Data Sheets on Quarantine Pests

Ophiostoma wageneri

IDENTITY

Name: *Ophiostoma wageneri* (Goheen & Cobb) Harrington
Synonyms: *Ceratocystis wageneri* Goheen & Cobb
Anamorph: *Leptographium wageneri* (Kendrick) M.J. Wingfield var. *ponderosum* (Harrington & Cobb) Harrington & Cobb
Synonyms: *Verticicladiella wageneri* Kendrick var. *ponderosa* Harrington & Cobb
Taxonomic position: Fungi: Ascomycetes: Ophiostomatales
Common names: Black stain root disease (English)
Notes on taxonomy and nomenclature: Originally describedas a *Ceratocystis*, this fungus has now been redescribed as an *Ophiostoma* (Harrington, 1987). In any case, most publications refer to the anamorph. In this data sheet three varieties of *L. wageneri* are referred to, but Harrington & Cobb (1986) separated these strains into *L. wageneri* var. *wageneri*, *L. wageneri* var. *ponderosum* and *L. wageneri* var. *pseudotsugae*. To date, no teleomorph has been reported for *L. wageneri* var. *pseudotsugae* and *L. wageneri* var. *wageneri*.
Bayer computer code: LEPGWA
EPPO A1 list: No. 179

HOSTS

The main hosts of *O. wageneri* (*L. wageneri* var. *ponderosum*) are the conifers *Pinus contorta*, *P. jeffreyi* and *P. ponderosa*. According to Harrington &Cobb (1987), *P. monophylla* and *P. edulis* are the primary hosts for *L. wageneri* var. *wageneri*, and Pseudotsuga menziesii is the primary host for *L. wageneri* var. *pseudotsugae*.

In the European and Mediterranean region, *Pinus contorta* and *P. sylvestris* are grown extensively and would present a huge host plant reservoir for the fungus (Webber & Hansen, 1990).

GEOGRAPHICAL DISTRIBUTION

The fungus is indigenous to western North America. With one exception (Colorado), it has never been found east of the continental divide (Cobb, 1988).
EPPO region: Absent.
North America: Canada (British Columbia), USA (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington).
EU: Absent.

BIOLOGY

O. wageneri is a unique pathogen which causes a unique disease. One of the surprising features of the pathogen is that its mycelium can grow from an infected root through the soil to an adjacent healthy root for some centimetres. The mycelium normally enters the healthy root via wounds or natural openings since the fungus lacks cellulolytic enzymes

which would allow it to degrade cell walls and penetrate (Hansen *et al*., 1988). In most cases secondary rootlets are colonized first. From there the fungus colonizes the tracheids of the xylem and grows axially and vertically up to the root crown and further up the stem.

The pathogen is most frequently found in the outer xylem but can also extend to some adjacent inner growth rings (Cobb, 1988). Within the xylem, mycelial growth is very rapid. The mycelium can grow up to 6 mm per day or up to 2 m per year in the host xylem (Hessburg & Hansen, 1986) and can reach heights up to 15 m. This is dependent on environmental factors; higher temperatures favour colonization but not infection. This colonization of the tracheids while the host is alive resembles the behaviour of "vascular wilt" fungi.

Bark beetles and weevils which are believed to be main vectors of the fungus acquire conidia of *O. wageneri* when building galleries in or through infected tissue. Conidia of the fungus occur in a sticky droplet (Cobb,1988) which adheres to the insect. Root-feeding scolytids (*Hylastes macer, H. nigrinus*) are thought to be important vectors of the fungus (Cobb, 1988).

The period of survival of *O. wageneri* in dead trees or logs is uncertain. While one report stated that after a few months in dead tissue the fungus could no longer be isolated, there are other reports of pine seedling mortality continuing for 4 years near infested stumps (Cobb, 1988).

The discovery of perithecia in infected *P. ponderosa* trees (Goheen & Cobb, 1978) led to the description of *Ceratocystis wageneri* as the teleomorph of the fungus previously known as *Leptographium wageneri*. Perithecia were found in five trees at one location in California (USA). They are not known to play an important part in the disease cycle.

DETECTION AND IDENTIFICATION

Symptoms

The disease is characterized by tangential bands or arcsof stain in the sapwood. These are often widest at the root collar and taper away up the stem and down into the roots. This stain is due to the presence of dark mycelium in the tracheids and to a discoloration of the tracheid walls. Other types of conifer sapwood stain differ from this in that they involve radial growth of the fungus through the medullary rays and the production of a pattern of stain that is wedge-shaped in cross section. The needles on affected trees are often smaller than normal. They may turn yellow or brown or fall prematurely. Resin exudation may occur from the lower trunk.

The disease normally occurs in patches or centres of dead and/or diseased trees. Normally bark beetles are associated with these trees since, due to infection by the fungus, the resistance of the trees to bark beetle infestation is somewhat decreased.

Young trees, seedlings or saplings can be killed within months and older trees within 2 years of infection (Cobb, 1988). In young trees and seedlings the disease can become systemic, even reaching the xylem of juvenile needles (Cobb, 1988).

Morphology

In culture (Goheen & Cobb, 1978), hyphae are first hyaline, then brownish-green, branched, thick-walled, septate, 3-12 µm in diameter. Erect conidiophores have stipe dark-brown, thick-walled, 8-12 septate, 540-914 µm long and 10-12 µm in diameter; ramified heads up to 60 µm across, made up of repeatedly branching metulae, light-brown at the base becoming hyaline at the tips; conidia hyaline, obovate 6.5-7.0 x 1.8-2.0 µm.

Detection and inspection methods

O. wageneri is the only fungus which is likely to be found on microscopic inspection of the xylem tracheids of living or freshly felled conifers.

Leptographium species can be isolated quite readily onto conventional agar media supplemented with 0.01% cycloheximide (Harrington, 1981). However, separation of the conidial state of *O. wageneri* from those of other less damaging species is a task for experts.

MEANS OF MOVEMENT/DISPERSAL

Natural spread of *O. wageneri* occurs locally via root grafts between adjacent trees and through the transport of the fungus by insects, and perhaps by water. In addition, and somewhat surprisingly, the fungus is capable ofgrowing freely through the soil for a few centimetres. Bark beetles (*Hylastes* spp.) and weevils (*Pissodes* spp. and *Steremnius* spp.) are the chief insect vectors. They breed readily in diseased roots and are able to create new infection courts by their feeding activities on healthy roots. The disease normally appears in patches or centres which can extend up to 7 m per year (Cobb, 1988).

International spread would most readily occur by trade of living coniferous host plants. The fungus is not likely to be carried by wood, unless this is infested by bark beetles and weevils acting as vectors.

PEST SIGNIFICANCE

Economic impact

The fungus colonizes the sapwood of the roots and lower stem. Affected trees grow poorly for several years and then usually die. The disease typically occurs in enlarging foci, spreading at rates averaging 1 m per year. It is considered a major threat to managed crops of *Pseudotsuga menziesii* and *Pinus ponderosa*. Its potential for damage in the forest regions of the northern hemisphere is very considerable. For more information, see Hansen (1985), Sinclair *et al.* (1987).

The disease has become important within the last two decades and coincides with the plantation of large areas of susceptible species as well as the increased use of heavy machinery in forestry (Hansen *et al.*, 1988). It is thought to be potentially one of the most dangerous pathogens of *Pinus* in North America and losses due to *O. wageneri* are expected to increase in the future (Hansen *et al*., 1988).

Control

Currently there are no control methods available based on chemical or biological products. However, certain cultural practices can limit the spread of the pathogen. *O. wageneri* causes most damage on areas which are disturbed by human causes, such as roadsides, pre-thinnedplantations of *Pinus*, and areas logged with heavy machinery. Therefore, to control the disease it would be preferable to use less heavy equipment to avoid excessive soil compaction (Hansen *et al*., 1988). The felling and removal of diseased trees can help to limit the spread of the fungus.

Phytosanitary risk

O. wageneri is an EPPO A1 quarantine pest. A study carried out by Webber & Hansen (1990) examined the possibilities of establishment of *L. wageneri* in Europe, and especially the UK, and concluded that host plants as well as climatic conditions would permit the fungus to establish. Besides the host and climatic conditions, the fungus could be vectored by European *Hylastes* spp. and spread further. It could cause considerable economic and ecological damage in Europe if introduced.

PHYTOSANITARY MEASURES

The specific quarantine requirements for *O. wageneri* are currently being developed by EPPO. In general, strict control is required over the importation of coniferous plants from North America, and appropriate precautions should be taken for wood. Probably, EPPO's recommended specific quarantine requirements for non-European Scolytidae could easily be adapted for *O. wageneri* (OEPP/EPPO, 1990).

BIBLIOGRAPHY

Cobb, F.W. (1988) *Leptographium wageneri*, cause of black stain root disease; a review of its discovery, occurrence and biology with emphasis on pinyon and ponderosa pine. In: *Leptographium root disease in conifers* (Ed. by Harrington, T.C.; Cobb, F.W.), pp. 41-62. American Phytopathological Society, St Paul, Minnesota, USA.

Goheen, D.J.; Cobb, F.W. (1978) Occurrence of *Verticicladiella wageneri* and its perfect state, *Ceratocystis wageneri* sp. nov., in insect galleries. *Phytopathology* **68**, 1192-1195.

Hansen, E.M. (1985) Forest pathogens of N.W. North America and their potential for damage in Britain. *Forestry Commission Forest Record* No. 129. HMSO, London, UK.

Hansen, E.M.; Goheen, D.J.; Hessburd, P.F.; Witchosky, J.J.; Schowalter, T.D. (1988) Biology and management of black stain root disease in Douglas fir. In: *Leptographium root disease in conifers* (Ed. by Harrington, T.C.; Cobb, F.W.), pp. 63-80. American Phytopathological Society, St Paul, Minnesota, USA.

Harrington, T.C. (1981) Cycloheximide sensitivity as a taxonomic character in *Ceratocystis*. *Mycologia* **73**, 1123-1129.

Harrington, T.C. (1987) New combinations in *Ophiostoma* of *Ceratocystis* species with *Leptographium* anamorphs. *Mycotaxon* **28**, 39-43.

Harrington, T.C.; Cobb, F.W. (1986) Varieties of *Verticicladiella wageneri*. *Mycologia* **78**, 562-567.

Hessburg, P.F.; Hansen, E.M. (1986) Soil temperature and the growth of *Verticicladiella wageneri* in Douglas fir. *Phytopathology* **76**, 627-631.

OEPP/EPPO (1990) Specific quarantine requirements. *EPPO Technical Documents* No. 1008.

Sinclair, W.A.; Lyon, H.H.; Johnson, W.T. (1987) *Diseases of trees and shrubs*. Comstock Publishing Association, Ithaca, USA.

Webber, J.F.; Hansen, E.M. (1990) Susceptibility of European and N.W. American conifers to the North American vascular pathogen *Leptographium wageneri*. *European Journal of Forest Pathology* **20**, 347-354.