents from Australia where they had been reported the previous year. It is speculated that the rusts entered Australia on illegally imported cutting material (Wilkinson & Spiers 1976). When poplar rust arrived in New Zealand approximately 20 poplar cultivars were available for erosion and shelter plantings. However, only three (*Populus* × *euramericana* (Dode) Guinier cv. I78, I455, I488) were being extensively propagated because of superior form and growth. All three were rapidly defoliated by rust and could no longer be propagated in the North Island. Fortunately, the cultivars *P.* × *euramericana* cv. Flevo, I154, and *P. yunnanensis* Dode proved resistant and were used in the interim, along with tree willows for soil conservation. The Lombardy poplar proved too susceptible for continued use as horticultural shelter in the North Island (van Kraayenoord *et al.* 1974; Spiers 1974).

In view of the very narrow genetic base of poplars grown in New Zealand at that time, the solution to poplar rust was seen in the importation of new genetic material from overseas. To this end some 239 cultivars and 290 seedlots comprising several species such as *P. angustifolia* James, *P. deltoides, P. fremontii* S. Watson, *P. maximowiczii* Henry, *P. simonii* Carr, *P. trichocarpa* Torr & Gray, and *P. yunnanensis* were introduced. Rust-resistant selections were propagated in gene pool arboreta and in nursery and field trials. Eleven cultivars resistant to *Melampsora* spp. have been released, including the possum-resistant hybrid *P. deltoides* × *yunnanensis* cv. Kawa. A large range of interspecific hybrids is under test and the first group of improved cultivars of American cottonwood and Lombardy poplar will be released in 1990. The new cultivars are better adapted to New Zealand's windy climate, have straighter stems, low possum palatability, and faster growth (Wilkinson 1987). The planting of genetically diverse clonal mixtures is being advocated to avoid the establishment of monoclonal plantings. In recent years attacks of rust have moderated as the host and pathogen have reached an equilibrium. *Melampsora larici-populina* overwinters on larch throughout New Zealand wherever larch and poplar occur together (Spiers & Hopcroft 1985). *Melampsora medusae* had disappeared from New Zealand because of a lack of suitable overwintering hosts (Wilkinson 1988) but an outbreak was recorded in a nursery in Hamilton recently. Re-introduction from Australia will probably occur occasionally.

Marssonina brunnea

During February 1976, infections of the anthracnose fungus *Marssonina brunnea* were found amongst seedlings of *P. deltoides, P. deltoides* × *nigra,* and *P. deltoides* × *trichocarpa* raised from Dutch seedlines imported in July 1975. An unsuccessful attempt to eradicate the disease was made by destroying all infested material. One year later (January 1977), further infections of *M. brunnea* were detected in a plantation of poplars 400 m from the initial outbreak. *Marssonina brunnea* is now well established throughout New Zealand.

Laboratory studies later established that *M. brunnea* was readily transported as a seedborne contaminant of poplar seed. A simple seed screening technique based on the Bolley seed test was devised (Spiers & Wenham 1983a). This screening technique detected conidia of *M. brunnea* and *Septoria musiva* Peck in seedlines imported later from Europe and America. These seedlines were destroyed. The modified Bolley seed test is routinely used to screen imported poplar and willow seed for conidia of potential pathogens. Also, fungicidal seed treatments to control *M. brunnea* contamination were developed (Spiers & Wenham 1983b).

Although *M. brunnea* can cause defoliation of susceptible cultivars in moist regions, it is not considered a serious problem. All new selections of poplars are routinely screened for resistance to *Marssonina* spp. (Wilkinson 1988).

Melampsora coleosporioides

When the willow rust *Melampsora coleosporioides* was first reported in eastern Australia in April 1978 its transport to New Zealand was considered inevitable. Within 7 months it had been recorded on a weeping willow in Whangarei. This rust is endemic to Asia and it is thought to have entered Australia on illegally imported cutting material (Latch 1980). Within 2 years *M. coleosporioides* spread throughout New Zealand defoliating the weeping willow (*Salix babylonica*) and its hybrids. Fortunately, *S. matsudana* Koidz, its hybrids with *S. alba,* and the crack willow (*S. fragilis*) used for horticultural shelter, soil conservation, and river control were not infected (Spiers & Hopcroft 1988).

New cultivars of *S. matsudana* imported from China have been used to broaden the genetic base of this species which prior to 1973 was represented by a single cultivar. These have been hybridised with *S. alba* giving a large number of genetically diverse rust-resistant hybrids available for planting in cultivar mixtures. *Melampsora coleosporioides* repeatedly defoliates weeping willow in the warmer regions of the North Island and has killed trees in Northland. The fungus overwinters as uredinia on persistent leaves. Abundant telia and basidiospores form on overwintered leaves in spring; however, the alternate host of this species is unknown. It will form pycnia but not aecia on larch (Spiers & Hopcroft 1988). The host range and pathogenicity of *M. coleosporioides* is regularly monitored on the willow collection at Aokautere. No significant changes have been observed to date. Several rust-resistant varieties of the weeping willow are available.

Marssonina castagnei

In February 1984, the anthracnose fungus *M. castagnei* was identified from Silver Poplar in Sydney, Australia, and 100 km west. By March 1986 it had spread to

Victoria and Canberra (J.C. Walker, pers. comm.). These reports were viewed with concern in New Zealand. However, it was hoped that the oft reported "short distance, rain-splash wind-dispersal spore transmission mechanism" of anthracnose fungi would preclude trans-Tasman transport.

Marssonina castagnei specifically attacks white poplars (*Populus alba*) which were at the time monitored closely for infection. In March 1984 no infection was found on Silver Poplar in the Manawatu, Wairarapa, or Wellington districts, whereas by December 1985 the disease was found to be widespread on Silver Poplar throughout New Zealand. By February–March, trees were defoliating. Laboratory studies, comparing the host range and pathogenicity of New Zealand and Australian isolates of *M. castagnei,* established their equivalence and possible common origin (Spiers 1988).

It is not known how or when *M. castagnei* entered Australia. It is difficult to reconcile the rapid spread of *M. castagnei* throughout New Zealand in less than one season with the slow spread of *M. brunnea* which took several years. One possible explanation for the blanket distribution of *M. castagnei* could be that the fungus was transported from Australia via wind currents which entered New Zealand at the base of the South Island and moved up the length of the country depositing conidia. Alternately, several independent trajectories may have been involved (Spiers 1988). The rapid spread of *M. castagnei* would have been facilitated by the extremely high susceptibility of *P. alba* cv. Silver Poplar to infection. This particular cultivar was introduced into New Zealand in the 1850s and is widely planted throughout the country. It suckers profusely and in some districts has been accorded noxious weed status.

Apothecia of the sexual state represented by *Drepanopeziza populi-albae* (Kleb.) Nannf. have not been found in New Zealand. This favours maintenance of host resistance as there is likely to be less genetic recombination within the pathogen population. The fungus overwinters possibly as conidia on buds and twigs, and newly emergent foliage is infected within 1 month of bud burst. Infection spreads rapidly and defoliation occurs in January–February. Most stands of Silver Poplar have been defoliated successively for three seasons, and stem dieback and root death are occurring. It is expected that Silver Poplar will be eliminated by *M. castagnei.* This is already causing problems in extensive East Coast plantings where defoliated trees are toppling as roots die (P. Hall pers. comm.). Fortunately, the *P. alba* × *P. glandulosa* cultivars Yeogi 1 and 2, which have supplemented *P. alba* cv. Silver Poplar in new plantings, and the Italian selections of *P. alba* viz BO-2, I40-57, I59-1, and hybrids of these cultivars with *P. tremula* L. have high field resistance and their growth is unlikely to be affected (Spiers 1988).

This disease clearly demonstrates the perils of extensive monoclonal planting.

Melampsora sp.

During December 1985 a new *Melampsora* rust appeared on *Salix interior* Rowlee and on *S. viminalis* and its hybrids simultaneously throughout New Zealand (Spiers & Hathaway 1987). This *Melampsora* sp. may also have entered New Zealand via Australia. Rust has previously been recorded on *S. viminalis* in Australia although we have been unable to confirm this report. Morphologically the new *Melampsora* sp. is very similar to *Melampsora epitea* Thum. As yet it has not been determined whether *Larix* species are the alternate hosts of this rust. Infection appears on the first-formed leaves of some *S. viminalis* cultivars within 1 month of bud burst, which suggests that the rust overwinters in bud tissue.

Salix viminalis is a shrub willow and is used widely for river bank protection plantings. Seedling mixtures have been used in these plantings and not all are defoliated by rust. Accordingly, this *Melampsora* sp. is not considered a serious problem.

Xanthomonas campestris pv. *populi*

During the unusually wet 1985–86 growing season when Palmerston North received 64% more rain than average (in November–February rain fell on 52 out of 120 days), stem necrosis was observed on several poplars of *P. deltoides* × *trichocarpa* parentage. The causal bacterium was identified as *Xanthomonas campestris* pv. *populi* which had previously been reported causing a similar disease on poplars in Holland. New Zealand isolates differed from Dutch isolates in their inability to utilise melezitose and gluconate (Haworth & Spiers 1988).

The bacterium was also isolated from healthy foliage and it is thought to be a facultative parasite. The disease did not reappear in following seasons despite continued presence of the bacterium. The origins of this disease are unknown. Did the bacterium enter New Zealand via seed or cutting material (which is held in quarantine at Auckland for 2 years) or has the bacterium been present in New Zealand for many years waiting for the right combination of a susceptible host and a favourable environment?

CONCLUSION

Since 1973, poplars and willows in New Zealand have suffered greatly from the ravages of introduced pathogens. It is disturbing that so many have been received via Australia which clearly needs to improve its quarantine and interception services. We have responded to and overcome these diseases by importing seed and cutting material (not without some risk) to broaden the genetic diversity of poplars and willows in New Zealand. We now have sufficient genetic diversity to breed for resistance to new pathogens. We are only too aware of the dangers posed by large-scale monoclonal plantings. We intend to release and advocate the planting of clonal mixtures of some 10–15 genetically divergent cultivars. This concept has to be pushed hard as people have short memories and always want to plant the best or most fashionable cultivar.

We must remain vigilant to the danger of illegal imports both in New Zealand and in Australia as there are still serious diseases of poplars and willows which we do not have. Quarantine services must remain affordable and user-friendly so as not to encourage people to indulge in illegal importation.

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