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Wood Decay Fungi and Their Role in the
Decline of Fruit and Nut Trees in California

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ABSTRACT

In the fall and winter seasons of 1986-87 and 1987-88, surveys in commercial fruit and nut orchards were conducted in ten counties throughout the Sacramento and San Joaquin Valleys of California. Orchards assessed for wood decay were generally ≥ 15 yr old and included: almond, peach and nectarine, apricot, plum and prune, fig, and walnut. Fungal species collected as fruiting bodies and their incidence differed between crops and orchards surveyed. Fruiting bodies of wood decay fungi were also collected from the hosts previously mentioned as well as from cherry, pistachio, and olive, in orchards not surveyed for wood decay. Thirty-three species of fungi were collected from 23 genera. The majority of the fungi collected caused or were associated with white wood rots; whereas three genera caused brown wood rots; and the decay of one genus was undetermined. Wood decay and fruiting bodies were primarily associated with wounds on trunks and scaffold branches. Trees with wood decay were commonly associated with orchards showing a decline in shoot growth, limb breakage, and decayed root systems. Several species collected in this survey have been implicated as pathogens of various fruit tree species by other researchers.

INTRODUCTION

Wood decay disorders occur in commercial fruit and nut trees throughout California. The fungi causing these disorders are primarily in the Basidiomycotina. Information available on these fungi in fruit orchards is limited to mycological descriptions (Overholts 1953; Gilbertson and Ryvarden 1986, 1987) and scattered reports of incidence on various hosts (Anonymous 1961; Shaw 1973; French 1987). Detailed surveys of wood decay fungi on apple trees have been conducted in Washington (Dilley and Covey 1980; Helton and Dilbeck 1984) and Minnesota (Eide and Christensen 1940; Bergdahl and French 1985). To date no specific studies or surveys of wood decay fungi have been published on stone fruit trees in California.

OBJECTIVE

The purpose of this study was to determine: i) species of wood decay fungi found on selected stone fruit trees, ii) incidence of these species and wood decay in surveyed orchards, and iii) association of tree wounds and decay fungi on surveyed trees.

PROCEDURE

Twenty-nine, 15-yr old orchards in California under commercial production were selected in 10 counties in both the San Joaquin and Sacramento Valleys. Numbers of trees, orchards surveyed, and crop varieties were (crop/no. of orchards/total trees/varieties): almond/15/2688/Carmel,

Drake, Merced, Mission, NePlus Ultra, Nonpareil, and Thompson; apricot/2/210/Blenheim, and Perfection; fig/2/50/Calimyrna; nectarine and peach/4/408/Flamekist (nectarine), Loadel, Starn, and Fay Elberta; plum and prune/3/300/Friar and French, respectively; and walnut/3/133/English on native Black. Fruiting bodies, type of decay, and wounds associated with specific tree portions were determined for each tree surveyed.

Fruiting bodies of wood decay fungi were also collected from the hosts previously mentioned as well as from cherry, pistachio, and olive, in orchards not surveyed for wood decay. Fruiting bodies collected were identified using macro- and microscopic characteristics (Gilbertson and Ryvarden 1986, 1987; Juelich and Stalpers 1980). Fungi were cultured on 2% malt extract agar and identified (Nobles 1948, 1965; Stalpers 1978).

RESULTS AND CONCLUSION

Wood decay within the orchards ranged from 21-92% with almond having 25%, peach and nectarine 36%, apricot 21%, plum and prune 36%, fig 92%, and walnut 34% decay. Table 1 indicates the incidence of decay fungi collected as fruiting bodies from each crop surveyed. Predominate fungal genera found on *Prunus* sp. were *Oxyporus*, *Ganoderma*, *Laetiporus*, *Trametes*, *Fomitopsis*, *Armillaria*, *Phellinus*, and *Perenniporia*. Common genera on walnut were *Armillaria* and *Pleurotus*, while on fig only species in the genus *Inonotus* were found.

Thirty-three species of fungi were collected from the following genera: *Armillaria*, *Ceriporia*, *Coprinus*, *Fomitopsis*, *Ganoderma*, *Hyphoderma*, *Hyphodontia*, *Inonotus*, *Laetiporus*, *Lenzites*, *Oxyporus*, *Peniophora*, *Perenniporia*, *Phanerochaete*, *Phlebia*, *Phellinus*, *Pholiota*, *Pleurotus*, *Schizophyllum*, *Schizopora*, *Sistotrema*, *Stereum*, and *Trametes*. Three genera, *Coprinus*, *Fomitopsis*, and *Laetiporus*, caused brown wood rots, decay by the *Pholiota* species was undetermined, while the remaining genera were associated with or caused white wood rots. Species collected or reported in California on stone fruit trees are presented in Table 2.

Basidiocarps and decayed wood were commonly associated with tree wounds created by: mechanical harvesters, canopy support methods, pruning, and sunburn. Limb breakage during fruit production and uprooted trees during wind storms were damages primarily associated with wood decay in scaffold branches and roots of infected trees, respectively. In some cases, wood decay of specific portions of infected trees was limited to certain genera of fungi. For example, species of *Perenniporia*, *Schizophyllum*, *Stereum*, and *Trametes*, were commonly found on scaffold branches associated with pruning and sunburned wounds. Species in the genera *Armillaria*, *Ganoderma*, and *Oxyporus* were primarily collected from roots and lower portions of trees in association with trunk injuries. Other fungi, such as those in the genera *Laetiporus* and *Phellinus*, caused decay in roots, trunks, and scaffold branches of trees.

Two of the eight most common fungal genera, *Laetiporus* and *Fomitopsis*, collected in surveyed orchards caused brown wood rots. Generally, fungi that cause brown wood rots cause a greater reduction in wood strength and weight loss than fungi that cause white wood rots in the same time period. The high incidence and destructive nature of species in these two genera suggests that

these species may play a major role in the decline of fruit and nut trees in California.

The majority of fungi collected caused white wood rots. The role of these fungi in the decline of fruit and nut trees is not well established, except for species of *Armillaria* which are known root rot pathogens of fruit trees (Raabe 1967; Wilbur et al. 1972; and Proffer et al. 1987) and *Chondrostereum purpureum*, the causal organism of silver leaf disease of fruit trees (Setliff 1973). The other genera of fungi in high incidence in surveyed orchards that may contribute to declining orchards are *Ganoderma*, *Trametes*, and *Oxyporus*. Bergdahl and French (1985) indicated that *Oxyporus latemarginatus* (= *Irpex tulipiferae*), *Trametes versicolor* (= *Coriolus versicolor*), and *Schizophyllum commune* could cause decline of 3 yr old apple trees in less than optimal growing sites in Minnesota. Pathogenicity of *Trametes versicolor* on young apple trees (2-3 leaf stage) in Washington has also been reported (Covey et al. 1981). Dilley and Covey (1981) further associated dieback symptoms with *T. versicolor* on mature apple trees in Washington, while in Australia this fungus is also known to cause a serious disease of mature apple trees (Darbyshire et al. 1974; Kile and Wade 1974, 1975; and Kile 1976). The significance of wood decay fungi in California needs to be further evaluated and management strategies designed to limit their introduction and spread in newly established (2-3 years) and older commercial orchards.

REFERENCES

- Anonymous. 1960. Index of Plant Diseases in the United States. U.S. Dept. Agric. Agriculture Handbook No. 165, 531 pp.
- Bergdahl, D.R. and D.W. French. 1985. Association of wood decay fungi with decline and mortality of apple trees in Minnesota. Plant Disease 69:887-90.
- Covey, R.P., H.J. Larson, T.J. Fitzgerald, and M.A. Dilley. 1981. Coriolus versicolor infection of young apple trees in Washington State. Plant Disease 65:280.
- Darbyshire, B., G.C. Wade, and K.C. Marshall. 1969. In vitro studies of the role of nitrogen and sugars on the susceptibility of apple wood to decay by *Trametes versicolor*. Phytopathology 59:98-102.
- Dilley, M.C., and R.P. Covey. 1980. Survey of wood decay and associated hymenomyces in central Washington apple orchards. Plant Disease 64:560-61.
- , and ----- . 1981. Association of Coriolus versicolor with a dieback disease of apple trees in Washington State. Plant Disease 65:77-78.
- Eide, C.J. and C.M. Christensen. 1940. Wood decay in apple trees in Minnesota. Phytopathology 30:936-44.
- French, A.M. 1987. California Plant Disease Host Index: Part 1. Fruits and Nuts. California Dept. of Food and Agriculture, Division of Plant Industry, Sacramento. 39 pp.
- Gilbertson, R.L., and L. Ryvarden. 1986. Polypores of North America. Vol. 1. Fungiflora. Oslo, Norway. 1-433.
- Gilbertson, R.L., and L. Ryvarden. 1987. Polypores of North America. Vol. 2. Fungiflora. Oslo, Norway. 434-885.
- Helton, A.W., and R. Dilbeck. 1984. Wood decay fungi in fruit trees. Proceedings: Washington State Horticultural Association. 80:171-75.

- Juelich, W., and J.A. Stalpers. 1980. The resupinate non-poroid Aphylophorales of the temperate northern hemisphere. North Holland Publishing, Amsterdam. 335 pp.
- Kile, G.A. 1976. The effect of season of pruning and of time since pruning upon changes in apple sapwood and its susceptibility to invasion by *Trametes versicolor*. *Phytopath. Z.* 87:231-40.
- Kile, and G.C. Wade. 1974. *Trametes versicolor* on apple. I. Host-pathogen relationship. *Phytopath. Z.* 81: 328-38.
- , and ----- . 1975. *Trametes versicolor* on apple. II. Host reaction to wounding and fungal infection and its influence on susceptibility to *T. versicolor*. *Phytopath. Z.* 86:1-24.
- Nobles, M.K. 1948. Studies in forest pathology. VI. Identification of cultures of wood-rotting fungi. *Can. J. Res. C.* 26:281-431.
- . 1965. Identification of cultures of wood-inhabiting Hymenomycetes. *Can. J. Bot.* 43:1097-1139.
- Overholts, L.O. 1953. Polyporaceae of the United States, Alaska, and Canada. University of Michigan Press, Ann Arbor, Mich. 466 pp.
- Proffer, T.J., A.L. Jones, and G.R. Ehret. Biological species of *Armillaria* isolated from sour cherry orchards in Michigan. *Phytopathology* 941-943.
- Raabe, R.D. 1967. Variation in pathogenicity and virulence in *Armillariella*. *Phytopathology* 57:73-75.
- Setliff, E.C., and E.K. Wade. 1973. *Stereum purpureum* associated with sudden decline and death of apple trees in Wisconsin. *Plant Dis. Rep.* 57:473-74.
- Shaw, Charles G. 1973. Host Fungus Index for the Pacific Northwest I. Hosts. Washington Agricultural Experiment Station, Bulletin No. 765. 121 pp.
- Stalpers, J.A. 1978. Identification of wood-inhabiting Aphylophorales in pure culture. Centraalbureau Voor Schimmelcultures, Baarn. *Studies in Mycology* 16:1-248.
- Wilbur, W., D.E. Munnecke, and E.F. Darley. 1962. Seasonal development of *Armillaria* root rot of peach as influenced by fungal isolates. *Phytopathology* 52:567-570.

Table 1. Predominant fungal genera and their incidence in fruit and nut tree orchards in California.¹

Orchards Surveyed ²					
Almond	Apricot	Fig	Peach and Nectarine	Plum and Prune	Walnut
<i>Armillaria</i> (0.8%)	<i>Laetiporus</i> (4.3%)	<i>Inonotus</i> (18.3%)	<i>Armillaria</i> (0.8%)	<i>Fomitopsis</i> (4.3%)	<i>Armillaria</i> (1.5%)
<i>Ganoderma</i> (3.1%)	<i>Oxyporus</i> (5.7%)		<i>Ceriporia</i> (0.2%)	<i>Oxyporus</i> (0.7%)	<i>Laetiporus</i> (0.7%)
<i>Laetiporus</i> (1.6%)	<i>Phellinus</i> (0.9%)		<i>Ganoderma</i> (24.3%)	<i>Perenniporia</i> (0.7%)	<i>Pleurotus</i> (3.0%)
<i>Oxyporus</i> (4.0%)	<i>Perenniporia</i> (1.0%)		<i>Oxyporus</i> (0.7%)	<i>Phellinus</i> (2.7%)	
<i>Perenniporia</i> (0.6%)	<i>Trametes</i> (6.7%)		<i>Phellinus</i> (1.2%)	<i>Stereum</i> (1.0%)	
<i>Phellinus</i> (1.0%)			<i>Pholiota</i> (0.2%)	<i>Trametes</i> (0.3%)	
<i>Stereum</i> (0.4%)			<i>Schizophyllum</i> (0.9%)		
<i>Trametes</i> (1.6%)			<i>Trametes</i> (1.7%)		

¹ - Predominant fungal genera collected as basidiocarps on living trees in commercial production and their incidence based on total trees surveyed for each crop.

² - Orchards surveyed: almond (Carmel, Drake, Merced, Mission, NePlus Ultra, Nonpareil, and Thompson); apricot (Blenheim and Perfection); fig (Calimyrna); nectarine (Flamekist); peach (Loadel, Starn, and Fay Elberta); plum (Friar); prune (French); and walnut (English grafted on California Black).

Table 2. Common Wood Decay Fungi of Selected Fruit and Nut Tree Species in California.

Fungus	Host ^a	HA ^b	Decay ^c	Source ^d
<i>Abortiporus biennis</i> (Bull.:Fr.) Sing.	2,3	1,2	W	L
<i>Armillaria</i> spp.	1-10	1,(2)	W	L
<i>Armillaria mellea</i> Fr.	5,9	1,(2)	W	A
<i>Ceriporia spissa</i> (Schw.: Fr.) Rajch.	9	2	W	A
<i>Chondrostereum purpureum</i> (Pers.:Fr.) Pouz.	6,8,9	1,2	W	L
<i>Coprinus</i> spp.	11	1,2	B	A
<i>Daedalea quercina</i> Fr.	2	(1),2	B	L
<i>Daedaleopsis confragosa</i> (Bolt.: Fr.) Schroet.	2	(1),2	W	L
<i>Fomitopsis cajanderi</i> (Karst.) Kotl. et Pouz.	8	(1),2	B	A
<i>Ganoderma annularis</i> (Fr.) Gilbn.	5,9	1,(2)	W	A
<i>G. applanatum</i> (Pers.) Pat.	9	1,(2)	W	A
<i>G. brownii</i> (Murr.) Gilbn.	5,9	1,2	W	A
<i>G. lucidum</i> (W.Curt.:Fr.) Karst.	5,7,9,11	1,2	W	A
<i>Hyphoderma puberum</i> (Fr.) Wallr.	5	2	W	A
<i>Hyphodontia aspera</i> (Fr.) J. Erikss.	5	2	W	A
<i>Inonotus cuticularis</i> (Bull.:Fr.) Karst.	1	1	W	A
<i>I. rickii</i> (Pat.) Reid	1	1	W	A
<i>Irpex lacteus</i> (Fr.:Fr.) Fr.	7,11	(1),2	W	L
<i>Laetiporus sulphureus</i> (Bull.:Fr.) Murr.	2,5,11	1,(2)	B	A
<i>Lenzites betulina</i> (Fr.) Fr.	5,7	(1),2	W	A
<i>Oxyporus corticola</i> (Fr.) Ryv.	9,11	2	W	A
<i>O. latemarginatus</i> (Dur. & Mont. ex. Mont.) Donk	7	1,2	W	A
<i>O. similis</i> (Bres.) Ryv.	5,9	1,2	W	A

<i>Peniophora albobadia</i> (Schw.:Fr.) Boidin	5	2	W	A
<i>Perenniporia medulla-panis</i> (Jacq.: Fr.) Donk	11	1	W	A
<i>Phanerochaete velutina</i> (Fr.) Karst.	9	2	W	A
<i>Phlebia rufa</i> (Fr.) M.P. Christ.	5	2	W	A
<i>Phellinus ferruginosus</i> (Schard.: Fr.) Bourd. et Galz.	11	(1),2	W	L
<i>P. gilvus</i> (Schw.) Pat.	5,9,11	1,2	W	A
<i>P. igniarius</i> (L.: Fr.) Quél.	11	1	W	L
<i>P. pomaceus</i> (Pers.: S.F. Gray) Maire	5	2	W	A
<i>P. robustus</i> (Karst.) Bourd. & Galz.	5,8	1	W	A
<i>P. texanus</i> (Murr.) A. Ames	8	1	W	A
<i>Pholiota</i> sp.	11	1	NS	A
<i>Pleurotus ostreatus</i> (Fr.) Kummer	2,4	1,2	W	A
<i>Pycnoporus cinnabarinus</i> (Jacq.: Fr.) Karst.	11	2	W	L
<i>Schizophyllum commune</i> Fr.	1,2,4-7	1,2	W	A
<i>Schizopora flavipora</i> (Cke.) Ryv.	5	2	W	A
<i>Sistotrema brinkmannii</i> (Bres.) J. Erikss.	9	2	W	A
<i>Stereum hirsutum</i> (Willd.: Fr.) S.F. Gray	5,8,9	1,2	W	A
<i>Trametes hirsuta</i> (Wulf.:Fr.) Pilát	6,9,11	1,2	W	A
<i>T. versicolor</i> (L.: Fr.) Pilát	3,5-9	1,2	W	A

a- Hosts included: (1) *Ficus carica* L. (Fig); (2) *Juglans* spp. (Walnut); (3) *Olea* spp. (Olive); (4) *Pistacia vera* L. (Pistachio); (5) *Prunus dulcis* (Mill.) W.A. Webb (Almond) (6) *P. armeniaca* L. (Apricot); (7) *P. avium* L. (cherry); (8) *P. domestica* L. and *P. americana* L. (Prune, Plum); (9) *P. persica* (L.) Batsch. (Peach); (10) *P. salicina* Lindl. (Japanese Plum); and (11) *Prunus* species. Host numbers separated by semicolons correspond to occurrence by state.

b- Host association (HA): 1- Living trees; (1)- Possibly living trees; 2- Dead wood; (2)- Possibly dead wood; 3- Not specified.

c- Wood Decay: W = White wood rot; B = Brown wood rot; NS = not specified.

d- Information obtained from author (A) or from literature (L) listed in reference section of this paper.