

## HOSTS OF *Phytophthora Cinnamomi* RANDS, THE CAUSAL ORGANISM OF AVOCADO ROOT ROT

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The soil fungus *Phytophthora cinnamomi* Rands has been known to science as a pathogenic organism for a period of some thirty years. Not until relatively recent years, however, have pathologists learned many of the details of the life cycle of the fungus and of its extensive host range.

In 1922 plant pathologist R. D. Rands, conducting investigations in Sumatra, isolated a fungus from stripe cankers of cinnamon trees which he subsequently identified and named *Phytophthora cinnamomi*. Since Rands' discovery, scientists in many lands have reported this fungus from diseased plant material. In the greater percentage of this literature conditions of soil, temperature, moisture, and drainage appear similar. Heavy, compact soils, or soils with an impervious layer near the surface, with resultant poor drainage provide situations ideally suited to the fungus.

Of interest to the American forester and agriculturist is the report in 1824 of the dying of chestnut and chinquapin trees in the southeastern United States. This is believed to be the same chestnut root disease that Crandall described in the 1930's as caused by *Phytophthora cinnamomi*. This is similar if not identical with the "Ink disease" of chestnuts in Europe with which both *P. cinnamomi* and *P. cambivora* have been associated. These early reports have given rise to speculation that *P. cinnamomi* may have been introduced into the southern United States in the early nineteenth century, possibly by way of importation of exotic tropical or semitropical plants from Asia and the East Indies through the southern ports to the plantations of the antebellum South. Once establishing a foothold it apparently spread slowly northward and westward by way of the susceptible native hosts, the chestnut, chinquapin, and pine. W. A. Campbell recently has reported *P. cinnamomi* on shortleaf pine in the Appalachian region.

The first definite record of *P. cinnamomi* in the United States is R. P. White's report of the recovery of the fungus from rhododendron in New Jersey in 1930. Two years later a fungus of the genus *Phytophthora* was reported as the causal agent of a root rot of chestnut and chinquapin trees in the southeastern United States; this fungus was identified later as *P. cinnamomi*. In 1933 this fungus was found to be the cause of a destructive root rot of red pine in nursery seedbeds in the southeastern United States.

Of perhaps greater interest and certainly of more importance to the avocado industry was the first account in 1929 of root rot of avocado, reported by C. M. Tucker in Puerto Rico and describing *P. cinnamomi* as the causal organism. The first report of *P.*

*cinnamomi* in California came in 1940 when V. A. Wager, a pathologist from South Africa doing research in southern California, isolated *P. cinnamomi* from avocado trees affected with "decline." B. S. Crandall, pathologist with the U. S. Department of Agriculture, observed declining and dying avocado trees at Tingo Maria, Peru, in 1944, and isolated *P. cinnamomi* from such trees the following year. Señora Bazan de Segura, a Peruvian pathologist, in 1952 reported the same disease as involving 50,000 avocado trees between 18 and 22 years of age, on hard pan soil in the Chanchamayo Valley, Peru. Zentmyer isolated *P. cinnamomi* for the first time from avocado roots collected in Mexico in April, 1951, and in September, 1951, recovered the same fungus from avocado roots sent into California under quarantine permit from Costa Rica. In January, 1951, Zentmyer and Popenoe reported *P. cinnamomi* as responsible for avocado root rot in Honduras.

Further evidence indicating the widespread range of this fungus is seen in literature from many parts of the world. The only record of *P. cinnamomi* on citrus is that of H. S. Fawcett who isolated this fungus in Brazil in 1937 from a young sour orange tree affected with root rot. *P. cinnamomi* has not been found on citrus in the United States. In New South Wales *P. cinnamomi* has caused destruction of 20,000 to 25,000 peach trees in a nursery. Hawaiian pineapple plantations have been severely affected by the same fungus, which along with other species of *Phytophthora*, causes root rot, heart rot, and green fruit rot of pineapple. A number of different types of coniferous and broad-leaf trees have been found affected by *P. cinnamomi* in forest nurseries in the eastern United States. Other trees found to be susceptible include quinine in Guatemala and Malaya, oak in France, cypress in Argentina, and papaya in Peru.

In southern California *P. cinnamomi* has been found causing a root rot of many different types of nursery stock, including deodar, Italian cypress, incense cedar, arbor-vitae, camellia, myrtle, heather, and Lawson cypress. Despite the many cultivated hosts in southern California the fungus has not yet been collected from native vegetation. *P. cinnamomi* has also been isolated from Lawson cypress and yew in Oregon.

Following is a list of the hosts of *Phytophthora cinnamomi* reported in scientific literature up to the end of the year 1952:

Common Name	Scientific Name	Reported From
<b>Coniferous Trees</b>		
1. Arbor-vitae	<i>Thuja</i> sp.	Argentina
Arbor-vitae	* <i>Thuja compacta</i>	Southern California
2. Cypress	<i>Cupressus</i> sp.	Argentina
Cypress (Italian)	* <i>Cupressus sempervirens glauca</i>	Southern California
3. Cypress, Lawson	* <i>Chamaecyparis lawsoniana</i>	Oregon & so. California
4. Deodar cedar	* <i>Cedrus deodora</i>	Southern California
5. Douglas fir	* <i>Pseudotsuga taxifolia</i>	Southeast U. S.
6. Fir, Nordmann	* <i>Abies nordmanniana</i>	Southeast U. S.
Fir, Silver	* <i>Abies pectinata</i>	Southeast U. S.
Fir, Siberian	* <i>Abies siberica</i>	Southeast U. S.
7. Incense Cedar	* <i>Libocedrus decurrens</i>	Southern California
8. Juniper	* <i>Juniperus</i> sp.	Maryland
9. Larch, European	* <i>Larix decidua</i>	Southeast U. S.
Larch, Japanese	* <i>Larix leptolepis</i>	Southeast U. S.
10. Pine, Shortleaf	<i>Pinus echinata</i>	Southeast U. S.
Pine, Red	* <i>Pinus resinosa</i>	Southeast U. S.
Pine, Monterey	<i>Pinus radiata</i>	Australia, Argentina, southern California
Pine	* <i>Pinus</i> sp.	Southeast U. S.
Pine, Canary Island	* <i>Pinus canariensis</i>	Southern California
Pine, Scotch	* <i>Pinus sylvestris</i>	Southeast U. S.
Pine, Eastern White	* <i>Pinus strobus</i>	Southeast U. S.
11. Spruce	* <i>Picea excelsa</i>	Southeast U. S.
Spruce, Colorado	* <i>Picea pungens</i>	Southeast U. S.
12. Yew, Japanese	* <i>Taxus cuspidata</i>	Southeast U. S.
Yew, English	* <i>Taxus baccata</i>	Southeast U. S.
Yew, Anglojap	* <i>Taxus media</i>	Southeast U. S.
<b>Evergreen Broadleafed Trees</b>		
13. Avocado, Guatemalan	<i>Persea americana</i>	Puerto Rico
Avocado, Mexican	<i>Persea americana</i> var. <i>drymifolia</i>	S. Calif., Peru, Costa Rica, Honduras, South Africa, Mexico, Australia
14. Cinnamon, Malay	<i>Cinnamomum burmanni</i>	Sumatra
15. Eucalyptus	** <i>Eucalyptus</i> spp.	Australia
16. Olive	* <i>Oleo</i> sp.	Australia
17. Orange, Sour	<i>Citrus aurantium</i>	Brazil
18. Papaya	<i>Carica papaya</i>	Peru
19. Quinine	<i>Cinchona ledgeriana</i> } <i>Cinchona succirubra</i> }	Guatemala, Malaya, Peru
20. Tanoak	* <i>Lithocarpus densiflora</i>	Southeast U. S.
21. Tung	<i>Aleurites</i> sp.	Louisiana
<b>Deciduous Broadleafed Trees</b>		
22. Beech, European	<i>Fagus sylvatica</i>	England

23. Birch, Paper	* <i>Betula papyrifera</i>	Southeast U. S.
Birch, White	* <i>Betula alba</i>	Southeast U. S.
24. Chestnut, American	<i>Castanea dentata</i>	Southeast U. S.
Chestnut, European	<i>Castanea sativa</i>	England
Chestnut, Japanese	* <i>Castanea crenata</i>	Southeast U. S.
Chestnut, Ashe	* <i>Castanea ashei</i>	Southeast U. S.
Chestnut	* <i>Castanea margaretta</i> var. <i>arcuata</i>	Southeast U. S.
Chestnut	* <i>Castanea japonica</i>	Southeast U. S.
Chestnut, Chinese	* <i>Castanea mollissima</i>	Southeast U. S.
Chinquapin, Allegheny	<i>Castanea pumila</i>	Southeast U. S.
Chinquapin, Alabama	<i>Castanea alabamensis</i>	Southeast U. S.
Chinquapin, Bush (trailing)	* <i>Castanea alnifolia</i>	Southeast U. S.
Chinquapin, Ozark	<i>Castanea osarkensis</i>	Southeast U. S.
25. Jacaranda	** <i>Jacaranda</i> sp.	Australia
26. Locust, Black	* <i>Robinia pseudacacia</i>	Southeast U. S.
27. Oak, White	* <i>Quercus alba</i>	Southeast U. S.
Oak, Northern Red	* <i>Q. borealis</i>	Southeast U. S., France
Oak, Chestnut	* <i>Q. montana</i>	Southeast U. S.
Oak, English	* <i>Q. robur</i>	Southeast U. S., France
Oak, Cork	<i>Q. suber</i>	England
Oak, Pyrenees	<i>Q. pyrenaica</i>	France
Oak	<i>Quercus</i> sp.	Southern California
28. Peach	* <i>Amygdalus</i> sp.	Australia
29. Plane, Oriental	* <i>Platanus orientalis</i>	Southeast U. S., Argentina
30. Plum	* <i>Prunus</i> sp. (Mariana and Myrobolan stocks)	Australia
31. Pomegranate	** <i>Punica</i> sp.	Australia
32. Walnut, Black	* <i>Juglans nigra</i>	Southeast U. S.
Walnut, English	* <i>Juglans regia</i>	Southeast U. S.
<b>Shrubs, Perennials, Annuals</b>		
33. Australia heath	** <i>Epacris impressa</i>	Australia
34. Azalea	* <i>Azalea mollis</i>	Australia
35. Butterflyflower	* <i>Schizanthus</i> sp.	England
36. Calceolaria	* <i>Calceolaria</i> sp.	England
37. Camellia	* <i>Camellia japonica</i>	Alabama, Florida, southern California
	* <i>Camellia sasanqua</i>	Florida
	* <i>Camellia magnolineflora</i>	Australia
38. Castor Oil	* <i>Ricinus communis</i>	Hawaii
39. Chilean Firebush	** <i>Embothrium coccineum</i>	Australia
40. Cineraria (Common)	* <i>Senecio cruentus</i>	England

41. Eriostemon	** <i>Eriostemon crowei</i>	Australia
42. Heather	* <i>Erica hiemalis</i>	England
	* <i>E. nivalis</i>	England
	* <i>E. willmoreana</i>	England
	<i>E. regerminans</i>	Southern California
43. Holly, Japanese	* <i>Ilex crenata</i>	Maryland
44. Micrantheum	** <i>Micrantheum ericoides</i>	Australia
45. Myrtle	* <i>Myrtis compacta</i>	Southern California
46. Pineapple	<i>Ananas comosus</i> (sativas)	Hawaii, Australia
47. Pultenaea	** <i>Pultenaea elliptica</i>	Australia
48. Rhododendron	* <i>Rhododendron ponticum</i>	New Jersey
	* <i>R. carolineanum</i>	New Jersey
	* <i>R. californicum</i>	New Jersey
	* <i>R. mucronulatum</i>	Southeast U. S.
	<i>Rhododendron</i> sp.	Argentina
	<i>Rhododendron</i> sp.	Australia
49. Snapdragon	* <i>Antirrhinum majus</i>	England
50. Stock	* <i>Matthiola</i> sp.	England
51. Tobacco	* <i>Nicotiana glutinosa</i>	England
52. Viburnum	* <i>Caprifoliaceae</i> sp.	Maryland
53.	* <i>Chamaelaucium uncinatum</i>	Australia
54.	** <i>Baeckia brevifolia</i>	Australia
55.	** <i>Phyllota phyllocooides</i>	Australia
56.	** <i>Sprengelia incarnata</i>	Australia
57.	** <i>Styphelia longiflora</i>	Australia
58.	** <i>Leucopogon microphyllus</i>	Australia

\*Reported only on nursery stock.

\*\*Report does not specify; probably on nursery stock.