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Checklist of Micro-Organisms Associated With Tree Seeds in the World, 1985

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Most plant seeds carry spores of various fungi either on the surface or within the seed. Surface fungi are almost always found because the spores easily stick to the outer seedcoat. Fungi inside the seed most often occur as mycelium. Their mode of entry in tree seeds is not known. It is theorized that the fungi may enter anytime during seed development or through cracks in the seedcoat, especially after harvesting. Spore counts as high as 150,000 per tree seed have been reported; some seed lots have several hundred thousand spores per gram of seed.

Forestry throughout the world is becoming increasingly dependent on a constant supply of good-quality seeds from trees selected for increased growth, yield, and resistance to diseases and insects. In the past, collections of seeds from wild trees were less expensive, and the loss of seeds and seedlings could be compensated by increasing the volume of seed used. However, the introduction of more intensively managed areas such as seed orchards and seed collection stands has considerably increased the cost of seed per pound. The cost of insecticides, herbicides, fertilizers, labor, and tree selection are all accrued in the final cost per pound of seed. Also, the germination of seeds from some of these intensively managed areas has been less than that of seeds collected from wild trees (Rowan and DeBarr 1974).

A number of causal agents, such as insects, have been documented as causing seed-germination losses, but the complete role of fungi is not well defined. Several kinds of fungi can be isolated from conifer seeds. There are species that cause decay and reduce germination of stored seeds, species that attack germinating seeds and seedlings, and other species that are more or less harmless. Current knowledge is insufficient to precisely separate individual species of fungi occurring on seeds. It is clear that some fungi usually viewed as harmless can cause serious losses in adverse conditions such as improper seed storage. In some cases, fungi that are normally considered to be saprophytes can cause decay of seeds, for instance Trichoderma (Urosevic 1961). Some fungi, such as Caloscypha fulgens on spruce, have been documented as being pathogenic to the seed (Sutherland and Van Eerden 1980); others, such as many of the Fusarium spp., reside on or inside the seeds but cause losses to germinating seedlings.

Identifying Seedborne Pathogens

A few years ago, the International Seed Testing Association (ISTA) published "An Annotated List of Seedborne Diseases (Richardson 1979), which was later followed by supplements. These reports listed the fungi occurring on all plant species including trees, how

the fungi affect seeds, whether a control is available, and the source of information. In 1981, the Forest Tree and Shrub Seed Committee of ISTA formed the Tree Seed Pathology Working Group. The assigned tasks for the group were to identify tree seedborne pathogens that could cause a serious problem if transported to other geographic areas, to develop or identify testing methods, to submit infested seeds for comparative tests, and to submit proposals for ISTA rules changes.

To accomplish this, it was necessary to identify the micro-organisms that are found on seeds. Step one was to extract the tree seed information from Richardson's books. Step two was to add other known references and send the list to scientists worldwide for comments and suggested revisions. The checklist included in this Report is the result of this cooperative work. Listed are the host, its associated micro-organism, reference, and the country of origin. Also noted is whether the organism causes a disease of economic importance, has an available treatment, or information is incomplete.

International Testing

By using the checklist, the Tree Seed Pathology Working Group identified three fungi worthy of international testing:

1. Fusarium moniliforme var. subglutinans occurring on Pinus elliottii, P. elliottii var. elliottii, and P. taeda, from the United States.

2. Caloscypha fulgens occurring on Picea spp., from Canada.

3. Sirococcus strobilinus occurring on Picea spp., from Canada.

A quick, reliable method has been established for F. moniliforme var. subglutinans. In the Southern United States, this fungus causes a disease of pines called pitch canker. It can be found in the cones and seeds as well as in resinous branch cankers of pines. The fungus can be isolated from a pine seed by placing the seed on blue filter paper in a plastic tray, crushing the seed, then spraying seed and blotter paper with a liquid medium semiselective for Fusarium spp. The tray is covered and incubated at room temperature (about 20 ^{o}C) for 14 days or until the colonies are 2 cm in diameter. Each colony is examined microscopically for the conidia and polyphialides diagnostic for F. moniliforme var. subglutinans. This method permits rapid screening of representative samples of pine seed lots for the pitch canker fungus and gives the same result as using a selective agar medium (Anderson 1986). This method has been evaluated and is ready for submission to ISTA.

Caloscypha fulgens and Sirococcus strobilinus on spruce have been selected for comparative testing.

This list and its future additions will serve as the basis for identification of organisms that are seedborne and are of international concern (such as the three mentioned above). It will also assist those who are working on organisms of tree seeds to readily identify if an organism has been found on or in a seed and its possible significance. In addition, it can serve as a valuable tool for those people involved in seed testing and transport.

Literature Cited

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Sutherland, Jack R.; Van Eerden, Evert. Disease and insect pests in British Columbia forest nurseries. British Columbia Ministry of Forests/ Canadian Forestry Service, Joint Rep. 12; 1980. 55 pp.

Urosevic, B. The influence of saprophytic and semiparasitic fungi on the germination of Norway spruce and Scots pine seeds. Proceedings, International Seed Testing Association 26(3):341-346; 1961.

MICRO-ORGANISMS ASSOCIATED WITH TREE SEEDS IN THE WORLD, 1985

Following the name of the country, if a treatment is available, this is indicated by an asterisk (*); where an organism causes a disease of considerable economic importance, this is indicated by a dagger (†); where evidence concerning the seedborne nature of the organism is incomplete or contradictory, this is indicated by a section symbol (§). Where no country is listed, the origin of the organism is not known. The complete references and an alphabetical list of organisms with their authors follows the checklist.

Host and organism	Reference No.	Country
Abies spp.		
Fusarium culmorum	16	England
Heterobasidion annosum	16	North America
Lirula macrospora	16	USSR
Melanospora zamiae	16	England
Sclerotium sp.	16	
Truncatella hartigii	16	England
Abies amabilis Dougl. ex Forbes		
Botrytis cinerea	13	South Korea
Fusarium semitectum	13	South Korea
Abies grandis (Dougl. ex D. Don) Lindl.		
Fusarium moniliforme	13	South Korea
Abies nordmanniana (Steven) Spach		
Fusarium moniliforme	13	South Korea
Acacia spp.		
Fusarium oxysporum f. sp. *koae*	18	Hawaii
Hapalophragmiopsis ponderosum	18	India
Phoma sp.	13	Egypt
Acacia auriculiformis A. Cunn. ex Benth.		
Aspergillus flavus	15	Philippines
Aspergillus niger	15	Philippines
Chaetomium sp.	15	Philippines
Curvularia pallescens	15	Philippines
Fusarium semitectum	15	Philippines
Phoma sp.	13	India
Acacia confusa Merr.		
Aspergillus spp.	2	Philippines
Botryodiplodia theobromae	2	Philippines
Cladosporium cladosporoides	2	Philippines
Curvularia lunata	2	Philippines
Penicillium spp.	2	Philippines
Phoma sp.	2	Philippines
Rhizopus sp.	2	Philippines

Host and organism	Reference No.	Country
Acacia modesta Wall.		
Fusarium semitectum	13	India
Phoma sp.	13	India
Acacia raddiana Savi		
Fusarium moniliforme	13	Israel
Phoma sp.	13	Israel
Acer spp.		
Botrytis cinerea	13	South Korea
Fusarium moniliforme	13	South Korea
Gloeosporium acericola	16	USSR
Phyllosticta sp.	16	
Phyllosticta platanoidis f. sp. *negundinis*	16	USSR
Acer campestres L.		
Verticillium sp.	13	South Korea
Acer ginolamax Thunb.		
Botrytis cinerea	13	South Korea
Acer palmatum Thunb.		
Ascochyta sp.	13	South Korea
Colletotrichum sp.	13	South Korea
Fusarium semitectum	13	South Korea
Acer palmatum Thunb. (con't)		
Pestalotia sp.	13	South Korea
Phoma sp.	13	South Korea
Phomopsis sp.	13	South Korea
Septoria sp.	13	South Korea
Acrocarpus fraxinifolius Wright		
Botryodiplodia theobromae	13	Rwanda
Botrytis cinerea	13	West Bengal
Cephalosporium sp.	13	Rwanda*
Colletotrichum sp.	13	Rwanda
Fusarium equiseti	13	India, Rwanda*
Fusarium moniliforme	13	India, Rwanda*
Fusarium semitectum	13	India, Rwanda*
Myrothecium roridum	13	Rwanda*
Phoma sp.	13	India, Rwanda*
Phomopsis sp.	13	Rwanda*
Adenanthera microsperma Teijsm. & Binn.		
Botryodiplodia sp.	13	India
Fusarium moniliforme	13	India
Fusarium semitectum	13	India
Pestalotia sp.	13	India
Phoma sp.	13	India
Adiana cardifolia Benth. & Hook. ex Brandis		
Phoma sp.	13	India

Host and organism	Reference No.	Country
Agathis dammara (Lamb.) Rich.		
Fusarium solani	15	Philippines
Agathis macrophylla (Lindley) Masters		
Colletotrichum gloesporioides	15	Philippines
Agathis robusta (C. Moore) F. M. Bailey		
Aspergillus flavus	15	Philippines
Phoma sp.	15	England (seeds came from Oxford)
Albizia falcataria Fosb.		
Alternaria tenuis	2	Philippines
Aspergillus spp.	2	Philippines
Cephalosporium sp.	13	Philippines
Chaetomium sp.	2	Philippines
Fusarium moniliforme	13	Philippines
Fusarium semitectum	13	Philippines
Penicillium spp.	2	Philippines
Pestalotia sp.	13	Philippines*
Phoma sp.	13	Philippines
Albizia gumifera C. A. Sm.		
Fusarium equiseti	13	Rwanda
Fusarium semitectum	13	Rwanda
Albizia julibrissin Durazzini		
Fusarium oxysporum f. sp. *perniciosum*	16	USA
Albizia lebbek Benth.		
Penicillium spp.	2	Philippines
Albizia procera Benth.		
Aspergillus spp.	2	Philippines
Fusarium semitectum	2	Philippines
Penicillium spp.	2	Philippines
Pestalotia sp.	2	Philippines
Albizia stipulata Boivin		
Fusarium moniliforme	13	India
Fusarium solani	13	India
Macrophomina phaseolina	13	India
Phoma sp.	13	India
Alnus spp.		
Ciboria alni	16	Czechoslovakia
Cylindrosporella alena	16	Denmark§
Taphrina alni-incanae	16	Poland§
Alnus maximowiczii Callier ex Schneid.		
Cephalosporium sp.	13	South Korea

Host and organism	Reference No.	Country
Castanea spp.		
Ceratocystis fagacearum	16	Italy†
Ciboria batschiana	16, 17	France
Crytodiaporthe castanea	16	North America, Brazil
Dothiorella sp.	16	North America, Brazil
Endothia parasitica	16	France, USA*†
Phomopsis endogena	16	Italy
Phomopsis viterbensis	16	Italy
Casuarina equisetifolia L. ex J. R. & G. Forst.		
Aspergillus flavus	15	Philippines
Aspergillus niger	15	Philippines
Botryodiplodia theobromae	15	Philippines
Chaetomium sp.	15	Philippines
Cladosporium cladosporoides	15	Philippines
Curvularia brachyspora	15	Philippines
Curvularia lunata	15	Philippines
Curvularia pallescens	15	Philippines
Fusarium moniliforme	15	Philippines
Macrophoma phaseoli	15	Philippines
Penicillium sp.	15	Philippines
Pestalotiopsis sp.	16	Mauritius
Phoma sp.	13	Philippines
Phomopsis casuarinae	16	Australia
Stemphylium botryosum	13	Philippines
Cedrela odorata L.		
Colletotrichum sp.	13	Colombia*
Fusarium moniliforme	13	Colombia*
Fusarium semitectum	13	Colombia*
Fusarium solani	13	Colombia*
Macrophomina phaseolina	13	Colombia*
Phoma sp.	13	Colombia*
Cedrela serrata Royle.		
Phoma sp.	13	India
Cedrela serrulata Miq.		
Pestalotia sp.	13	Rwanda
Phoma sp.	13	Rwanda
Cedrela toona Roxb.		
Botrytis cinerea	13	India
Fusarium moniliforme	13	India
Cedrus deodara (Roxb.) Loud.		
Alternaria tenuis	19	Uruguay
Trichothecium roseum	19	Uruguay
Chamaecyparis spp.		
Pestalotiopsis sp.	16	Japan

Host and organism	Reference No.	Country
Chamaecyparis obtusa (Sieb. & Zucc.) Endl.		
Arthrinium sp.	13	South Korea
Drechslera rostrata	13	South Korea
Fusarium solani	13	South Korea
Monilia sp.	13	South Korea
Pestalotia sp.	13	South Korea
Chukrasia tabularis Juss.		
Fusarium moniliforme	13	India
Macrophomina sp.	13	India
Phoma sp.	13	India
Citrus spp.		
Citrus exocortis virus	16	Brazil
Citrus psorosis virus	16	Argentina, USA, USSR
Citrus wood pocket virus	16	USA
Citrus xyloporosis virus	16	Cyprus, USA
Citrus yellow shoot virus	16	North China§
Deuterophoma tracheiphila	16	USSR
Phoma sp.	16	Rumania
Phytophthora citrophthora	16	USA*
Phytophthora nicotianae var. *parasitica*	16	USA*
Spiroplasma citri	16, 17	
Stem pitting virus	16	Corsica§
Xanthomonas citri	16	USA, India*†
Cocos nucifera L.		
Diplodia palmicola	16	West Germany
Cephalosporium sp.	13	Japan
Fusarium semitectum	13	Japan
Fusarium solani	13	Japan
Marasmiellus sp.	18	Malaysia*
Marasmiellus cocophilus	18	Solomon Islands*
Marasmiellus semiustus	22	Malaysia
Monilia sp.	13	Japan
Rhadinaphelenchus cocophilus	16	Africa, USA, West India
Rigidoporus zonalis	18	Solomon Islands
Root wilt pathogen	16	India
Coniferae		
Caloscypha fulgens	17	Canada
Iodophanus carneus	16	Fennica, Scotland
Cordia alliodora Cham.		
Botryodiplodia theobromae	13	Colombia*
Fusarium moniliforme	13	Colombia*
Fusarium semitectum	13	Colombia*
Phoma sp.	13	Colombia*
Phomopsis sp.	13	Colombia*

Host and organism	Reference No.	Country
Corylus avellana L.		
Macrophoma corylina	16	Denmark
Sclerotinia laxa	16	Italy†
Cryptomeria japonica D. Don		
Phoma sp.	13	Madagascar
Cupressus spp.		
Fusarium equiseti	13	Syria
Nigrospora sp.	13	Syria
Pestalotia sp.	13	Madagascar
Phoma sp.	13	Syria
Cupressus arizonica Greene		
Alternaria sp.	19	Uruguay
Macrophomina sp.	19	Uruguay
Cupressus cashmeriana Royle. ex Carr.		
Pestalotia sp.	13	India
Phoma sp.	13	India
Cupressus funebris Endl.		
Pestalotiopsis funerea	19	Uruguay
Cupressus lusitanica Mill.		
Pestalotia sp.	13	India, Kenya
Phoma sp.	13	India
Cupressus macrocarpa Hartw.		
Alternaria sp.	19	Uruguay
Pestalotiopsis guepini	19	Uruguay
Cupressus torulosa Don.		
Alternaria sp.	19	Uruguay
Dendrophoma sp.	19	Uruguay
Dalbergia sissoo Roxb.		
Fusarium moniliforme	13	Madagascar
Fusarium solani	13	Madagascar
Delonix regia (Boj. ex Hook.) Raf.		
Aspergillus sp.	13	Brazil
Chaetomium sp.	15	Philippines
Cladosporium cladosporoides	15	Philippines
Fusarium equiseti	13	Brazil
Fusarium semitectum	13	Brazil
Phoma sp.	13	Brazil
Diospyros kaki L.		
Nigrospora spherica	13	South Korea
Penicillium sp.	16	India*
Penicilliopsis clavariaeformis	18	India
Pestalotia diospyri	13	South Korea
Phoma sp.	13	South Korea
Elaeis guineensis Jacq.		
Fusarium oxysporum f. sp. *elaeidis*	16	Africa, Surinam, Colombia
Schizophyllum commune	23	Malaysia*

Host and organism	Reference No.	Country
Endosperum peltatum Merr.		
Cephalosporium sp.	2	Philippines
Cladosporium sp.	2	Philippines
Fusarium moniliforme	2	Philippines
Fusarium solani	2	Philippines
Enterolobium contoritisiliqum Morong		
Alternaria sp.	19	Uruguay
Eucalyptus spp.		
Cylindrocladium braziliensis	16	Brazil*
Eucalyptus alba Reinw. ex Bl.		
Pestalotiopsis funerea	13	India
Phoma sp.	13	India
Eucalyptus camaldulensis Dehn.		
Fusarium semitectum	13	Egypt
Phoma sp.	13	India
Eucalyptus citriodora Hook. f.		
Aspergillus sp.	21	India
Cephalosporium sp.	21	India
Chaetomium sp.	21	India
Colletotrichum sp.	21	India
Fusicoccum sp.	21	India
Gliocephalotrichum sp.	21	India
Macrophoma sp.	21	India
Monocillium sp.	21	India
Paecilomyces sp.	21	India
Penicillium sp.	21	India
Phomopsis sp.	21	India

Host and organism	Reference No.	Country
Eucalyptus deglupta Bl.		
Cephalosporium sp.	13	Philippines
Fusarium equiseti	13	Philippines
Penicillium sp.	2	Philippines
Pestalotia sp.	13	Philippines
Eucalyptus globulus Labill.		
Aspergillus sp.	21	India
Cephalosporium sp.	21	India
Chaetomium sp.	21	India
Fusarium sp.	13	Portugal
Monocillium sp.	21	India
Mucor sp.	21	India
Paecilomyces sp.	21	India
Penicillium sp.	21	India
Stachybotrys sp.	21	India
Eucalyptus grandis Hill ex Maiden		
Alternaria sp.	19	Uruguay
Aspergillus sp.	21	India
Botryodiplodia sp.	13	Uruguay
Curvularia sp.	19	Uruguay
Drechslera sp.	19	Uruguay
Fusarium moniliforme	13	Uruguay
Monocillium sp.	21	India
Mucor sp.	21	India
Myrothecium roridum	13	Uruguay
Penicillium sp.	21	India
Pestalotiopsis funerea	19	Uruguay
Phoma sp.	13	India
Rhizopus sp.	19	Uruguay
Verticillium sp.	19	Uruguay
Eucalyptus maidenii F. Muell.		
Alternaria sp.	19	Uruguay
Curvularia sp.	19	Uruguay
Fusarium semitectum	19	Uruguay
Penicillium sp.	19	Uruguay
Pestalotiopsis sp.	19	Uruguay
Trichoderma viride	19	Uruguay

Host and organism	Reference No.	Country
Eucalyptus tereticornis Sm.		
Aspergillus sp.	21	India
Monocillium sp.	21	India
Mucor sp.	21	India
Penicillium sp.	21	India
Phoma sp.	13	India
Eucommia ulmoides Oliver		
Phoma sp.	13	USA
Euonymus europaeus L.		
Euonymus mosaic virus	16	Czecho-slovakia
Fagus sylvatica L.		
Rhizoctonia solani	18	France*
Ficus benjamina L.		
Botryodiplodia sp.	13	India
Fusarium moniliforme	13	India
Fusarium semitectum	13	India
Verticillium sp.	13	India
Ficus krishnane C. DC.		
Cephalosporium sp.	13	India
Fraxinus sp.		
Macrophoma fraxini	16	Czecho-slovakia
Phyllosticta osteospora var. *samaricola*	16	USSR (Moscow)
Ginkgo biloba L.		
Virus	16	Czecho-slovakia, Hungary
Gmelina arborea Roxb.		
Aspergillus sp.	2	Philip-pines
Botrytis cinerea	13	Philip-pines
Cephalosporium sp.	13	India
Fusarium equiseti	13	India
Fusarium moniliforme	13	India
Fusarium semitectum	13	India
Fusarium solani	13	India
Penicillium sp.	2	Philip-pines
Phoma sp.	13	India
Gmelina mollucana Bocker ex K. Heyne		
Cephalosporium sp.	13	Solomon Islands
Fusarium semitectum	13	Solomon Islands
Grevillea robusta A. Cunn.		
Botryodiplodia theobromae	13	Rwanda*
Discocia sp.	13	Rwanda*
Fusarium equiseti	13	Rwanda
Fusarium moniliforme	13	Rwanda*
Fusarium semitectum	13	Rwanda*
Fusarium solani	13	Rwanda*
Pestalotia sp.	13	Rwanda*

Host and organism	Reference No.	Country
Hevea brasiliensis Muell.-Arg.		
Botryodiplodia theobromae	16	India*†
Microcyclus ulei	5	South and Central America, Caribbean*
Phomopsis hevea	16	Malaysia
Phytophthora botryosa	16	Malaysia§
Horenia dulcis Thunb.		
Phoma sp.	13	India
Howeia forsteriana Becc.		
Dothiorella sp.	16	North America
Jacaranda mimosaefolia D. Don		
Botrytis cinerea	13	India
Drechslera sp.	13	India
Fusarium moniliforme	13	India
Phoma sp.	13	India
Juglans spp.		
Alternaria nucis	16	Czechoslovakia, Romania
Cherry leaf roll virus	17, 18	Southern Italy, United Kingdom, USA
Erwinia sp.	18	
Gnomonia leptostyla	16	USA†
Pseudomonas sp.	18	
Xanthomonas juglandis	16	Romania, Italy†
Juniperus coreana Nakai		
Fusarium moniliforme	13	South Korea
Juniperus virginiana L.		
Phomopsis occulta	16	Denmark
Kydia calycina Roxb.		
Fusarium moniliforme	13	India
Fusarium semitectum	13	India
Phoma sp.	13	India
Lagerstroemia speciosa (L.) Pers.		
Aspergillus flavus	15	Philippines
Cephalosporium sp.	15	Philippines
Cladosporium sp.	15	Philippines
Penicillium sp.	15	Philippines
Phoma sp.	13	India
Larix spp.		
Cytospora curreyi	16	Scotland
Phoma lineolata	16	Scotland, USA, Denmark
Phomopsis occulta	16	Denmark
Leucaena spp.		
Botryodiplodia sp.	13	Philippines
Fusarium moniliforme	13	Philippines
Fusarium semitectum	13	Philippines
Fusarium solani	13	Philippines
Macrophomina	13	Philippines

Host and organism	Reference No.	Country
Leucaena spp. (con't)		
Phoma sp.	13	Philippines
Rhizoctonia solani	13	Philippines
Leucaena cunningham Benth.		
Fusarium moniliforme	13	Malawi
Leucaena diversifolia Benth.		
Fusarium moniliforme	13	Guatemala*
Macrophomina phaseolina	13	Guatemala*
Phoma sp.	13	Guatemala*
Phomopsis sp.	13	Guatemala*
Leucaena latisiliqua (L.) Gillis		
Fusarium moniliforme	13	Philippines
Leucaena leucocephala (Lam.) de Wit		
Aspergillus sp.	2	Philippines
Cephalosporium sp.	13	Philippines
Cladosporium sp.	2	Philippines
Drechslera tetramera	2	Philippines
Fusarium moniliforme	13	Philippines, Malaysia*
Fusarium semitectum	2	Philippines
Penicillium sp.	2	Philippines
Pestalotia sp.	13	Philippines

Host and organism	Reference No.	Country
Leucaena leucocephala var. *cunningham leucaena* Benth.		
Phoma sp.	13	Cuba
Libocedrus decurrens Torr.		
Pestalotiopsis funerea	16	England
Liriodendron tulipifera L.		
Gloesporium sp.	1	USA† (in nursery)
Malelenca spp.		
Fusarium semitectum	13	India
Malus spp.		
Chaetomium sp.	16	
Pestalotia sp.	16	Denmark, Romania, Australia
Raspberry bushy dwarf virus	16	Scotland
Tobacco mosaic virus	16	USA
Tomato bushy stunt virus	16	Canada
	18	East Germany
Mangifera indica L.		
Glomerella cingulata	16	

Host and organism	Reference No.	Country
Mimosa caesalpiniafolia Benth.		
Cephalosporium sp.	13	Brazil
Fusarium moniliforme	13	Brazil
Fusarium semitectum	13	Brazil
Pestalotia sp.	13	Brazil
Phoma sp.	13	Brazil
Septoria sp.	13	Brazil
Mimosa scabrella Benth.		
Fusarium moniliforme	13	Brazil
Fusarium oxysporum	13	Brazil
Fusarium semitectum	13	Brazil
Morus spp.		
Ciboria carunculoides	16	§
Microglossum shiraianum	16	§
Sclerotinia shiraiana	16	USA§
Musa spp.		
Botryodiplodia theobromae	16	Panama, Honduras, Malaysia
Virus	16	USA
Musanga cecropoides R. Br.		
Cladosporium cladosporoides	2	Philippines
Curvularia lunata	2	Philippines
Macrophomina phaseolina	2	Philippines
Penicillium sp.	2	Philippines
Nothofagus spp.		
Mycogone sp.	16	England (London)
Truncatella hartigii	16	England (London)
Ougeinia dalbergioides Benth.		
Phoma sp.	13	
Panax schinseng C. A. Mey.		
Cephalosporium sp.	13	South Korea
Parkia roxburgii G. Don		
Aspergillus flavus	15	Philippines
Chaetomium sp.	15	Philippines
Penicillium sp.	15	Philippines
Persea americana Mill.		
Phytophthora cinnamomi	16	USA*§
	17	Australia*
Rhizoctonia solani	16	USA
Sunblotch virus	16	USA, Africa
	18	USA, New Zealand, Australia

Host and organism	Reference No.	Country
Picea spp.		
Caloscypha fulgens	17	Canada*
	18	Canada, USA
Geniculodendron pyriform	16	Canada*
Pucciniastrum areolatum	18	USA
Sirococcus strobilinus	18	Canada
Verticillium sp.	16	England
Picea engelmannii Parry ex Engelm.		
Sirococcus strobilinus	9	USA
Picea excelsa Link		
Acremoniella atra	24	USSR
Acrostalagmus cinnabarinus	24	USSR
Alternaria brassicae	24	USSR
Alternaria tenuis	24	USSR
Aspergillus flavus	24	USSR
Aspergillus niger	24	USSR
Aspergillus oryzae	24	USSR
Botrytis allii	24	USSR
Botrytis cinerea	24	USSR
Cephalosporium acermonium	24	USSR
Cephalosporium subverticillatum	24	USSR
Chaetomium globosum	24	USSR
Cladosporium epiphyllum	24	USSR
Cladosporium herbarum	24	USSR
Cladosporium naumovi	24	USSR
Cladosporium sphaerospenum	24	USSR
Coniosporium aterrimum	24	USSR
Coniothirium quercinum	24	USSR
Curvularia inaqualis	24	USSR
Cylindrocarpon radicicola	24	USSR

Host and organism	Reference No.	Country
Picea excelsa (con't)		
Fusarium arthrosporioides	24	USSR
Fusarium culmorum	24	USSR
Fusarium heterosporum	24	USSR
Fusarium lateritium	24	USSR
Fusarium moniliforme	24	USSR
Fusarium oxysporum	24	USSR
Fusarium redolens	24	USSR
Fusarium sarcochrum	24	USSR
Fusarium semitectum	24	USSR
Fusarium solani	24	USSR
Fusarium sporotrichioides	24	USSR
Gliocladium roseum	24	USSR
Helminthosporium rostratum	24	USSR
Helminthosporium sativum	24	USSR
Melanconium apiocarpon	24	USSR
Melanconium bicolor	24	USSR
Mucor plumbeus	24	USSR
Mucor racemosus	24	USSR
Mucor ramanianus	24	USSR
Oospora verticilloides	24	USSR
Ophiostoma sp.	24	USSR
Paecilomyces varioti	24	USSR
Penicillium arenarium	24	USSR
Penicillium chrysogenum	24	USSR
Penicillium crustaceum	24	USSR
Penicillium divergens	24	USSR
Penicillium roqueforti	24	USSR
Pestalotia glandicola	24	USSR
Pestalotia quercina	24	USSR
Pullularia sp.	24	USSR
Rhizopus arrhizas	24	USSR
Stemphylium atrum	24	USSR
Stemphylium ilicis	24	USSR
Stemphylium piriforme	24	USSR
Torula convoluta	24	USSR

Host and organism	Reference No.	Country
Picea excelsa (con't)		
Trichoderma lignorum	24	USSR
Trichothecium roseum	24	USSR
Verticillium albo-atrum	24	USSR
Pilliostigma malabaricum Benth.		
Aspergillus flavus	15	Philippines
Aspergillus niger	15	Philippines
Chaetomium sp.	15	Philippines
Fusarium semitectum	15	Philippines
Penicillium sp.	15	Philippines
Pinus spp.		
Botryodiplodia theobromae	18	Nicaragua
Diplodia pinea	16	United Kingdom, USA
Lophodermium pinastri	16	United Kingdom, North America (on debris only)†
Pestalotiopsis funerea	16	England
Phoma sp.	13	Japan
Pyronema omphalodes	16	Poland
Pinus caribaea Morel.		
Botryodiplodia sp.	13	Madagascar
Botryodiplodia theobromae	13	Guatemala
Botrytis cinerea	13	Cuba
Chaetomium sp.	13	Central America

Host and organism	Reference No.	Country
Pinus caribaea (con't)		
Drechslera bicolor	13	Cuba
Fusarium moniliforme	13	Madagascar
Fusarium oxysporum	13	Cuba
Fusarium semitectum	13	Cuba
Fusarium solani	13	Cuba
Macrophomina phaseolina	13	Central America
Pestalotia sp.	13	Madagascar
Pinus caribaea var. *bahanansis* Barr. & Golf.		
Fusarium moniliforme	13	Brazil
Pinus caribaea var. *caribae* Barr. & Golf.		
Fusarium moniliforme	13	Brazil
Fusarium solani	13	Brazil
Pinus caribaea var. *hondurensis* Barr. & Golf.		
Fusarium moniliforme	13	Brazil
Fusarium semitectum	13	Brazil
Phoma sp.	13	India
Pinus elliottii Engelm.		
Botryodiplodia theobromae	13	USA
Fusarium moniliforme	13	Canada
Fusarium semitectum	13	USA
Fusarium solani	13	USA
Pestalotia sp.	13	USA
Verticillium sp.	13	USA

Host and organism	Reference No.	Country
Pinus elliottii Engelm. var. *elliottii*		
Alternaria sp.	19	Uruguay
Aspergillus sp.	19	Uruguay
Cephalosporium sp.	19	Uruguay
Chaetomium globosum	19	Uruguay
Curvularia sp.	19	Uruguay
Diplodia gossypina	14	USA†
Drechslera sp.	19	Uruguay
Fusarium moniliforme	13	Brazil
Fusarium moniliforme var. *subglutinans*	14, 2	USA, Philippines†
Fusarium semitectum	19	Uruguay
Fusarium solani	13	Brazil
Gliocladium sp.	19	Uruguay
Mycothypa sp.	19	Uruguay
Oedocephalum sp.	19	Uruguay
Penicillium sp.	19	Uruguay
Pestalotiopsis guepini	19	Uruguay
Rhizopus sp.	19	Uruguay
Trichoderma viride	19	Uruguay
Trichothecium roseum	19	Uruguay
Verticillium sp.	19	Uruguay
Pinus insularis Endl.		
Altenaria tenuis	2	Philippines
Cladosporium cladosporoides	2	Philippines
Drechslera maydis	2	Philippines
Fusarium moniliforme	2	Philippines
Macrophomina phaseolina	2	Philippines
Mycelia sterilia	2	Philippines
Pestalotia sp.	2	Philippines
Phoma sp.	2	Philippines
Stemphylium radicinum	2	Philippines
Pinus kesiya Royle ex Gord.		
Aspergillus niger	15	Philippines
Fusarium semitectum	15	Philippines
Penicillium sp.	15	Philippines
Pinus khasya Royle		
Botryodiplodia sp.	13	Madagascar
Fusarium moniliforme	13	Brazil
Fusarium semitectum	13	Madagascar
Pestalotia sp.	13	Zambia
Phoma sp.	13	Philippines
Pinus lambertiana Dougl.		
Cylindrocladium sp.	20	USA
Fusarium oxysporum	6	USA*†
Fusarium roseum	20	USA*†
Mucor sp.	20	USA
Penicillium sp.	20	USA
Rhizopus sp.	20	USA
Pinus merkusii Jungh. & de Vriese		
Aspergillus sp.	2	Philippines
Botryodiplodia theobromae	2	Philippines
Cephalosporium sp.	2	Philippines
Fusarium equiseti	13	Zambia
Fusarium moniliforme	2	Philippines
Fusarium semitectum	2	Philippines
Fusarium solani	2	Philippines
Macrophomina phaseolina	2	Philippines

Host and organism	Reference No.	Country
Pinus merkusii (con't)		
Penicillium sp.	2	Philippines
Pestalotia sp.	13	Zambia
Phoma sp.	13	Zambia
Pinus occidentalis Sw.		
Fusarium moniliforme	16	Cuba
Pinus oocarpa Schiede		
Botryodiplodia theobromae	13	Central America
Chaetomium sp.	13	Central America
Fusarium moniliforme	13	Central America
Fusarium solani	13	Central America
Pestalotia sp.	13	Zambia
Pestalotiopsis foedans	13	Central America
Phoma sp.	13	Central America
Pinus palustris Mill.		
Fusarium sp.	17	
Pinus patula Schlecht. & Cham.		
Fusarium semitectum	13	Madagascar
Pestalotia sp.	13	Madagascar
Pinus pinaster Ait.		
Chaetomium globosum	19	Uruguay
Fusarium moniliforme	19	Uruguay
Fusarium semitectum	19	Uruguay

Host and organism	Reference No.	Country
Pinus ponderosa Dougl. ex Laws.		
Alternaria alternata	10, 11	USA
Aspergillus sp.	10, 11	USA*†
Aureobasidium pullulans	10, 11	USA
Bacteria (unidentified)	10, 11	USA
Botrytis cinerea	10, 11	USA
Cephalosporium sp.	10, 11	USA
Chaetomium sp.	10, 11	USA
Cladosporium cucumerinum	10, 11	USA
Diplodia pinea	10, 11	USA
Fusarium oxysporum	10, 11	USA*†
Fusarium solani	10, 11	USA*†
Gliocladium sp.	10, 11	USA
Lacellina graminicola	10, 11	USA
Mucor mucedo	10, 11	USA
Penicillium chrysogenum	10, 11	USA*
Penicillium claviforme	10, 11	USA*
Penicillium expansum	10, 11	USA*
Penicillium fuscum	10, 11	USA*
Penicillium glabrum	10, 11	USA*
Penicillium oxalicum	10, 11	USA*
Penicillium viridicatum	10, 11	USA*

Host and organism	Reference No.	Country
Pinus ponderosa (con't)		
Phoma sp.	10, 11	USA
Pyrenochaeta sp.	10, 11	USA
Pythium aphanidermatum	10, 11	USA
Rhizopus arrhizas	10, 11	USA
Trichoderma viride	10, 11	USA
Trichothecium roseum	10, 11	USA*†
Ulocladium sp.	10, 11	USA
Verticillium sp.	10, 11	USA
Yeast (unidentified)	10, 11	USA
Pinus pungens Lamb.		
Fusarium moniliforme	13	USA
Pinus roxburghii Sarg.		
Fusarium equiseti	13	India
Pinus sylvestris L.		
Acremoniella atra	24	USSR
Acrostalagmus cinnabarinus	24	USSR
Alternaria brassicae	24	USSR
Alternaria tenuis	24	USSR
Aspergillus niger	24	USSR
Aspergillus oryzae	24	USSR
Botrytis allii	24	USSR
Botrytis cinerea	24	USSR
Cephalosporium acermonium	24	USSR
Cephalosporium subverticillatum	24	USSR
Chaetomium globosum	24	USSR
Cladosporium epiphyllum	24	USSR
Cladosporium herbarum	24	USSR
Cladosporium naumovi	24	USSR
Cladosporium sphaerospenum	24	USSR
Coniosporium aterrimum	24	USSR
Coniothirium quercinum	24	USSR
Curvularia inaqualis	24	USSR
Cylindrocarpon radicicola	24	USSR
Fusarium arthrosporioides	24	USSR
Fusarium culmorum	24	USSR
Fusarium heterosporum	24	USSR
Fusarium lateritium	24	USSR
Fusarium moniliforme	24	USSR
Fusarium oxysporum	24	USSR
Fusarium redolens	24	USSR
Fusarium sarcochrum	24	USSR
Fusarium semitectum	24	USSR
Fusarium solani	24	USSR
Fusarium sporotrichioides	24	USSR
Gliocladium roseum	24	USSR
Helminthosporium rostratum	24	USSR
Helminthosporium sativum	24	USSR
Melanconium apiocarpon	24	USSR
Melanconium bicolor	24	USSR
Mucor plumbeus	24	USSR
Mucor racemosus	24	USSR
Mucor ramanianus	24	USSR
Oospora verticilloides	24	USSR
Ophiostoma sp.	24	USSR
Paecilomyces varioti	24	USSR
Penicillium arenarium	24	USSR
Penicillium chrysogenum	24	USSR
Penicillium crustaceum	24	USSR
Penicillium divergens	24	USSR

Host and organism	Reference No.	Country
Pinus sylvestris (con't)		
Penicillium roqueforti	24	USSR
Pestalotia glandicola	24	USSR
Pestalotia quercina	24	USSR
Pullularia sp.	24	USSR
Rhizopus arrhizas	24	USSR
Stemphylium atrum	24	USSR
Stemphylium ilicis	24	USSR
Stemphylium piriforme	24	USSR
Torula convoluta	24	USSR
Trichoderma lignorum	24	USSR
Trichothecium roseum	24	USSR
Verticillium albo-atrum	24	USSR
Pinus taeda L.		
Acrospeira sp.	3	USA
Alternaria sp.	3	USA
Aspergillus sp.	3	USA
Asteromella sp.	3	USA
Bispora sp.	3	USA
Candida sp.	3	USA
Cephalosporium sp.	3	USA
Chaetomium sp.	3	USA
Chaetophoma sp.	3	USA
Chlamydomyces sp.	3	USA
Cladosporium sp.	3	USA
Curvularia sp.	3	USA
Dendrophoma sp.	3	USA
Diplodia sp.	3	USA
Diplodia pinea	19	Uruguay
Epicoccum nigrum	12	USA
Erysiphe sp.	3	USA
Fusarium moniliforme	13	Brazil
Fusarium moniliforme var. *subglutinans*	4	USA*†
Fusarium oxysporum	12	USA
	19	Uruguay
Fusarium roseum	12	USA
Fusarium semitectum	13	Canada
Fusarium solani	13	USA
Fusarium tricinctum	12	USA
Geotrichum sp.	3	USA
Gilmaniella sp.	3	USA
Gliocladium sp.	3	USA
Gonatobotrys sp.	3	USA

Host and organism	Reference No.	Country
Pinus taeda (con't)		
Gonatobotryum sp.	3	USA
Hansfordia sp.	3	USA
Helminthosporium sp.	3	USA
Humicola sp.	3	USA
Hyalodendron sp.	3	USA
Isaria sp.	3	USA
Melanospora sp.	3	USA
Metarrhizium sp.	3	USA
Monilia sp.	3	USA
Monocillium sp.	3	USA
Monotospora sp.	3	USA
Myrothecium roridum	13	USA
Nigrospora spp.	3	USA
Nodulisporium sp.	3	USA
Oidium sp.	3	USA
Olpitrichum sp.	3	USA
Papulospora sp.	3	USA
Penicillium sp.	3	USA
Pestalotia sp.	3	USA
Phomopsis sp.	3	USA
Rhizopus sp.	3	USA
Sphaeronaema sp.	3	USA
Spondylocladium sp.	3	USA
Sporothrix sp.	3	USA
Sporotrichum sp.	3	USA
Staphylotrichum sp.	3	USA
Syncephalastrum racemosum	12	USA
Tetracoccosporium sp.	3	USA
Torula sp.	3	USA
Trichaegum sp.	3	USA
Trichoderma sp.	3	USA
Trichothecium sp.	3	USA
Trichothecium roseum	19	Uruguay
Tritirachium sp.	3	USA
Umbelopsis sp.	3	USA
Verticillium sp.	3	USA
Pistacia vera L.		
Nematospora coryli	16	Central Asia§

Host and organism	Reference No.	Country
Pittosporum resiniferum Hemsl.		
Aspergillus flavus	15	Philippines
Cladosporium cladosporoides	15	Philippines
Fusarium solani	15	Philippines
Polyscias nodosa Seem.		
Chaetomium sp.	2	Philippines
Cladosporium sp.	2	Philippines
Fusarium moniliforme	2	Philippines
Fusarium semitectum	2	Philippines
Phoma sp.	2	Philippines
Populus tremuloides Michx.		
Necrotic leaf spot virus	16	Canada
Prosopis juliflora (Sw.) DC.		
Fusarium equiseti	13	Chile*
Fusarium moniliforme	13	Chile*
Fusarium semitectum	13	Chile*
Fusarium solani	13	Chile*
Prosopis tamarugo Phil.		
Fusarium equiseti	13	Chile
Fusarium semitectum	13	Chile

Host and organism	Reference No.	Country
Prunus spp.		
Agrobacterium tumefaciens	16	USA
Apricot gummosis virus	16	USA
Cherry leaf roll virus	16	East Germany
Cherry necrotic rusty mottle virus	16	
Prune dwarf virus	16	West Germany, USA
	17	West Germany
	18	United Kingdom
Prunus necrotic ring spot virus	16	USA, East Germany*
Pseudomonas syringae	16	USA
Virus	16	
	17	Romania
Prunus amygdalus Batsch		
Bud failure	16	USA
Gnomonia circumscissa	16	Italy
Prunus necrotic ring spot virus	16	USA
Pseudotsuga menziesii (Mirb.) Franco		
Fusarium oxysporum	8	USA†
Fusarium solani	9	USA
Mucor sp.	9	USA
Penicillium chrysogenum	9	USA
Penicillium italicum	9	USA
Pestalotiopsis funerea	16	England (London)
Rhizopus sp.	9	USA
Schizophyllum commune	16	
Trichoderma viride	9	USA
Verticillium spp.	16	England (London)

Host and organism	Reference No.	Country
Pterocarpus indicus Willd.		
Chaetomium sp.	2	Philippines
Cladosporium cladosporoides	2	Philippines
Colletotrichum gloeosporioides	13	Philippines
Fusarium moniliforme	2	Philippines
Fusarium semitectum	2	Philippines
Fusarium solani	2	Philippines
Macrophomina phaseolina	2	Philippines
Nigrospora sp.	13	Philippines
Pestalotia sp.	2	Philippines
Phoma sp.	2	Philippines
Phomopsis spp.	2	Philippines
Verticillium sp.	13	Philippines
Pterospermum acerifolium Willd.		
Fusarium moniliforme	13	India
Fusarium oxysporum	13	India
Fusarium solani	13	India
Pestalotia sp.	13	India
Phoma sp.	13	India
Punica granatum L.		
Coniella granati	17	USA
Pyrus spp.		
Pear bark measles virus	16	USA§
Tobacco mosaic virus	16	
Truncatella laurocerasi	16	Romania
Quercus spp.		
Ciboria batschiana	17	France*
Pestalotiopsis spp.	16	Scotland
Quercus alba L.		
Fusarium solani	25	USA
Epecoccum purpurascens	25	USA
Quercus falcata Michx.		
Fusarium solani	25	USA
Epecoccum purpurascens	25	USA
Quercus nigra L.		
Fusarium solani	25	USA
Epecoccum purpurascens	25	USA
Quercus phellos L.		
Fusarium solani	25	USA
Epecoccum purpurascens	25	USA
Quercus rubra L.		
Ciboria batschiana	7	France*†
Discala umbrinella	7	France
Robinia pseudoacacia L.		
Guignardia robiniae	16	Japan*

Host and organism	Reference No.	Country
Saanea saman Merr.		
Aspergillus flavus	15	Philippines
Aspergillus niger	15	Philippines
Penicillium sp.	15	Philippines
Sambucus spp.		
Cherry leaf roll virus	16	East Germany
Tomato ring spot virus	16	USA
Serialbizia acle Kosterm.		
Aspergillus flavus	15	Philippines
Chaetomium sp.	15	Philippines
Penicillium sp.	15	Philippines
Sesbania grandiflora Pers.		
Aspergillus spp.	15	Philippines
Colletotrichum capsici	16	India
Sesbania sesban Merr.		
Fusarium semitectum	13	Rwanda*
Phoma sp.	13	Rwanda

Host and organism	Reference No.	Country
Swietenia macrophylla King.		
Botryodiplodia theobromae	2	Philippines
Chaetomium sp.	2	Philippines
Cladosporium sp.	2	Philippines
Curvularia lunata	2	Philippines
Fusarium solani	2	Philippines
Macrophomina phaseolina	13	India
Nigrospora	2	Philippines
Pestalotia sp.	2	Philippines
Phoma sp.	2	Philippines
Tabebuia heptaphylla Vell.		
Macrophomina phaseolina	13	Brazil
Taxodium mucronatum Ten.		
Fusarium semitectum	13	India
Fusarium solani	13	India
Pestalotia sp.	13	India
Phoma sp.	13	India
Tectona grandis L. f.		
Aspergillus spp.	21	India
Alternaria spp.	21	India
Botryodiplodia spp.	21	India
Botryodiplodia theobromae	13	
Cephalosporium sp.	13	India
Cercospora spp.	21	India
Chaetomium spp.	21	India
Curvularia spp.	21	India
Fusarium spp.	21	India
Fusarium culmorum	13	
Fusarium equiseti	13	

Host and organism	Reference No.	Country
Tectona grandis (con't)		
Fusarium moniliforme	13	Thailand, India*
Fusarium oxysporum	13	
Fusarium semitectum	13	Thailand, India*
Fusarium solani	13	Philippines
Fusicoccum spp.	21	India
Gonatobotryum spp.	21	India
Hansfordia spp.	21	India
Humicola spp.	21	India
Macrophomina	13	
Memnoniella spp.	21	India
Monocillium spp.	21	India
Mucor spp.	21	India
Myrothecium sp.	13	
Oedocephalum spp.	21	India
Paecilomyces spp.	21	India
Penicillium spp.	21	India
Periconia spp.	21	India
Pestalotia spp.	21	India
Phoma sp.	13	
Phomopsis sp.	13	
Pithomyces spp.	21	India
Sporothrix spp.	21	India
Syncephalastrum spp.	21	India
Torula spp.	21	India
Trichothecium spp.	21	India
Verticillium sp.	13	
Terminalia myriocarpa Heurck & Muell.-Arg.		
Pestalotia sp.	13	India
Theobroma cacao L.		
Botryodiplodia theobromae	16	
Cacao swollen shoot virus	16	
Crinipellis perniciosa	16	Africa, Trinidad, Dominican Republic†
Glomerella cingulata	16	Romania

Host and organism	Reference No.	Country
Theobroma cacao (con't)		
Hollow heart	16	Venezuela
Monilia roreri	16	†
Phytophthora sp.	16	
Phytophthora palmivora	16	Nigeria§
Thuja spp.		
Pestalotia sp.	16	Spain*
Tilia americana L.		
Myrothecium sp.	13	USA
Triplaris cumingiana Fisch. & Mey. ex C. A. Mey.		
Aspergillus flavus	15	Philippines
Aspergillus niger	15	Philippines
Botryodiplodia theobromae	15	Philippines
Cladosporium cladosporoides	15	Philippines
Curvularia lunata	15	Philippines
Fusarium moniliforme	15	Philippines
Fusarium semitectum	15	Philippines
Fusarium solani	15	Philippines
Macrophoma phaseoli	15	Philippines
Penicillium sp.	15	Philippines
Pestalotia sp.	15	Philippines
Tsuga heterophylla (Raf.) Sarg.		
Verticillium spp.	16	England

Host and organism	Reference No.	Country
Ulmus spp.		
Cherry leaf roll virus	16	USA
Elm mottle virus	16	United Kingdom
Gloeosporium ulmicola	16	Romania*
Rhizoctonia solani	16	Denmark
Ulmus davidiana Planch.		
Fusarium moniliforme	13	South Korea
Fusarium solani	13	South Korea
Pestalotia sp.	13	South Korea
Phoma sp.	13	South Korea
Vitex parviflora Juss.		
Aspergillus spp.	2	Philippines
Penicillium spp.	2	Philippines
Wallaceodendron celibcum Koord.		
Fusarium semitectum	15	Philippines
Fusarium solani	15	Philippines

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ALPHABETICAL LIST OF FUNGI IN THE 1985 REPORT

Identifying micro-organisms requires establishing the correct taxonomy. Often there are errors in spelling, incorrect author attributions, or established name changes that are not reflected in some studies. This listing gives species names and authors that follow the most recent taxonomic information, hence may vary slightly from that given in the reference source. Page numbers following the entries refer to the checklist.

Other Damage Types in the 1985 Report

Anderson, Robert L.

Checklist of micro-organisms associated with tree seeds in the world, 1985. Gen. Tech. Rep. SE-39. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1986. 34 pp.

Listed alphabetically by host are the major micro-organisms associated with tree seeds. Included are the countries where the organism originated, whether the organism causes a disease of considerable economic importance, whether treatment is available, and where evidence of the seedborne nature of the organism is incomplete or contradictory. The complete reference for the source of information on each organism is included.

KEYWORDS: Fungi, bacteria, seedborne, pathology, International Seed Testing Association.

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