Twig, Branch, and Upper Trunk Cankers of *Eucalyptus marginata*

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ABSTRACT

Davison, E. M., and Tay, F. C. S. 1983. Twig, branch, and upper trunk cankers of *Eucalyptus marginata*. Plant Disease 67:1285-1287.

Cytospora eucalypticola, Discosporium eucalypti, Endothia havanensis, and *Botryosphaeria ribis* were associated with twig, branch, and upper trunk cankers of *Eucalyptus marginata* (jarrah). *B. ribis* and *Endothia havanensis* caused lesions in the phloem when inoculated into jarrah coppice and saplings; *C. eucalypticola* and *D. eucalypti* persisted in the phloem but did not cause lesions. Limited sampling of cankers on other eucalypts native to or widely grown in Western Australia showed that *C. eucalypticola, B. ribis*, and *E. havanensis* have a wide host range.

Jarrah (*Eucalyptus marginata* Donn ex Sm.) is the most important timber tree in Western Australia, where it occurs throughout the Mediterranean climatic region in the southwest portion of the state (3). Prime jarrah forest, where jarrah occurs in pure stands or in association with *E. calophylla* R. Br., covers an area of about 1.6 million ha on the deep, generally well-drained, lateritic soils of the Darling Range (5) (Fig. 1). Other eucalypts that have a more restricted distribution in the jarrah forest include *E. accedens* W. V. Fitzg., *E. diversicolor* F. Muell., *E. megacarpa* F. Muell., and *E. wandoo* Blakely (5).

Although dead twigs and branches are common on jarrah trees throughout the forest, fungi associated with twig and branch death have never been investigated. Cankers, if they completely girdle a limb, will cause twig and branch death. This paper reports an investigation of cankers in twigs, branches, and upper trunks of jarrah.

MATERIALS AND METHODS

Samples of recently dead twigs, branches, and upper trunks from jarrah trees in the northern jarrah forest and Swan Coastal Plain (Fig. 1) were collected during 1981 and 1982. In addition, branches showing long-standing apical death and subsequent development of epicormic shoots were also sampled. When recently felled trees were available, the periderm was removed and the phloem was examined for necrotic lesions. Cankers from several other forest eucalypts or eucalypts indigenous to eastern Australia that are used for planting on rehabilitated mine sites (*E. globulus* Labill., *E. resinifera* Sm., and *E. saligna* Sm.) were also sampled.

Tissue from the margins of necrotic lesions in the phloem and from healthy phloem was surface-sterilized with 70% ethanol for 5 sec and plated onto half-strength potato-dextrose agar (½PDA) (19.5 g Difco PDA, 7.5 g Gibco agar per liter) and 0.2% malt agar (2 g liquid malt, 15 g Gibco agar per liter). The plates were incubated at 20 C under near-UV light.

Pathogenicity of the fungi isolated was tested on jarrah coppice stems and saplings in the forest (young coppice 3–5 m tall, 5–8 cm in diameter, old coppice 7–10 m tall, 15–20 cm in diameter, and saplings 3–4 m tall, 5–7 cm in diameter). Holes 6 mm in diameter were drilled into stems to about the depth of the cambium. A 5-mm plug of fungus growing on ½PDA was pushed into the hole, sterile water added, and the hole sealed with Vaseline. Control inoculations were made in the same way using plugs of agar without test fungi. Inoculations of different fungi were done on the same stem, and stems from the same stump were harvested between 1 and 8 mo after inoculation (Table 1). Inoculations were done in winter, spring, and summer with one or two isolates of the test fungi. When stems were harvested, the periderm was removed either before or after splitting through the point of inoculation. Pieces of tissue from the margins of necrotic lesions were surface-sterilized, plated onto ½PDA, and incubated under near-UV light at 20 C.

RESULTS

Symptoms. Cankers in jarrah were obvious on the smooth bark of twigs and juvenile branches, and conidiomata were frequently embedded in the dead periderm (Fig. 2). Because the outer bark of persistent branches and trunks is rough and fissured (10), cankers could be located only if the periderm was removed and the necrotic phloem exposed (Figs. 3 and 4). Cankers girdled some branches and trunks and extended as necrotic strips down the branches (Fig. 4). Discoloration of the xylem was associated with phloem death; although kino (8) was associated with some cankers, it did not form consistently.

About 25% of the cankers examined were associated with obvious insect damage that ranged from oviposition sites on small twigs to Cerambycid, Buprestid, and Scolytid galleries in branches and trunks.

Isolations. Four fungi (*Cytospora eucalypticola* van der Westhuizen, *Endothia havanensis* Bruner, *Discosporium eucalypti* Sutton & Davison, and *Botryosphaeria ribis*, Grossenb. & Dugg.), singly or in combination, were isolated from 105 of 108 cankers sampled. They were not isolated from healthy phloem. *C. eucalypticola*, the most common fungus, was isolated from about 60% of the cankers and with about equal frequency from twigs, branches, and trunks. *D. eucalypti* was isolated from about 35% of the cankers, with little difference in frequency of isolation from limbs of different diameters. *E. havanensis* was most commonly isolated from twigs up to 0.5 cm in diameter; in branches and trunks, it was usually isolated from discrete phloem lesions. *B. ribis* was

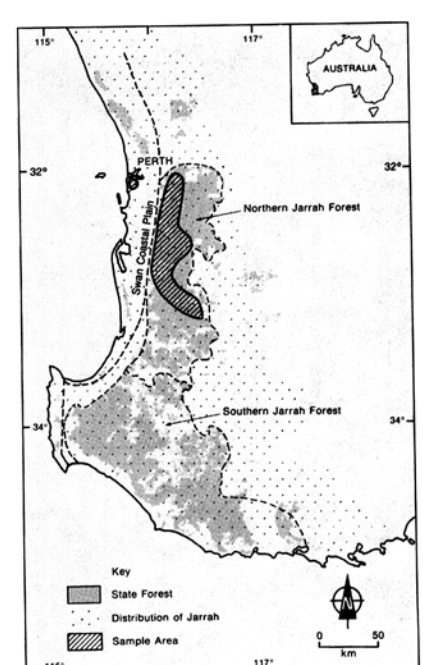

Fig. 1. Distribution of jarrah and sampling area in Western Australia.

Accepted for publication 8 July 1983.

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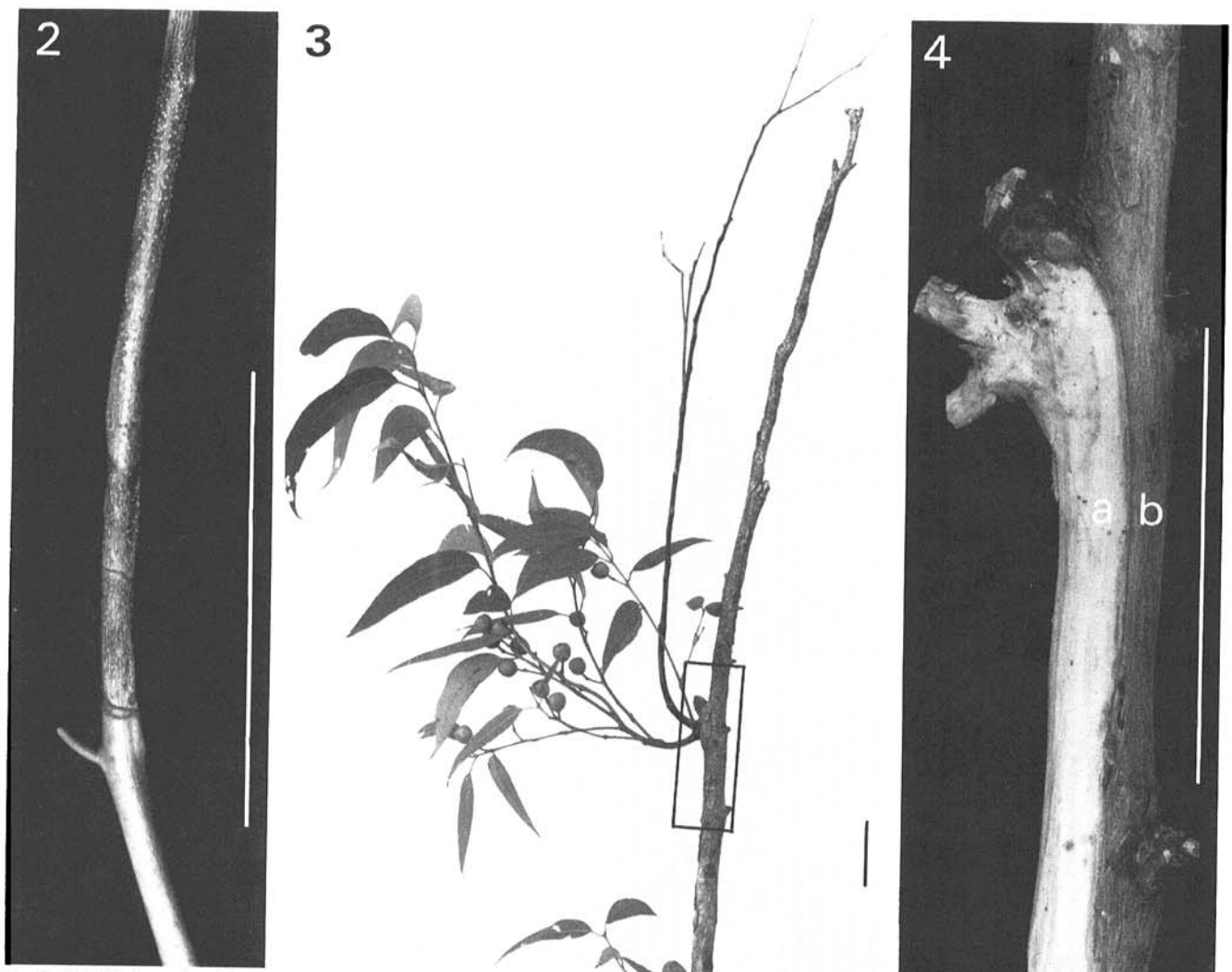
isolated from about 10% of cankers on twigs, branches, and trunks. When it occurred, there was no association between insect damage and any of the four fungi. *E. havanensis* was associated with frost-damaged jarrah and *Eucalyptus calophylla* on one site.

Other fungi isolated occasionally from cankers included *Cephalosporium* spp., *Harknessia eucalypti* Cke. apud Cke. & Harkn., *Pestalotiopsis* sp., *Phialophora* sp., *Phytophthora nicotianae* van Breda

Table 1. Pathogenicity of fungi associated with cankers on *Eucalyptus marginata*

	Inoculation dates, plant material inoculated, and harvesttimes					
	10 June 1981 (young coppice; 2, 4, 6, 8 mo)		22 October 1981 (young and old coppice, saplings; 2, 4 mo)		17 February 1982 (young and old coppice; 1, 4, 8 mo)	
Test fungus	Successful inoculations[a]	Max. lesion size (mm)	Successful inoculations	Max. lesion size (mm)	Successful inoculations	Max. lesion size (mm)
Botryosphaeria ribis						
Isolate 1	4/4	15 × 12 (8)[b]	7/7	55 × 11 (4)	4/4	87 × 26 (1)
Isolate 2	6/6	135 × 85 (4)	8/8	80 × 80 (2)	...	...
Cytospora eucalypticola						
Isolate 1	4/6	12 × 10 (4)	8/10	19 × 9 (4)	3/4	16 × 10 (1)
Isolate 2	...	...	...	...	3/3	15 × 9 (1)
Discosporium eucalypti						
Isolate 1	...	...	4/4	14 × 12 (2)	1/5	28 × 11 (8)
Isolate 2	...	...	...	...	1/4	18 × 11 (1)
Endothia havanensis						
Isolate 1	4/4	22 × 11 (8)	9/9	39 × 16 (4)	4/4	41 × 24 (8)
Isolate 2	...	...	...	...	3/3	33 × 15 (1)
Control	0/7	15 × 11 (4) 12 × 9[c]	0/8	17 × 10 (4) 12 × 9[c]	0/2	15 × 10 (1) 13 × 10[c]

[a] Incidence of reisolation of test organism/wounds inoculated.
[b] The harvesttime when maximum lesion size occurred is given in parentheses.
[c] Mean size of control lesion.



Figs. 2–4. (2) Twig canker of jarrah, with conidiomata of *Endothia havanensis* on the dead bark. Scale bar = 5 cm. **(3)** Typical branch dieback of jarrah. Scale bar = 5 cm. **(4)** Enlargement of boxed area in Fig. 3 with the periderm removed (a = healthy phloem, b = necrotic phloem). Scale bar = 5 cm.

de Haan, a phomalike fungus, sterile dark mycelium, and a sterile hyaline basidiomycete.

Stylet-bearing nematodes were isolated from 10 of 63 branch and trunk cankers. Limited sampling of cankers, by us and others, from other eucalypts showed that *C. eucalypticola, E. havanensis,* and *B. ribis* were common on these hosts (Table 2).

Pathogenicity tests. Although *B. ribis, C. eucalypticola, D. eucalypti,* and *E. havanensis* could all be reisolated from coppice up to 8 mo after inoculation, extensive phloem invasion only occurred when jarrah was inoculated with *B. ribis* in winter, spring, and summer and with *E. havanensis* in spring and summer (Table 1).

Table 2. Isolation of canker fungi from eucalypts other than jarrah, which are native to or widely grown in the southwest portion of Western Australia

	Canker fungi			
***Eucalyptus* sp.**	***Botryosphaeria ribis***	***Cytospora eucalypticola***	***Discosporium eucalypti***	***Endothia havanensis***
E. accedens[a]	+	+	...	...
E. calophylla	...	+	+	+
E. diversicolor	+	...	...	...
E. globulus	...	+	...	...
*E. megacarpa**	+	+	...	...
*E. resinifera**	...	+	...	...
*E. saligna***	+	+	...	+
E. wandoo	+	+	...	+

[a]* = J. Gardner, *personal communication,* ** = D. R. Fraser, *personal communication.*

DISCUSSION

Of the four fungi most frequently isolated from cankers in jarrah, *B. ribis* has previously been both recorded on and shown to be pathogenic to eucalypts in the United States (9,14) and Argentina (4). Its importance on eucalypts in Australia is not known.

C. eucalypticola was described from *Eucalyptus saligna* in South Africa (12), where it was associated with the death of drought-stressed saplings (13). It was first recorded in Western Australia in 1971, when it was isolated from a eucalypt branch canker (A. G. P. Brown, *personal communication*), and it has been isolated from jarrah roots (7).

Endothia havanensis was described from Cuba on several eucalypts and other trees where it was considered to be a saprophyte (1); it was first recorded on eucalypts in Australia in 1982 (2). *Cryphonectria cubensis* (Bruner) Hodges has been confused with *E. havanensis* (6); the two fungi are similar, but the conidiomata of *C. cubensis* are pycnidial, whereas those of *E. havanensis* are stromatic. Conidia of *E. havanensis* are longer and narrower than those of *C. cubensis* (6). *D. eucalypti* is a new species described separately (11).

Isolations from several eucalypt species that are either native to or widely grown in Western Australia have shown that *B. ribis, C. eucalypticola,* and *E. havanensis* are common on a wider range of hosts than *D. eucalypti.* We suggest that these fungi, apart from *B. ribis,* which may have been introduced, are part of the indigenous fungal flora of Western Australian eucalypts.

B. ribis and *E. havanensis* were pathogenic on jarrah. In twigs and small branches, *C. eucalypticola* and *D. eucalypti* were frequently isolated in association with *E. havanensis,* whereas in old cankers in persistent branches and upper trunks, they were usually found independently. This may indicate that *C. eucalypticola* and *D. eucalypti* invade after or in association with *E. havanensis* and gradually replace the latter fungus.

Cultures and herbarium specimens have been deposited at the Commonwealth Mycological Institute, London, and Department of Agriculture, Rydalmere, New South Wales.

ACKNOWLEDGMENTS

We thank Murdoch University for laboratory facilities; B. C. Sutton of the Commonwealth Mycological Institute, London, for identifying the fungi; S. C. Curry of the Department of Agriculture, for identifying the insects; B. M. Stewart for preparing the figures; the Jarrahdale office of the Forests Department for assistance; and the Interim Foundation for Dieback Research for financial support. We also thank M. J. Mulcahy for his encouragement throughout this project.

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