European Larch canker- *Lachnellula willkommii*

The cause of European larch canker, *Lachnellula willkommii*, is apparently native to Japan but established in Europe. It was identified as a pathogen, particularly in Northern Europe, due to its damage to plantations of exotic and native *Larix* species beginning in the 19th century (Yde-Anderson, 1980). Once introduced this fungus attacks and spreads among various species of *Larix*.

**Lachnellula willkommii** (R. Hartig) Dennis, Persoonia 2(2): 184 (1962)

Ascomata apothecial, 2-4 mm tall, conspicuous, solitary or gregarious, frequently in clusters from two to many, erumpent, breaking through the bark where canker developed; apothecia cup-shaped to discoid, with a short stout stipe; sides and disk margin covered with conspicuous white hairs, hairs white, cream, beige, pale brown, to gray in dried specimens.

Disk 3-4(-6) mm diam, orange to orange-yellowish when fresh, ochraceous to beige, margin thick, enrolled.

Stipe white to pale grey-brown, smooth, ca. 1 mm diam wide at base, narrowing towards apex, 1 mm tall.

Hairs simple or divided, cylindrical, (1.0-)1.5-3(-4) µm diam, wider at apex, clavate or lanceolate, (1.5-)2-3.5(-4) µm, septate, thick walled, finely granulate, individual or agglutinated into pointed hair tufts or into rounded warts.

Asci uniserate, hyaline, clavate, apex obtuse to rounded, inoperculate, apical pore not bluing in iodine, (81-)98-168(-185)µm × (7-)8-12(13-) µm, eight spores per ascus, uniseriate to partially biseriate.

Ascospores hyaline, oblong-ellipsoid to ellipsoid fusoid or obovoid; ends different, apex slightly acute, basal end round, (7-)10-26(-29)µm × (3-)4-10(-11) µm, smooth, generally 0-septate, when germinating 1-septate.

Paraphyses with orange contents in recent specimens, hyaline in older specimens, filiform to inflated at the apex, (123-)140-187(-189) µm long, (0.7)1.0-2.5(-4) µm, slightly wider at apex, clavate to irregular (1-)2-3.5 (-4) µm, septate, simple or branched towards base.

The larch canker organism was introduced into Massachusetts in the northeastern United States on infected nursery stock brought from Scotland in 1904. The presence of the fungus was discovered in 1927 when some of the planted land was given to Harvard University. Over 7000 trees within a 5-mile radius of the affected plantations were then examined; over 5000 were found to be infected. Infected trees were destroyed by burning. Surveys were repeated in 1935, 1938 and 1952-1953, and a few infected trees were found and destroyed each time. During a survey in 1965, no infected trees were found among 2826 examined, and the eradication effort was considered successful. The smaller number of trees of susceptible species found in the area was probably due to losses from housing development, other diseases, and incidents of severe storm damage (Tegethoff, 1965).


Native to Asia, established in Europe. Eradication efforts in North America (Canada, USA-MA, ME) have been successful.

The placement of this species has changed with the definitions of genera (Oguchi, 1981). Dennis combined Nannfeldts genus of *Trichoscyphella* with *Lachnellula* due to the difficulty of separating the genera on the basis of ascospore shape. Within the family, *Lachnellula* species are characterized by the form of their paraphyses, the color of external hairs, the shape of ascospores, and their usual occurrence on conifers (Dennis, 1962). With respect to the species, Baral (1984) found that *L. willkommii* is difficult to distinguish from *L. occidentalis* on a morphological basis, and that the clearest difference is physiological, i.e., in the pathogenicity of *L. willkommii* and the saprobic nature of *L. occidentalis*.

A number of related and similar species occur on the susceptible trees, though most are saprobic, growing only on dead material, or only weakly pathogenic (Hahn and Ayers, 1943). Microscopic examination of the ascospores is necessary for the identification of white-haired *Lachnellula* species associated with dead parts of *Larix* and *Pseudolarix* species. Descriptions of individual species are available (Buczacki, 1975; Oguchi, 1981; Minter, 2005) but a key to most *Lachnellula* species (Baral, 1984) is not available. Based on Minters descriptions (Minter, 2005), *L. willkommii* can be easily distinguished from *L. arida* and *L. flavovirens* by having white instead of brown external hairs and broader.
ascospores. Among the other white-haired species, it can be distinguished from most species except L. *occidentalis* by its broad, cylindrical ascospores.

*Lachnellula arida* (W. Phillips) Dennis 1962. Usually on dead branches. Ascomata olive-green to brown with brown hairs up to 190 mm long. Ascospores shorter and narrower, 6-9 x 3.5-5 mm. Present in North America and Europe (Minter, 2005)

*Lachnellula calyciformis* (Willd.) Dharne 1965. Usually on dead branches. Ascospores shorter and narrower, 2.5-3.5 um. Paraphyses significantly shorter (60-70 um) than in *L. willkommii*. Present in North America, Asia and Europe (Minter, 2005)

Lachnellula flavovirens (Bres.) Dennis 1962. Usually on dead branches. Hairs brown, up to 300 um long. Ascospores narrow, 3.5-5.5 um. Present in North America, Asia & Europe (Minter, 2005)

*Lachnellula laricis* (Cooke) Dharne 1965. Ascospores shorter and narrower, 12-16 - 5.5-7.5um. In United States and Europe (Baral, 1984).


*Lachnellula resinaria* (Cooke & Phill.) Rehm. 1893. Spores much shorter, (2-)2.5-4(4.5) um. In North America, Asia and Europe (Baral, 1984)


The fungus kills the growing bark, resulting in swellings on twigs and branches, and sunken cankers on larger stems. The first circular or elliptical depressions often form around dwarf shoots. Resin is exuded. The bark cracks and is loosened. A ridge of new wood develops around enlarging cankers on stems and trunks as the tree grows. Needles above the canker shrivel up and die or turn yellow early. If the stem or trunk is girdled, branches and young trees will die (Sinclair and Lyon, 2005). Small white to yellow stromata bearing the microconidial form of the fungus emerge in cankers, followed by production of the apothecia (Yde-Anderson, 1979b). Apothecia are produced 1-several years after infection (Sylvestre-Guinot and Delatour, 1983). Spore release can occur at any time of the year when temperature and rainfall conditions permit (Sylvestre-Guinot,1981). Optimum conditions for ascospore germination in Japan were a temperature of 20 C and relative humidity greater than 92% (Ito et al., 1963). Wounded trees are susceptible to infection at all seasons of the year (Hahn and Ayers, 1943). Although a microconidial form of the fungus does also appear on cankers (Hahn and Ayers, 1943; Sylvestre-Guinot and Delatour, 1983), airborne ascospores produced 1-several years after infection are considered to be the inoculum carried between trees (Sinclair and Lyon, 2005). The pathogen can significantly affect the population of susceptible species. Infection rates ranged from 3% to 100% of trees examined at sites in New Brunswick, Canada (Magasi and Pond, 1982). In Serbia, approximately 48% of trees in a larch plantation were infected (Karadzik, 1989).

Disease is more severe when trees are grown in poor or less optimal conditions of soil and climate, and therefore a species, variety or genotype that is well-adapted to the location should be selected for planting (Hahn and Ayers, 1943; Ito et al, 1963; Sylvestre-Guinot, 1983). In northern Europe, larches of Alpine provenance were much more susceptible than those of Polish provenance (Yde-Anderson, 1979a). Canadian regulations on movement and importation of commodities likely to be infected exempt those non-growing wood materials that are free of bark or have been heat-treated to kill the pathogen (CFIA, 2008). However, the fungus is capable of infecting the xylem (Blanchette, 2001) and so could be present in logs without bark. Destruction of infected trees and branches appeared to be effective in eradicating the pathogen in Massachusetts (United States) over a period of 40 years (Tegethoff, 1965). A similar effort was made on Prince Edward Island, Canada (Simpson and Harrison, 1983). Removal and destruction of infected branches is still suggested as a means of control (The Nature Conservancy, 2009) but the effort and equipment needed may be considerable (Tegethoff, 1965).

As in the past, introduction could result from trade in nursery stock, but also from larch wood and wood products bearing bark. Both Canada and the United States restrict movement of such materials from the
provinces of New Brunswick and Nova Scotia (Canadian Food Inspection Agency, 2008; USDA/APHIS, 2009). Nevertheless, the pathogen is able to spread naturally from tree to tree on land; airborne ascospores may also have been its means of crossing water to reach Prince Edward Island in Canada. Living trees and bark-bearing wood must be inspected for the presence of cankers and/or the ascomata of the pathogen. The Canadian Food Inspection Agency regulations provide guidelines, noting that young cankers appear as swellings on twigs and branches, or as depressions on larger stems and are accompanied by exuding resin. The fruiting bodies in or around the canker during most of the year are also described. Inspectors must also watch for withered, dead and/or discolored needles, checking dead or dying branches and stems carefully (CFIA, 2008). Quarantine regulations in both Canada and the United States are established to prevent further introductions of *L. willkommii* by importation and its spread from the areas in which it already occurs (CFIA, 2008; USDA/APHIS, 2009). In Canada, these controls relate to all species, hybrids and horticultural varieties of Larix spp. and Pseudolarix spp., including plants, plant parts (branches, twigs, scions, logs with bark, pulpwood, isolated bark), plant propagative material and seed with debris, as well as firewood, wood chips, bark chips, logs, telephone poles, cants, railway ties, and lumber (CFIA regulation D-02-12) (CFIA, 2008).

No *Larix* or *Pseudolarix* species is known to be completely resistant. The Japanese larch (*L. kaempferi*) was considered to be resistant in Europe, but found not to be resistant in Japan (Ito et al, 1963). The hybrids *L. x marschlinsi* and *L. x leptoeuropaea* are relatively resistant (Sinclair and Lyon, 2005). Susceptibility is increased by lack of vigor (Hahn and Ayers, 1943).

References


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Asci and paraphyses 1000x. BPI 660621 BPI 660621