Phytophthora cinnamomi in Native Vegetation in South Australia

T. C. Lee
Adelaide Botanic Garden,
Adelaide, South Australia, 5000
and
T. J. Wicks
Department of Agriculture and Fisheries,
Adelaide, South Australia, 5000

In South Australia, *Phytophthora cinnamomi* Rands was first isolated from ornamental plants in the Adelaide Botanic Garden properties at Blackwood and Mount Lofty (1). Later investigations (1,6) showed that it was widespread in nurseries in metropolitan Adelaide and the Adelaide Hills. In the latter area, the fungus was also isolated from native vegetation, but was restricted to occasional roadside plants and a small area in Cleland Conservation Park (6). It was not detected however, in areas of native vegetation examined in the south east of South Australia (Wicks, unpublished).

In 1975, a survey was undertaken to examine further the incidence of *P. cinnamomi* in native vegetation in some Reserves and Conservation Parks located within 150 km of Adelaide. From August to November, 12 of these areas (Black Hill Conservation Park, Boat Harbour Creek Reserve, Bulls Creek Reserve, Cleland Conservation Park, Cox's Scrub Conservation Park, Hale Conservation Park, Hindmarsh Falls Reserve, Mount Crawford Reserve, Mount Magnificent Conservation Park, Para Wirra National Park, Warren Conservation Park, Willunga Hill Reserve) were examined. In all, more than 500 root and soil samples were collected from both apparently healthy and dying vegetation. Samples were collected from near bases of plants known to be susceptible to the fungus whether they appeared healthy or were chlorotic or dying. Two lots of soil plus roots from each sample were placed in plastic containers and baited with ripening pears (2,3) within a day after collection. *P. cinnamomi* was isolated only from patches of dying native vegetation in Boat Harbour Creek Reserve and Cleland Conservation Park. This paper reports on the association of *P. cinnamomi* with dying plants in these two areas.

Boat Harbour Creek Reserve is situated at the southern tip of Fleurieu Peninsula, approximately 120 km south of Adelaide, and Cleland Conservation Park is situated on the western side of Mount Lofty, approximately 20 km from Adelaide. These two areas are similar in a) topography, which consists of ridges and deep gullies; b) soil, which is a shallow lateritic podzol; and c) vegetation, which is a low open sclerophyll forest. In both areas, the dominant trees are *Eucalyptus baxteri* (Benth.) Maiden and Blakely and *E. obliqua* L'Herit, but the heath understorey is dominated at Boat Harbour Creek Reserve by *Xanthorrhoea semiplana*, F.v.M., and at Cleland Conservation Park by *Leptospermum juniperinum* Sm. The annual rainfall at Boat Harbour Creek Reserve and Cleland Conservation Park are 75 cm and 55 cm respectively (4).

Boat Harbour Creek Reserve

In this area the fungus was isolated from root and soil samples of dying or chlorotic *X. semiplana*, *X. teteana* F.v.M., *Isopogon ceratophyllus* R.Br., *Banksia marginata* Cav., and *Pultenea involucrata* Benth. The *Eucalyptus* spp. did not show any dieback symptoms, and soil samples from near the base of trees did not yield *P. cinnamomi*. Affected *Xanthorrhoea* had chlorotic or dark brown crowns, while others were dead (Fig. 1). Symptoms observed in other species were: chlorosis in *I. ceratophyllus* and *B. marginata*, and reddish leaves in dying branchlets of *P. involucrata*. These symptoms are similar to those described for diseased understorey plants associated with *P. cinnamomi* in the Brisbane Ranges, Victoria (5).

Figure 1 — View of affected vegetation in Boat Harbour Creek.

The patch of affected native vegetation is adjacent to the unsealed access road into the Reserve. Using *Xanthorrhoea* as an indicator plant, a distinct boundary between diseased and healthy vegetation was detected and the affected area was estimated to be about 6 ha. The results of isolations from soil samples obtained along transects through the area, and perpendicular to the road, showed *P. cinnamomi* was associated with dying vegetation inside the affected patch, and not outside with apparently healthy vegetation. Since most plants near the road were dead and those at the margin some distance away were dying, it suggests that the infection started from the edge of the road. The sloping terrain of the area would facilitate further spread of the fungus by freely draining water.

Cleland Conservation Park

The fungus was first isolated from this area in 1973 from a patch of native vegetation near the main bitumen road entering the Fauna Reserve area (6). Extensive sampling at that time indicated that the infection was confined to an area of less than 0.25 ha. In 1975, the area was examined by taking soil and root samples along transects radiating from the original infection. The results of isolations showed that the fungus had spread both uphill, and across the bitumen road downhill, and now affects an overall area of approximately 16 ha. The distribution of the fungus was patchy within this area.

The fungus was isolated from root and soil samples of chlorotic and dieback-affected plants of *L. juniperinum, E. baxteri, E. obliqua, X. semiplana, P. involucrata, Acacia myrtifolia* (Sm.) Wild., *I. ceratophyllus, B. marginata, Epacris impressa* Labill., *Tetratheca pilosa* Labill., and *Leucopogon virgatus* (Labill.) R.Br. The symptoms observed in the dominant species were chlorosis and dieback of terminals of *L. juniperinum*, and thinning of crowns and dieback of branchlets of *E. baxteri* and *E. obliqua*.

These two areas of dying native vegetation in Boat Harbour Creek Reserve and Cleland Conservation Park are the only major areas presently known to be associated with *P. cinnamomi* in South Australia. The presence of *P. cinnamomi* in these areas is of great concern because a) Boat Harbour Creek Reserve adjoins, and partly drains into, Deep Creek Conservation Park; and b) Cleland Conservation Park is a major recreational area for Adelaide and the Park's bush walking tracks traverse the infected area.

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Phytophthora cinnamomi in the Grampians, Victoria

Jill Kennedy and Gretna Weste

Botany Department, University of Melbourne, Vic. 3052

The Grampians, spectacular mountain ranges in Western Victoria, are famous for the colour, profusion and diversity of endemic wild flowers. At least 2000 different vascular plants grow within the area, approximately 1/3 of Victoria's indigenous flora. Twenty species are endemic.

Within the last few years outbreaks of dieback disease due to *Phytophthora cinnamomi* Rands have occurred in many areas. The ranges are mostly state forest and the Victorian Forests Commission has conducted a survey which has shown the pathogen to be widespread along the gravelled roads. Because of its exceptional flora, and dramatic rocky outcrop the Grampians have considerable conservation and tourist value in addition to timber assets. During 1976 a project was initiated to study the invasion of *P. cinnamomi* into the Grampians and an outline of the results is reported here.

The presence of the fungus in the Grampians has not been accompanied by sudden, dramatic destruction of the total forest flora. Nevertheless the gradual destruction of a number of species has resulted in a mosaic of dead and living plants in the invaded areas, especially in localities where the soil is shallow.

Many of the species are susceptible and the soil is characterised by poor water retention, so that its rapid drying-out imposes a great strain on those plants whose fine roots have been rotted by *P. cinnamomi*. Heavy rains during warm months, 1971-6, have favoured sporangial production, zoospore dispersal and root infection. During subsequent dry periods deaths have occurred amongst susceptible plants.

This report records changes due to the disease during 1976 in three experimental plots, compared with controls, all located in heathland and woodland. The evidence strongly suggests that the pathogen has invaded the bush from the gravelled road verge or from gravel pits and has been present for at least 10 years. High populations occur at all depths sampled to 88 cm on site 1 and in lower numbers to 72 and 56 cm in the other plots. Deaths and symptoms of chiorosis and dieback are obvious in the understorey and dieback is now evident among the trees, such that the canopy structure is being lost. Most of the eucalypts belong to the susceptible stringy bark group.

There is a change in the species composition of the flora:—

(1) Eight species have completely disappeared from diseased sites. They are as follows:— *Tetratheca ciliata* Lindl, *Hovea heterophylla R.Br, Acacia mucronata Wild ex H. Wendl, Astroloma conostephiodes Benth, Isopogon ceratophyllus R.Br, Pultenea humilis Benth, Hibbertia fasciculata R.Br,* and *Styphelia adscendens R.Br.*

(2) There is a reduction in percentage cover by another six species, so that these may eventually disappear. They are listed as follows:— *Persoonia juniperina* Labill, *Hakea ulicina* R.Br., *Correa reflexa* Vent., *Leucopogon ericoides* R.Br., *L. virgatus* R.Br., and *Hibbertia stricta* R.Br.

(3) There is an increase in grasses and sedges. This occurs because of their tolerance or resistance to the pathogen, the increase in soil moisture due to decreased transpiration with death of heathland species and the opening of the canopy with eucalypt dieback. For example, *Hypolaena fastigata* R.Br has increased from 35-55%, *Lepidasperma filiforme* Labill from 5-20; whereas highly susceptible species have been reduced 100% and others such as *Xanthorrhoea australis* R.Br. from 28-14%. Despite the reduction of *Xanthorrhoea*, monocotyledons have increased 38% and dicotyledons have decreased 45% in dry weight per 10 m^2. There is no re-emergence of highly susceptible species.

Changes in flora due to *P. cinnamomi* may therefore be recorded in three ways:— as a reduction in species diversity; as a change in species composition; and as a reduction in total percentage cover. The severity of this change is evidenced by the disappearance of eight species from invaded areas, a high reduction in six species, and a 3-5 fold increase in sedges. These changes are more dramatic in downhill areas, although symptoms are also obvious in areas uphill from the road verge.

Downhill, there is an increase in bare ground where susceptible species have disappeared, whereas uphill areas present a mosaic of diseased and apparently healthy plants. This difference is due to the relatively rapid dispersal of the pathogen by water, compared with the very slow growth of mycelium through root contacts.

In the Grampians the disease is not immediately severe, but progressive. The pathogen is responsible for a continuous destruction of susceptible species in the invaded areas. It should be accepted that such destruction will increase both in severity, and in area,