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Data Sheets on Quarantine Pests

Cronartium coleosporioides

IDENTITY

Name: *Cronartium coleosporioides* J.C. Arthur
Anamorph: *Peridermium stalactiforme* (Dietel) J.C. Arthur & Kern
Taxonomic position: Fungi: Basidiomycetes: Uredinales
Common names: Stalactiform blister rust (English)
Notes on taxonomy and nomenclature: A broader concept of *C. coleosporioides* has been followed in the past, by which it is considered to include a set of distinctive aecial stages: *Peridermium stalactiforme* (northern distribution), *P. filamentosum* (southern distribution) and *P. harknessii* (ubiquitous and autoecious) (Mordue & Gibson, 1978).
However, Hiratsuka (1969) concluded that the aeciospores of *P. harknessii* function as teliospores and erected the new genus *Endocronartium* to accommodate such endocyclic life cycles (see *Endocronartium harknessii*; EPPO/CABI, 1996c). This approach is followed here, so the aecial stage of *C. coleosporioides* is considered to be only *P. stalactiforme*. In other respects, it may be noted that *C. coleosporioides* belongs, with *C. comandrae* and *C. comptoniae*, to the group of the "blister rusts", heteroecious rusts with *P. banksiana* and *P. contorta* as main aecial hosts and wild indigenous herbaceous plants as telial hosts.
Bayer computer code: CRONCL
EPPO A1 list: No. 248
EU Annex designation: I/A1 - as *Cronartium* spp. (non-European)

HOSTS

The main aecial hosts are two- and three-needled *Pinus* spp., mainly jack pine (*P. banksiana)*, across Canada, and lodgepole pine (*P. contorta)*, in western Canada and USA. The western species Jeffrey pine (*P. jeffreyi*) and western yellow pine (*P. ponderosa*) are occasionally attacked. Of these species, *P. contorta* is widely planted in northern and western Europe and *P. ponderosa* to a certain extent in central Europe. Native European *Pinus* spp. have not been recorded to be hosts of *C. coleosporioides* in North America.

The telial hosts are in the Scrophulariaceae. The most important are *Castilleja* spp. (e.g. *C. miniata*) and *Melampyrum lineare*, but the fungus has also been found on *Cordylanthus*, *Lamourouxia*, *Orthocarpus luteus*, *Pedicularis bracteosa* and *Rhinanthus crista-galli*. None of these species occurs in Europe (*R. crista-galli* is a old name not now used for any European species of the genus). The main telial host genus (*Castilleja)* has representatives only in the far north of Russia and in the Urals, but the genera *Melampyrum*, *Pedicularis* and *Rhinanthus* are well represented in the European flora. For more information, see Spaulding (1956, 1961), Boyce (1961), USDA (1963), Davidson & Prentice (1967), Peterson (1967), Hepting (1971), Ziller (1974), Sinclair *et al.* (1987).

GEOGRAPHICAL DISTRIBUTION

EPPO region: Absent.
North America: Canada (practically throughout - Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Northwest Territory, Ontario, Quebec, Saskatchewan, Yukon Territory), USA (western and Great Lakes states - Alaska, Arizona, California, Colorado, Idaho, Iowa, Kansas, Michigan, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, Wyoming).
EU: Absent.
Distribution map: See IMI (1992, No. 541).

BIOLOGY

The biology of all the heteroecious North American *Cronartium* spp. is broadly the same, and the following general account can be applied to *C. coleosporioides.* Pycnia and aecia are produced on the *Pinus* hosts in the spring and early summer, one to several years after infection. Aeciospores can be carried over long distances in the wind and infect the alternate (telial) host; they cannot reinfect *Pinus*. About 2 weeks after infection, uredinia appear on the alternate hosts. Successive production of uredinia and reinfection throughout the summer result in high levels of infection on the alternate host. Telia are produced in late summer, and *Pinus* hosts become infected via the first-year needles by the wind-borne basidiospores which arise from germination of teliospores; the telial host cannot be reinfected by basidiospores. Basidiospore infection, which occurs in summer and autumn, is usually limited to an area within 1.5 km of the alternate host, owing to the spores being delicate and short-lived. Infection of *Pinus* by basidiospores completes the life cycle, the duration of which varies between species. The fungal mycelium of these rusts may overwinter in bark and galls of *Pinus*. Van der Kamp (1994) found that most infections of *P. contorta* by *C. coleosporioides* occurred within 2 m of the ground and disappeared as the branches concerned were progressively shed, without new infections appearing.

For more information, see also Boyce (1961), USDA (1963), Davidson & Prentice (1967), Peterson & Jewell (1968), Peterson (1973), Ziller (1974), Sinclair *et al.* (1987). The widely distributed and much studied *C. ribicola* has similar biology (Phillips, 1988).

DETECTION AND IDENTIFICATION

Symptoms

In *Pinus*, the fungus grows upward and downward from the infection point, progressively killing the branches, and subsequently the whole tree. Seedlings are usually killed but, while high mortality may occur in nurseries, the rust is not known to kill maturing whole stands. Necrosis or cankering of invaded twigs may occur in association with *Atropellis piniphila* (EPPO/CABI, 1996a), perennial cankers being about ten times longer than broad. Frequently, infected bark is gnawed off by rodents, which causes intense resinosis. In the alternate host, *Castilleja*, the fungus causes a pale-yellow leaf spot.

For more information, see also Boyce (1961), USDA (1963), Hepting (1971), Ziller (1974), Sinclair *et al.* (1987).

Morphology

Aecia scattered, caulicolous; aecial filaments usually abundant and nearly all stalactiform. Aeciospores subglobose to long-ellipsoid, orange; wall colourless and moderately to coarsely verrucose, 2.5-4 µm thick, with a conspicuous smooth spot and warts up to 3 µm high; 17-24 x 23-34 µm. Uredinia and telia hypophyllous, amphigenous or caulicolous.

Urediniospores globose-ellipsoid, wall colourless, 1-1.5 µm thick, sparsely echinulate; 14-22 x 17-27 µm. Telial columns cylindric and short; 0.5-1 mm. Teliospores oblong or fusiform-oblong, obtuse at both ends, wall colourless, uniformly 1 µm thick, smooth; 12-17 x 30-52 µm. See also Mordue & Gibson (1978). Van der Kamp (1993) reports that some populations seem to have lost the ability to form urediniospores.

Microscopic observation of sporulating structures is necessary to differentiate *C. coleosporioides* from other *Cronartium* spp. In particular, *C. coleosporioides* much resembles *C. comptoniae* (EPPO/CABI, 1996b), and inoculation of alternate hosts may be necessary to differentiate them. See also Boyce (1961), USDA (1963), Anderson & French (1965), Peterson & Jewell (1968), Ziller (1974).

Detection and inspection methods

Isozyme and protein analysis of aeciospores can differentiate between the different *Cronartium* spp. and *Endocronartium harknessii*.

MEANS OF MOVEMENT AND DISPERSAL

Cronartium spp. can be carried considerable distances as wind-borne aeciospores and can survive considerable periods in the airborne state (Chang & Blenis, 1989). More importantly, these rusts can also be carried to new areas on plants for planting of the coniferous aecial hosts, as has occurred in parts of the USA. The long incubation periods of *Cronartium* spp. mean that latent infections easily go undetected unless post-entry quarantine is applied. The alternate hosts of *C. coleosporioides* are wild plants which are extremely unlikely to be traded internationally. Similarly, there is no risk in movement of *Pinus* seeds or pollen.

PEST SIGNIFICANCE

Economic impact

The *Cronartium* rusts cause very important diseases in North America, resulting in malformation, reduced vigour and death of trees and seedlings. However, their abundance does depend primarily on the abundance and localization of the alternate host (Gross *et al.*, 1983). *C. coleosporioides* attacks are generally sporadic, although severe damage has been reported on *Pinus ponderosa* and *P. contorta* in nursery, Christmas tree and young plantation crops in Canada and the USA (Mordue & Gibson, 1978). Nevill *et al*. (1989) evaluated a loss in volume of about 30% in severe infections of *P. contorta*, also affected by *Atropellis piniphila* canker, in British Columbia. In general, *C. coleosporioides* is less important than *Endocronartium harknessii*, which occurs over practically the same area of North America on the *Pinus* hosts attacked by *C. coleosporioides*. In Alberta and Northwest Territory, Hiratsuka *et al*. (1988) found that *C. coleosporioides* was less aggressive than the other "blister rusts" *C. comandrae* and *C. comptoniae* in girdling trees of *P. banksiana* and *P. contorta* on which rust lesions had established, but still killed significant numbers of trees.

Control

Control can be effected by removing infected material and eradicating the alternate host, although this is rarely economically viable. Nurseries should be located away from possible infection sources. Chemical spraying is feasible in nurseries. Research into resistant cultivars of *P. contorta* shows some promise (Yanchuk *et al*., 1988); resistance to *C. coleosporioides* appears to be linked to resistance to *E. harknessii.*

Phytosanitary risk

C. coleosporioides is one of the non-European *Cronartium* spp. of the EPPO A1 list (OEPP/EPPO, 1979), and is also a quarantine pest for IAPSC. The danger presented by these fungi to the EPPO region is classically exemplified by reference to the quarantine pest *C. ribicola* (Phillips, 1988), which has made it almost impossible to grow *P. strobus* commercially in most areas in Europe and North America to which the fungus was introduced from Asia. However, it should be stressed that the potential risk from introduced *Cronartium* spp. is much affected by the status of the alternate hosts concerned. While the *Ribes* hosts of *C. ribicola* are widespread cultivated plants, the telial hosts of *C. coleosporioides* are wild plants which do not occur in Europe, and there is only a possibility that related European wild plants might also be infected. In addition, European *Pinus* spp. are not apparently infected and the North American pines which are hosts are planted only to a limited extent. Accordingly, *C. coleosporioides* can be considered to present only a moderate risk for the EPPO region.

PHYTOSANITARY MEASURES

Since symptoms may not be apparent in the aecial hosts for several years after infection, the only practical safeguard is to prohibit entry of the *Pinus* species which are aecial hosts (see Hosts) from countries where *C. coleosporioides* occurs (OEPP/EPPO, 1990). No specific measures are needed for the telial hosts. Bark and wood of host *Pinus* should have been appropriately treated (heat-treated, fermented, kiln-dried; EPPO quarantine procedures are in preparation).

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