PHYTOPHTHORA HEVEAE, A PATHOGEN OF KAURI

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ABSTRACT

Phytophthora heveae Thompson was isolated from discoloured sapwood and root tissue of unthrifty kauri (**Agathis australis** Salisb.) trees and from soil from affected and healthy stands. Laboratory tests showed that the fungus is capable of killing kauri seedlings.

INTRODUCTION

In early 1972, the officer-in-charge, Great Barrier State Forest, reported that kauri (*Agathis australis* Salisb.) trees on a small area on the island looked unhealthy, while adjoining stands appeared normal. The area was located in Compartment (Cpt) 47 (State Forest 165) above Kaitoke creek no. 2, on a steep slope with a south-westerly aspect. It was in a part of the forest that had been logged in 1931-33, and a few old stumps still remained. The affected area covered about 1.5 ha in which a few saplings and rickers from 5 to 30 cm diameter at breast height (d.b.h.) were dead and the rest had pale green to yellowish foliage and thin crowns. Many of the trees with thin crowns had cankers at the base. The cankers, which sometimes encircled the stem, extended to 45 cm up the trunk and were bleeding gum copiously. Pathogenic fungi were suspected to be the cause of the ill health, and isolations were made in the field and in the laboratory to see if any pathogens could be found.

ISOLATIONS OF MICRO-ORGANISMS

Excavation of soil around the main roots of two of the unhealthy rickers showed that the cankers on the stem were a continuation of cankers on the major roots. These rickers, about 20 cm d.b.h., were felled and small pieces of discoloured sapwood and cambium from within the cankered areas were placed on to plates of 3% malt agar and $P_{10}VP$ agar, the latter a medium formulated for isolation of pythiaceous fungi (Tsao and Ocana, 1969). These two media were also used for plating out discoloured root tissue. Isolations from healthy-looking roots were also made from another area (Cpt 26, west of Mt. Young) where the kauri appeared unaffected. Here, as much soil as possible was washed off the roots with sterile water and pieces of whole roots were placed on plates of the two media.

Samples of topsoil and subsoil were collected in the affected area along a transect which began in the adjoining healthy area (five samples), crossed the diseased area (eight samples), and ended in the healthy area on the opposite side (five samples). Part

of each sample was placed on to plates of $P_{10}VP$ agar in the field and the rest was taken back to the laboratory, where it was baited with newly germinated seedlings of *Lupinus angustifolius* L., a method used for selective isolation of *Phytophthora* spp. (Chee and Newhook, 1965). Ten soil samples were collected in Cpt 26 and they were similarly treated.

Results of the isolations from kauri tissues and lupin baiting are given in Table 1. A species of *Phytophthora* and a species of *Pythium* were the only fungi isolated from kauri tissues and roots on both the non-selective 3% malt agar and the selective $P_{10}VP$ agar. The soil plates from the affected area as well as the healthy area yielded these two organisms and a number of other, mainly mucoraceous, fungi.

TABLE 1—Results of isolations from kauri tissue and soil on 3% malt agar and $P_{10}VP$ agar

Isolated from	No. of samples	**Phytophthora** sp.	**Pythium** sp.	None
1. FIELD ISOLATIONS				
a. Diseased area				
Discoloured sapwood	18	16	0	2
Discoloured root tissue	5	4	0	1
b. Healthy area				
*Roots	10	6	2	2
2. SOIL ISOLATIONS (LUPIN BAITS)				
a. Diseased area				
Soil from adjoining healthy stands	10	6	1	3
Soil from diseased area	8	4	1	3
b. Healthy area				
Soil	10	4	2	4

* The roots could not be freed entirely of soil. The isolates may have come from either the roots or the soil or from both. The results of isolations on $P_{10}VP$ agar only are given.

PATHOGENICITY TESTS

Preliminary pathogenicity tests were made with the *Phytophthora* sp., the *Pythium* sp., and with *Phytophthora cinnamomi* Rands isolated from a nursery soil. *P. cinnamomi* was included because it has been claimed to be pathogenic to kauri (Podger and Newhook, 1971). Mucoraceous fungi isolated on soil plates were not included because they were deemed to be non-pathogenic. The three fungi under test were grown separately on sterilised oat seeds, and a single oat grain covered in mycelium was placed in an incision made at the base of a 60-cm-high kauri seedling growing in nursery potting mixture. The incision was covered over by grafting tape. Oat grains covered with mycelium were also introduced into the soil around the roots of other seedlings without any intentional wounding, although some roots were undoubtedly injured in the process. Sterile oat grains were used to inoculate control seedlings. Only the *Phytophthora* sp.

isolated from kauri tissues and soil was shown to be pathogenic (Table 2, A and B) under these conditions.

TABLE 2—Results of pathogenicity tests

Method of inoculation	Fungal species	Total no. of seedlings	No. dead	No. alive	Time elapsed between inoculation & observation
A. Wound inoculation	**Phytophthora** sp.	2	2	0	1 month
	Pythium sp.	2	0	2	
	Phytophthora cinnamomi	2	0	2	
	Control	2	0	2	
B. Direct soil inoculation	**Phytophthora** sp.	4	3	1	4 months
	Pythium sp.	2	0	2	
	Phytophthora cinnamomi	2	0	2	
	Control	4	0	4	
C. Indirect soil inoculation	**Phytophthora** sp.	13	12	1	6 months
	Rhizopus nigricans	1	0	1	
	Control	6	0	6	

Further tests were made using only the *Phytophthora* sp. Seventy-six-cm-high seedlings growing in 18-cm-diameter polythene tubes containing nursery potting mixture were used. Twenty holes, approximately 1 cm^2, were cut in the wall of each tube. Each tube was placed in a 27-cm-diameter undrained bucket. Nursery potting mixture containing 185 g of oats on which the *Phytophthora* sp. had been grown for 22 days was packed around the tube. Sterilised oats, and oats on which *Rhizopus nigricans* Ehrenberg (isolated on soil plates from the diseased area) had been grown, were used as control inocula. Care was taken to avoid overwatering. Results of the test are given in Table 2 C. The first kauri seedling died 2 months after inoculation with the *Phytophthora* sp. The *Phytophthora* sp. alone was isolated from the cankers which formed at the base of dead seedlings.

THE PATHOGEN

When freshly isolated, the mycelium of the *Phytophthora* sp. was coralloid (Fig. 1). Sporangia and oogonia were produced in abundance on 3% malt agar and on corn meal agar. The sporangia (30-45 μm × 18-25 μm) were papillate and the oogonia (25-33 μm diameter) had funnel-shaped bases and amphigynous antheridia (Fig. 2). Dr J. Stamps of the Commonwealth Mycological Institute kindly identified the fungus as *Phytophthora heveae* Thompson.

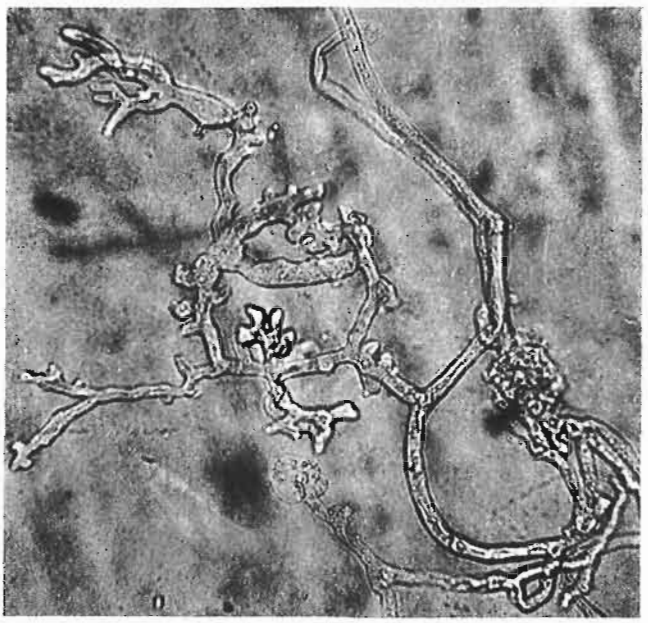

FIG. 1—Coralloid mycelium of **Phytophthora heveae**

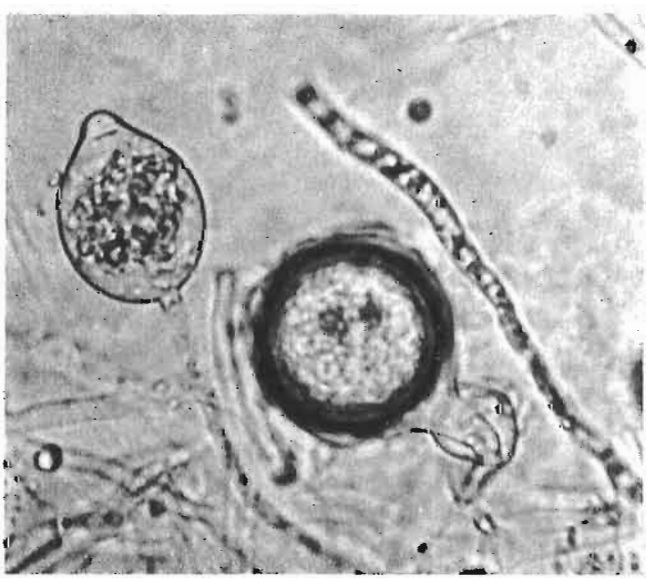

FIG. 2—A papillate sporangium and an oogonium with an amphigynous antheridium of **P. heveae**

DISCUSSION

This is the first published record of *P. heveae* as a pathogen of kauri in New Zealand although, according to Commonwealth Mycological Institute records, it has been isolated once before in New Zealand (A. Johnston, pers. comm.). Its pathogenicity in laboratory tests and the fact that it was the only fungus isolated from internal tissues of unthrifty kauri trees on a non-selective (as well as a selective) medium show that *P. heveae* is likely to be the cause of the ill health and death of kauri in the small area on Great Barrier Island. It is interesting that *P. heveae* was isolated not only from the diseased area but also from soil from areas with healthy-looking kauri. It would seem that the pathogenic activity of the fungus is governed by environmental factors which have still to be elucidated. Wet soil conditions probably favour this activity; in the summer of 1972-73, Great Barrier Island experienced prolonged drought and it was observed that the foliage of kauri in the diseased area had regained its normal green colour (W. Young, pers. comm.).

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