Stahl + Greaves 1959
P. cinnamomi W.A historical

REPORT ON A TRIP TO DWELLINGUP, WESTERN AUSTRALIA, FROM 7.9.59 TO 20.9.59, TO INVESTIGATE DIE-BACK IN JARRAH.

1. The Disorder.

Eight days were spent in the Dwellingup area of Western Australia investigating the disorder of jarrah (Eucalyptus marginata) known locally as die-back. The purpose of the investigation was to find out whether or not a pathogen was involved.

Several days were spent gaining an overall appreciation of the disorder and areas inspected, included healthy virgin and cut over bush, and disordered stands in pole regrowth, mature forest and isolated occurrences in virgin bush.

As has been reported before, (Hamilton 1951), Wallace & Hatch 1953), the disorder affects the whole plant community. Generally, only very limited areas of jarrah with dense crowns were observed, and there are no readily apparent signs in the jarrah crowns that an area will become a die-back area. Almost always, the first definite indications of the disorder are the massed deaths of Persoonia longifolia and Banksia grandis. There are also isolated deaths of Macrozamia reidlii and Xanthorrhoea preissii, but with these last species the deaths appear to be spread over a period of several seasons. Shortly after the death of the banksia understory, individual jarrah trees become moribund and die, and over a period, most of the jarrah in the area will die.

Although marri (E. calophylla) on these areas seldom dies, most appear unthrifty. Over a period, the surviving marri restock their immediate surroundings, although some areas (e.g. parts of Park Block) have not regenerated or are very slow in doing so.

2. The nature of occurrences in the localities inspected.

Inspections were made in the Gleneagle, Dwellingup, Marga Brook and Tallanalla area. The occurrence and apparent spread of the disorder in these areas is not inconsistent with the spread of a pathogenic organism, as the disorder appears to start from an outbreak point and spread outwards from that point. The rate of spread may vary with time and is not necessarily equal in all directions. Further, the disorder is now known to occur on a wide variety of topographic and forest quality situations in both cut-over and virgin stands.

3. Detailed Investigations.

Jarrah, banksia, macrozamia and persoonia were inspected in the following situations:-

(1) Healthy virgin bush (Chalk Brook).

(2) Disordered " " (Dell Park).

(3) Healthy and disordered mixed veteran and regrowth stands(Huntly).

(4) Healthy and disordered regrowth pole stands (Holmes Block).

In each case, several individuals were felled and the crowns inspected. The bark was then removed from the boles and some of the branches and twigs, and the phloem and wood inspected. A portion of the root system was excavated and inspected in most cases.

4. Results.

(a) Jarrah.

(1) Leaves. Two leaf spots with fruiting bodies were present on living leaves, and these will have to be identified.

A yellow mottling, perhaps indicative of a virus was also found on some leaves of nearly all trees felled. The leaves were typically falcate, which is unusual for jarrah, and the mottling appeared mostly on the inside half of the curved leaf. However, since this mottling was more common on the few marri crowns inspected, no definite conclusions can be drawn until further investigations are carried out. On one tree examined, all the epicormic shoots in the crown had a swollen appearance, similar to shoots in tomato plants affected by "big bud" virus. This also suggests a virus, but as it was found on only one tree, it is unlikely that it is an important factor. On some trees felled, it was noticed that the newly formed epicormic shoots had wilted, and a fungus with fruitifications was found beneath the bark of these epicormic twigs.

There was evidence of abundant attack by a wide variety of insects, including skeletonisers, leaf miners, scale insects, lerp insects and mites. It would appear that these are not the prime cause of the disorder, but should a virus be involved, the sap-sucking insects such as scale insects and lerp insects could be possible vectors.

(ii) The Stem.

Portion of the bark was removed from the bole, branches and twigs of each of thetrees examined. In many of the trees inspected in severe die-back areas, a thin sheet of kino was present just beneath the surface of the sapwood. This kino gave the normally white surface of the sapwood a pale-blue appearance. Kino sheets were most frequently encountered on the upper bole and because of this, it is unlikely that they were caused by fire. Also, they were seldom associated with branch shed or epicormic shoots.

On the upper parts of the bole and on the branches were found narrow lines of kino which went around the trunk normal to its long axi The phloem adjacent to these lines was stained a dark brown colour. These lines appeared to have resulted from insects boring in the cambia region, but definite evidence supporting this was not found.

Wood rots occurred in the heartwood of some trees, but they did not appear to have any connection with the incidence of die-back.

On one recently killed tree, fungal infection of the vessels was found. Such infections are known to be able to cause wilting. In many wood samples from trees in affected areas, the sapwood showed excessive tylova and this could also induce wilting.

Recently dead trees were attached by a variety of wood and bark-boring insects (esp. ~~Cerambycids~~ Cerambycids and Buprestids) and by fungi, but this attack is considered to have occurred after the death of the tree. While the boles and crowns in such trees were dead, the lower bole and roots frequently still appeared to be living.

(iii) Roots.

Portion of the root systems of several living and dead jarrah trees were excavated. In both types there was no evidence of unusual insect attack or of a large proportion of dead roots. There was, however, abundant fungal growth (presumably saprophytic) on the bark of the smaller roots from both the living and dead trees. No conclusions could be drawn from this small study as many small roots were lost in the excavations, owing to the nature of the soil.

(b) Banksia grandis.

In the live portions of living plants, there was no evidence of fungal infestations. In many small plants a pith borer (probably a Curculionid) was present in the bulbous root stock. In dead portion of living branches and in dead branches in living trees, there were numerous ambrosia beetles and ants. Fungi were common on living leaves.

Following the death of the plant, decay was extremely rapid and many fungi termites, borers and ants were found in the dead wood.

(c) Macrozamia reidlii.

Many macrozamia plants, in both healthy and unhealthy areas were characterised by a curling of the terminal portions of the leaves. It was also noticed that the cones on most plants failed to reach maturity.

In the lower portion of the leaves on some plants, there was a heavy infestation of mealy bugs. Curculionid beetles were also common in the leaf bases, but these were probably hibernating as there was no evidence of damage.

The growing points and the roots appeared to be identical in healthy and yellowing points.

(d) Persoonia longifolia.

Only very limited investigations were carried out on this species, as they are not (at least in numbers) an important component of the forest.

There was no apparent infectation of any description in living trees, but the terminal portions of roots up to 1 inch diameter were dead in unthrifty trees.

4. Discussion.

From the above, it can be seen that the problem is a complex one. Virus like symptoms have been noted on the leaves of some trees and the location and mode of spread of the disorder is not inconsistent with that of a virus. However, further work would be required to determine whether this mottling is due to a virus and should a virus be shown to exist, then the possibility of insect

vectors would also have to be investigated.

Harding was unable to transmit a virus, but his work also was not exhaustive. We were unable to check on Harding's work as the W.A. Forests Dept has no records of the details of his work.

No evidence has been recorded to suggest that the disorder is due solely to insect damage and observations made during this investigation support this view. Observations also preclude the possibility of an insect borne fungus as in both living and near dead jarrah no signs of extensive fungal attack were noted.

Frequent infestations of banksia by ambrosia beetles (together with the associated wood stain) were noted. As these were found only in dead or dying portions of banksia primary attack by the beetles would need to be demonstrated when they are again active. This is necessary as the possibility that the infections were initiated in living wood last season cannot be excluded at the present state of knowledge. If this last possibility is true, then a general decline in vigour may be a prior requirement.

In the excavation of the banksia root systems, numerous root structure, which could be ectotrophic mycorrhyza, were observed in the fine roots. The close association of banksia and jarrah deaths could perhaps be explained by a mycorrhyzal upset in which the ectotrophic mycorrhyza on the banksia become parasitic on the jarrah after the death of the banksia. This is doubtful, however, because jarrah is often in an unthrifty condition ahead of banksia deaths and also, banksia is not an understory species in all occurrences of the disorder.

There are no obvious signs of mycorrhyza on fine jarrah roots, but should they exist, an upset in this, brought about perhaps by adverse changes in environmental factors, might cause the death of the trees. Further work is also indicated in this field.

One unexplained feature which was encountered during the course of the investigation was the presence of the thin sheets of kino in dying trees, just below the current year's growth. These do not appear to be associated with any of the forms of injury described by Jacobs. The possibility that the thin sheets of kino are associated with a virus cannot be eliminated.

5. Conclusion.

With the possible exception of a virus, there is no evidence that a pathogen is the sole cause of the disorder. The problem is very complex and the investigation has indicated that mycorrhyzal and fungal pathogens may be possible contributing factors. However, further work in these fields, if carried out thoroughly, would entail considerable work.

E. Stehl.

R. Greaves.

30.1.1959.