INSECT AND FUNGAL DEFECTS IN RED AND SILVER BEECH

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ABSTRACT

In a mixed stand of pole-sized red beech and silver beech, pathological wood (a defective core) was present in 92% of the red and 68% of the silver beech sampled. Pinhole borer (**Platypus** spp.) attack had invariably led to the formation of pathological wood in both species, and in red beech, an additional type of pathological wood often not associated with **Platypus** holes or other wounds, was present in at least 22% of the trees. All stem rots were associated with pathological wood.

INTRODUCTION

Increased utilisation of the West Coast beech forest depends on demand for the produce. A study by the Utilisation and Development Division of the New Zealand Forest Service in 1973-74 showed that an additional 10 million board feet per annum would be required to satisfy the existing market for beech timbers. However, almost 90% of this unsatisfied demand was for high grade, defect-free timber (Foley, 1975). If management of regenerated beech forests is to be directed towards providing high quality timber, further information on the occurrence and causes of defects in living trees is essential. Butt rots, stem rots, and damage by wood boring insects (chiefly the native species of *Platypus*) account for a very large proportion of the defects which are encountered in beech sawlogs (Cutler, 1966; Purnell, 1965; Coates, 1972).

The nature and consequences of *Platypus* attack on living beeches has been described (Milligan, 1972, 1974; Kershaw, 1969; Coates, 1972; Faulds, 1973). Milligan (1969) first showed that mortality in red beech (*Nothofagus fusca* (Hook f.) Oerst.) could occur as a result of *Platypus* attack. Inoculation experiments by Faulds (1973) have shown that micro-organisms, and in particular a fungus associated with *Platyus* damage can be responsible for inducing sapwood discoloration in red beech. Subsequent experiments (Faulds, 1977) have shown that inoculation with this fungus can result in death of the tree, apparently due to loss of conducting sapwood. The term "pathological wood" was used by Milligan (1972) to describe discoloured wood, frequently present in the stems of all beech species, that could not be attributed to normal heartwood formation. In a disc, pathological wood is distinguishable by an irregular margin, often with narrow radial prolongations, and is non-uniform in colour.

The only substantial observations on *Platypus* attack on living silver beech (*Nothofagus menziesii* (Hook f.) Oerst.) apply to managed stands in Southland (Kershaw, 1969; Coates, 1972).

Coates showed that more than 70% of stem rots were associated with insect damage. Cutler (1966) in studies of timber defects in red, silver, and hard (*Nothofagus truncata* (Col.) Ckn.) beeches in Westland, found that stem rots, which he distinguished from butt rots, were often associated with dead branches, although the presence of dead branches did not always permit rots to enter the stem. He postulated that broken branches or those which died rapidly, might allow rots to enter the stem, while those which died as a result of normal suppression formed sealing tissue at the base which prevented rots from entering.

Investigations into other indigenous tree species may show similar phenomena are not uncommon. Shigo (1966, 1967) in studies of North American hardwoods has described discolorations and successions of causative organisms in a wide range of tree species, with particular reference to wounding.

Materials and Methods

The site chosen for the study is situated near McCallums Flat on the north bank of the Upper Grey River in the Reefton district and consists of alluvial river terrace covered largely with pole-sized red and silver beech. As no managed stands of comparable age exist on the West Coast, a naturally occurring pole stand was considered to be the nearest to a managed situation. As a guide to the stocking of trees over 17 cm d.b.h. (the lower limit selected for the study) all red and silver beeches, both living and dead, were tallied on ten 0.1-ha plots within the study area (Table 1).

TABLE 1—Inventory of standing trees >17 cm d.b.h.

	Living trees stems/ha	Dead trees stems/ha	% Dead
Red beech	310	54	15
Silver beech	240	13	5
Total	550	67	11

From visual inspection of the site it appeared that exposure to unusually strong winds coupled with a higher-than-average water table, had resulted in periodic windthrow over much of the area giving a fairly even-aged stand, presently aged around 70-100 years.

Sampling involved felling and sectioning one hundred trees (50 of each species) and was carried out according to the prescription used by Coates (1972) in his study of silver beech at Woodlaw State Forest, Southland, viz:

1. The lower 3 m of stem was sectioned into 30-cm lengths, the cut faces of which were examined for defects and evidence of insect attack.
2. If no defect was found, the entire log was assumed free of defect and classified as clean (some upper logs were further sectioned to examine the validity of this assumption and in no case was insect attack or defect evident).

3. If defect was present, the log was further sectioned at 30-cm intervals to a point 3 m above the last recorded defect or otherwise to a maximum height of 12 m.
4. All sections containing defect were split to locate insect holes and entry points of rots. Insect attacks were dated by counting annual growth rings where this was possible.

Defects were categorised as follows:
1. Pathological wood associated with insect damage or other wounds.
2. Pathological wood not associated with either of the above.
3. Stem rots.

Insect attack was classified according to the diameter of hole, i.e.,
1-mm hole (*Platypus gracilis* : Platypodidae)
2-mm hole (*P. apicalis* or *P. caviceps* : Platypodidae)
4-mm hole (*Psepholax* sp : Curculionidae).

Results

Total numbers of defective trees and total insect attacks have been summarised in Table 2. Few *Psepholax* attacks were found and these were present only in trees also attacked by *Platypus* and are therefore not considered an important cause of defect. The different intensity of *Platypus* attack occurring on red and silver beech is more obvious when attacks over the last 10 years only are considered (Table 3). Red beech had proportionately fewer older attacks than silver beech (Fig. 1).

TABLE 2—Comparison of defects in Red and Silver Beeches

	Red beech	Silver beech
Total no. of **P. gracilis** holes	1144	2310
Total no. of **P. apicalis** and/or **P. caviceps** holes	3250	587
Total no. of **Psepholax** holes	20	47
No. of trees with **P. gracilis** holes	14	17
No. of trees with **P. apicalis** or **P. caviceps** holes	30	19
No. of trees with **Psepholax** holes	5	11
Total no. of trees with insect attack	31	26
No. of trees with defect associated with other wounds	4	8
No. of trees with defect — no apparent cause	11	0
No. of trees with rots	15	10
No. of trees with no defects	4	16

TABLE 3—**Platypus** attack 1964-74

	Red beech	Silver beech
Total no. of **P. gracilis** holes	981	39
Total no. of **P. apicalis/P. caviceps** holes	2949	418
No. of trees with **P. gracilis** holes	14	7
No. of trees with **P. apicalis/P. caviceps** holes	29	8
Total no. of trees with **Platypus** attack	30	13

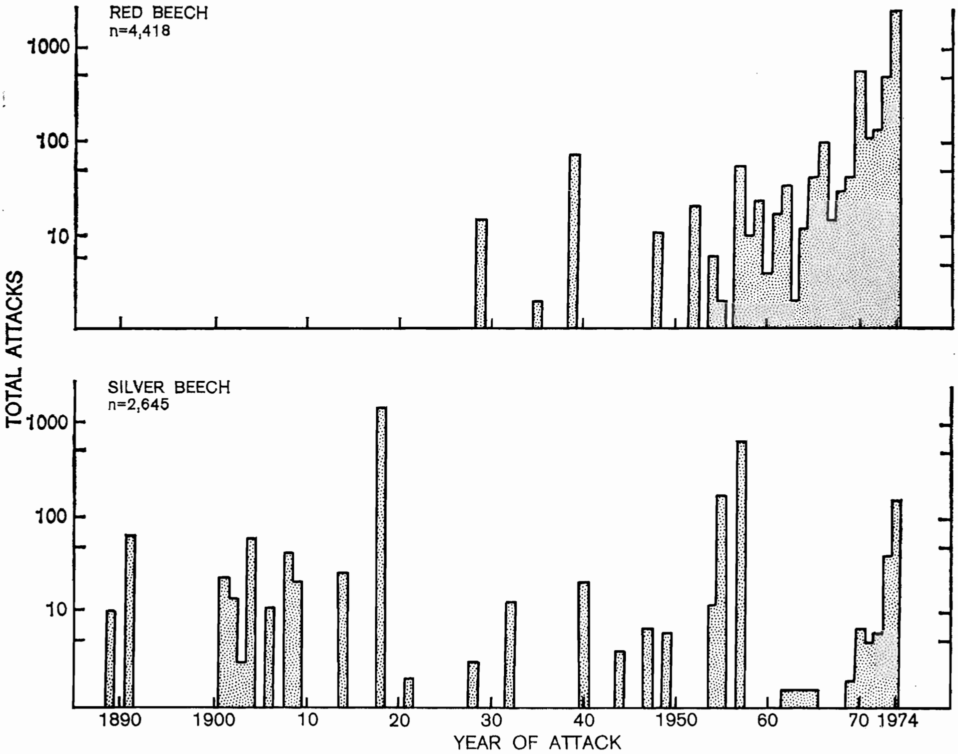

FIG. 1—Years when **Platypus** attacks occurred, based on ring counts of the study trees.

Larger diameter trees had more *Platypus* attack than smaller trees (Table 4). Density of attack also decreased progressively up the stem as is shown by the aggregated data in Fig. 2. However, the pattern of attack on individual trees varied considerably and the trend is apparent only over a large sample. Visual assessment of bark type also supports the findings by Coates (1972) that the *Platypus* species show no preference for smooth or rough bark.

TABLE 4—**Platypus** attacks on trees in two diameter classes (17-25 cm d.b.h. and >25 cm d.b.h.)

	Red beech		Silver beech	
	17-25 cm	>25 cm	17-25 cm	>25 cm
P. gracilis	1	1122	75	2149
P. apicalis and **P. caviceps**	86	3117	179	377
Total attacks	87	4239	254	2526
No. of trees	19	31	25	25
Mean attack per tree	4.6	137	10.2	101
Mean d.b.h. of total				
Red beech	mean 27.6 cm S.D. 6.1			
Silver beech	mean 27.5 cm S.D. 8.9			

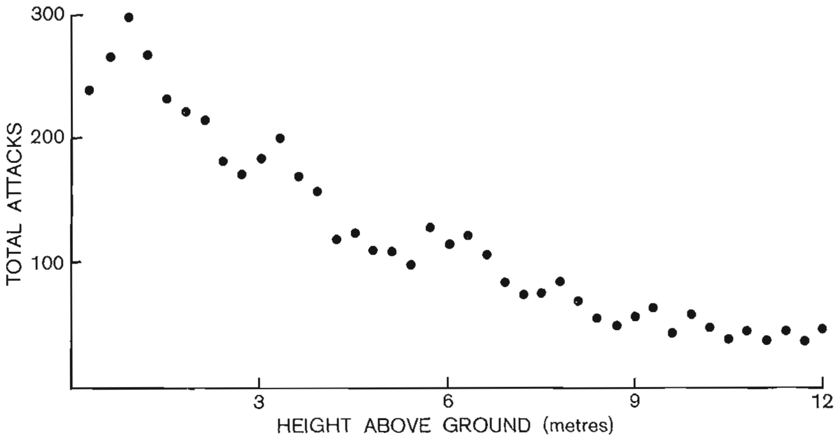

FIG. 2—Points represent the total attacks in successive 30-cm lengths from 50 red and silver beech.

A type of pathological wood not previously reported, and not associated with *Platypus* attack or wounds, was present in at least 22% of red beech trees. This defect (Fig. 3) was distinct from that associated with *Platypus* attack (Fig. 4), the margin (as seen in a transverse stem section) tends to be sinuate rather than stellate, and micro-

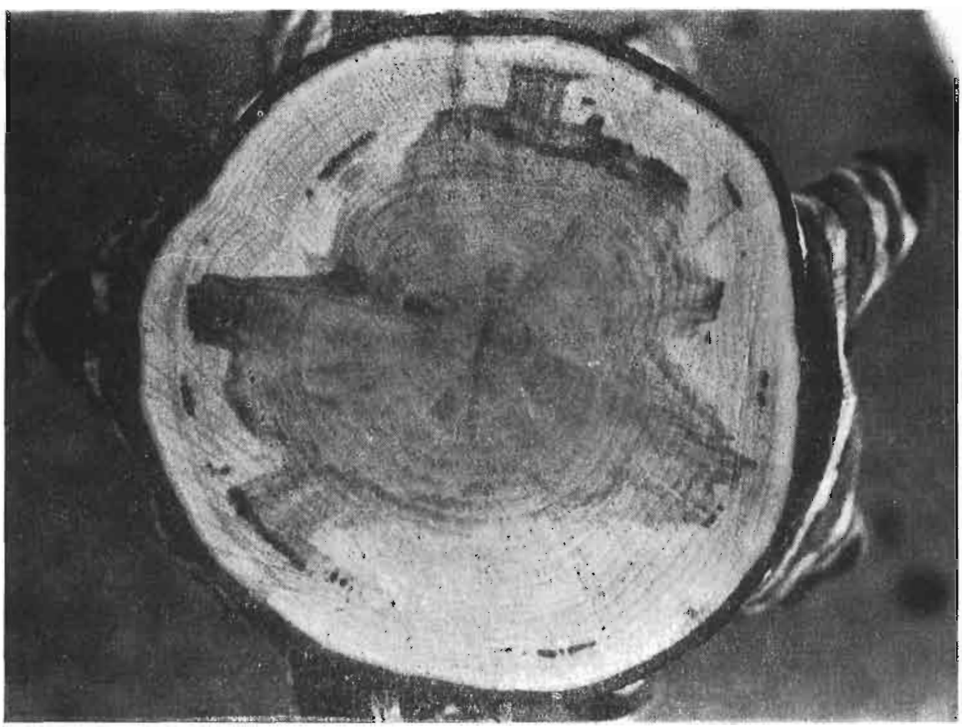

FIG. 3—Pathological wood in red beech caused by a pathogen introduced by **Platypus.**

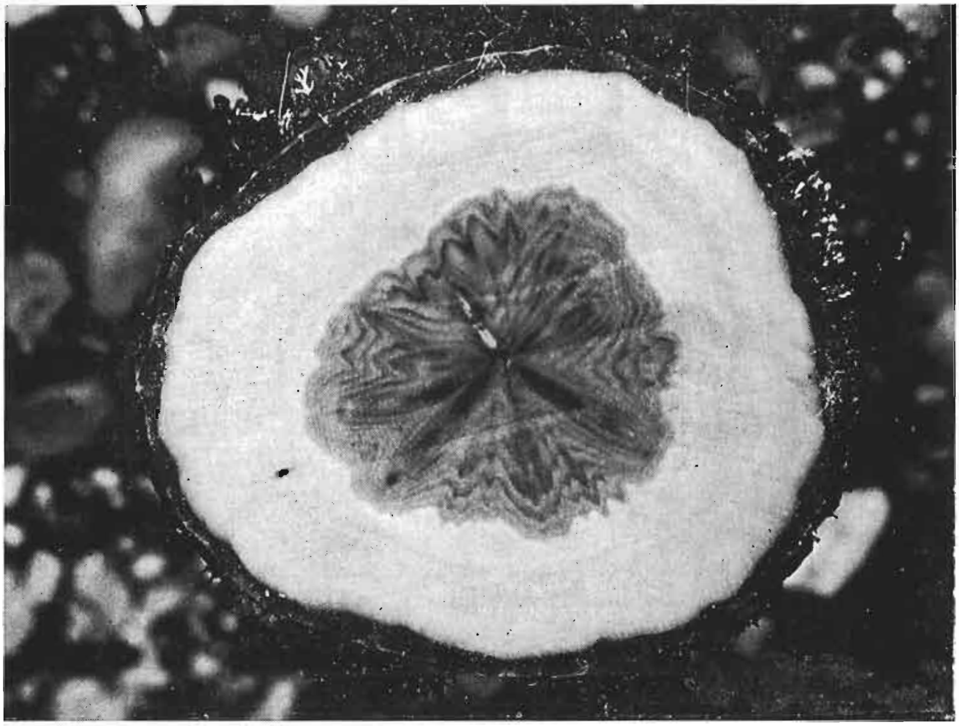

FIG. 4—Pathological wood in red beech caused by an unknown agent. The black lines possibly represent periodic advancement of the dead core.

scopic examination of the wood failed to reveal the presence of fungal hyphae. Until a pathogen has been shown to be responsible, the term pathological wood, by definition, may be inappropriate. However, it shares similarities in appearance and properties with the pathological wood associated with *Platypus* attack (in which fungal hyphae are readily found) and a pathological cause is at least a possibility. This wood was invariably found to be continuous with the butt and was often confined to the lower 3 m of stem. Since this second type of pathological wood was not recognised as distinct until part way through the study, an accurate estimate of its occurrence is not possible but it is almost certainly higher than indicated in Table 2 where it is recorded as "defect no apparent cause".

Thirty-five separate incidences of core rots were recorded from 25 trees. None occurred in the absence of pathological wood; none occurred unless there had been a pathway from the exterior provided by a dead branch or a wound.

DISCUSSION

The results of this study are not necessarily applicable to beech forests as a whole as the site chosen is probably atypical owing to the severity of the periodic windthrow. Nevertheless, the relative susceptibilities of red and silver beech to *Platypus* attack, and subsequent tree mortality, are likely to apply wherever mixed stands occur. Table 2 indicates that total *Platypus* attacks on red beech were about one and a half times as numerous as on silver beech. Considering the variability in the intensity of attack to individual trees, this probably does not indicate a marked preference for red beech. However, when only those occurring in the past ten years are considered (Table 3) attacks on red beech are 8-9 times as numerous as on silver beech. Additionally, all except one of the red beech trees with attacks, had sustained all or part of these in the last ten years, whereas half the silver beech had been attacked only prior to this. An explanation of why such a small proportion of attack on red beech, compared with silver beech, occured prior to the last ten years could be that during this period, more red than silver beech died following heavy attack. Therefore, fewer heavily attacked red beech survived to be included in the sample. This is substantiated by the higher proportion of dead red beech present in the stand at the time of sampling (Table 1).

The preference shown by *Platypus* for larger diameter trees (Table 4) has not been satisfactorily explained. Many larger trees are older and have therefore been exposed to attack over more seasons than smaller trees.

Longer exposure and greater surface area may be expected to lead to a greater number of attacks but the difference between large and small trees is too great to be accounted for solely on this basis and it seems likely that trees become more attractive with increase in size, growth rate, or both. Kershaw (1969) found that current attack to silver beech at Rowallan S.F. occurred in 80% of the trees in the diameter range 53-64 cm and in only 12% of those under 20 cm d.b.h. Milligan (pers. comm.), in yearly assessments of thinned silver beech plots in Longwood S.F., Southland, found that *Platypus* attack over a three year period was correlated with mean growth rate during the period but not with mean diameter at the end of the period. If growth rate is important, this could partially explain the lower incidence of *Platypus* attack to silver beech in this study. In a mixture of red and silver beech, the latter usually are sub-dominants which presumably grow more slowly than the dominant red beech.

The association of rots with pathological wood formation suggests that, at least in pole-sized trees, establishment of rots depends on a dead non-durable core. Shigo (1965, 1967) reports similar events in many North American tree species and found that decay fungi were usually preceded by non-decay organisms. However, rots are unlikely to become established unless there is continuity between the core and dead wood at the surface, such as provided by dead branches. Cutler (1966) noted that branch stubs only sometimes permitted the entry of rots and suggested that the rate of branch death and the formation of sealing tissue might be critical factors. Shigo (1965) investigated discoloured columns of wood associated with dead branches and attributed these directly to pathogens entering through the branch stub, sometimes followed by decay fungi. This study suggests that branch stubs serve as pathways for stem rots only where a core of pathological wood already exits.

Platypus attack invariably leads to pathological wood formation, but the occurrence of irregular cores in red beech in the apparent absence of *Platypus* attack or other wounds is still unexplained. As its lower limits were not determined, no conclusion can be drawn as to whether a root pathogen may be involved.

A more detailed appraisal of the factors affecting both types of pathological wood may be required before any substantially defect-free timber can be assured from managed stands and, even then, perhaps only from selected sites. Unless management greatly reduces windthrow, areas such as that selected for this study are unlikely to yield a high proportion of defect-free timber because of attack on the living trees by *Platypus* emerging from windthrown material. In addition, climate and soil may have an influence on the incidence of both types of pathological wood.

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