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Foliage Diseases in Western Larch in British Columbia

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Introduction

Premature needle discoloration of western larch, *Larix occidentalis* Nutt., is a common phenomenon in southeastern British Columbia (B.C.). The discoloration can be caused by one of a number of abiotic factors such as drought or frost, or a defoliating insect such as the larch casebearer, *Coleophora laricella* (Hubner), but is most often caused by a fungus disease. The most common diseases affecting the foliage of western larch in B.C. are: Larch needle blight—caused by *Hypodermella laricis* Tub. (Ascomycete); and Larch needle cast—caused by *Meria laricis* Vuill. (Hyphomycete).

Hypodermella laricis is native to North America, whereas *M. laricis* is native to Europe and was introduced to North America early in this century. Both pathogens occur in Europe on European larch, *Larix decidua* Mill.

Hypodermella laricis occurs on tamarack, *Larix laricina* Du Roi, in Ontario and the eastern United States, and on western larch in southeastern B.C., where it is a common cause of widespread premature foliar discoloration. It has not, however, been identified from tamarack in northern British Columbia or Yukon.

Meria laricis was first identified in North America on western larch in the northwestern U.S. in 1942 (4). In 1981 it was found for the first time on western larch in the Nelson and Kamloops forest regions of B.C., and on alpine larch, *Larix lyallii* Parl., in the Rocky Mountains of western Alberta (6). The broad distribution of infections at the time suggested that it had become established somewhat earlier. Since then, *M. laricis* has frequently infected the needles of western larch in native stands, sometimes in association with *H. laricis*, but has caused no significant damage. It has, however, long been recognized as the single most important disease of European larch in British nurseries (7). In British Columbia it has caused intermittent damage to containerized and bare-root western larch seedlings in southern interior nurseries since 1981. *Meria laricis* has not been reported on tamarack.

Fig. 1. Premature needle cast of western larch seedlings infected by *Meria laricis*.

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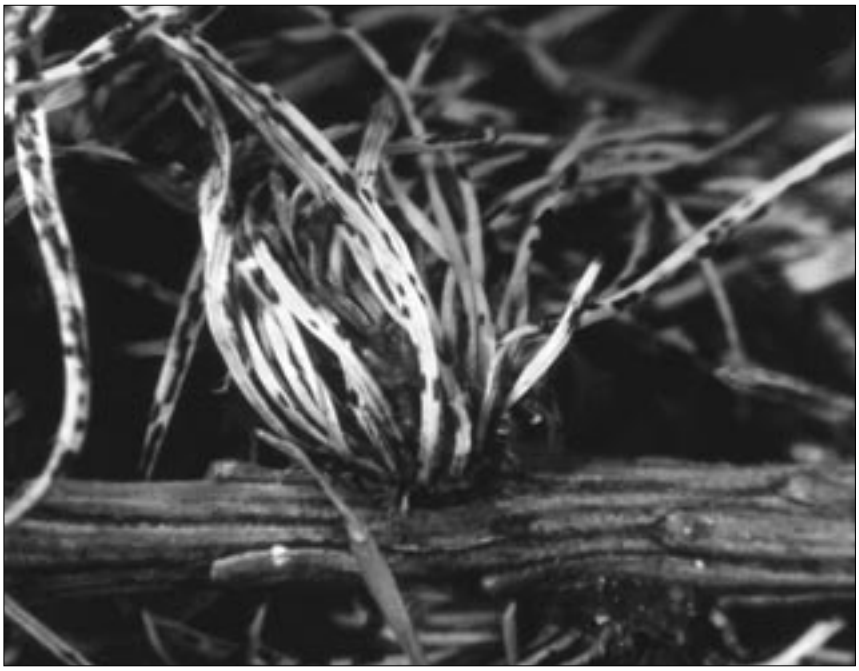

Fig. 2. *Hypodermella laricis* fruiting on western larch needles retained for up to two years.

Life history

Though *M. laricis* can infect western larch needles throughout the growing season, both fungi characteristically infect in May, within two weeks of needle elongation. Of the several climatic factors which influence the chance of infection by both fungi, moisture, provided by rainfall or high humidity at the time of budbreak, is the most important. Conversely, dry weather is unfavorable to the spread of these diseases, and new infections are checked by summer drought.

Hypodermella laricis

The maturation of *H. laricis* spores is timed to coincide with spring budbreak on the larch trees. Abundant moisture is not only the major vehicle for spore dispersal, it is also instrumental in triggering spore release. During spring rains, the walls of the fruiting bodies, or hysterothecia, absorb moisture, swell and split along a suture, exposing the spores (1,4). When the spores are dispersed by rain splash, some land on young needles where they germinate and penetrate the meristematic tissue at the needle base (1). Needles remain susceptible to infection by *H. larcis* only during this period of elongation, after which the cuticle of the mature needle forms a physical barrier to penetration.

About four weeks after infection, needles begin to discolor. In early August elongate black hysterothecia begin to form on the undersides. These hysterothecia house the fruiting structures or asci which produce the spores. *Hypodermella laricis* is thought to produce the growth regulating hormone indoleacetic acid (auxin) which inhibits the formation of an abscission layer at the base of the needles and prevents them from being cast (1). Dead needles are retained on the trees for one or more years, ensuring that the disease inoculum remains in proximity to its host.

Meria laricis

Most *M. laricis* infections also occur during the period of initial needle elongation. Though moisture does not play a direct role in the release of spores as with *H. laricis*, wind and rain splash are the primary mechanisms by which spores are transferred from dead needles to adjacent healthy needles. Germinating conidia gain entry through the tips or mid-portions of developing needles, probably because the older needle tissue is less resistant to infection (4). Shortly thereafter needles turn brown and are cast. Spores are produced in colorless, nearly invisible clusters on conidiophores, which project through the stomatal openings on the undersides of the needles (4). Conidiophores seem able to produce a succession of spores, budding new ones as the mature ones are shed (7). The cycle from infection to sporulation requires only two to four weeks (4).

In combination, the above characteristics enable *M. laricis* to continue reinfecting and intensifying disease damage throughout the growing season, as long as moist conditions prevail. However, the capacity of the fungus to reinfect trees in the forest environment is limited by the early casting of dead needles prior to spore maturation. This is less limiting in seedling nurseries where cast needles remain close to healthy susceptible ones. Most reinfection, however, seems to arise from the few needles that are retained in the fascicles, and possibly from those caught and retained in the crowns (7).

Recognition

Hypodermella laricis

Needles infected with *H. laricis* change from green to a yellow-orange color, normally in June. In severely diseased stands, the scorched appearance of the foliage is sudden and striking. Soon after needles die from *H. laricis* infection, oblong or elliptical (0.5–0.8 mm long) black hysterothecia appear, generally on the undersides of the needles. These fruiting structures are readily seen from early August onward, and remain prominent on the straw-colored needles that can be retained in the fascicles for up to two years. These features are diagnostic of *H. laricis*.

Meria laricis

The first symptoms of disease caused by *M. laricis* are yellowing and wilting of the infected portion of the needle, and the formation of characteristic necrotic bands. The discoloration then rapidly darkens to reddish brown and spreads over the remainder of the

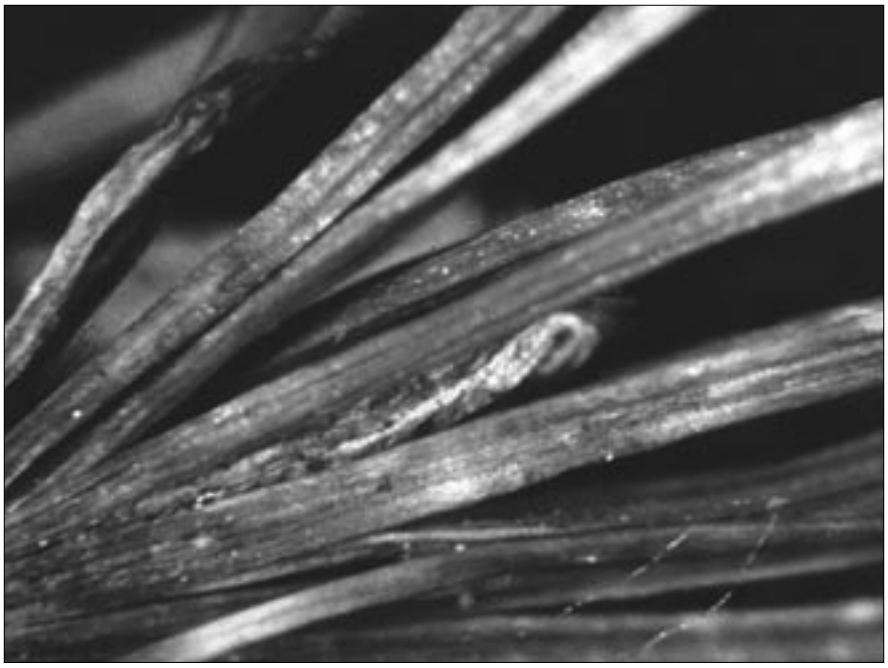

Fig. 3. *Meria laricis* fruiting on western larch needles cast in the year of infection.

needle. Symptoms often appear in May and June, but infection can occur at other times during wet weather. As *M. laricis* produces no fruiting structures, it cannot be identified with any certainty in the field. Spore clusters which appear on the underside of the needles as white spots on the stomata can only be seen with the aid of a strong hand lens or a dissecting microscope. To avoid confusion between spores and white waxy elements of the stomata, samples are usually treated with a stain such as cotton blue (7), which facilitates detection by staining the fungal structures deep blue.

Because of the similarity of symptoms, *M. laricis* damage may be confused with damage caused by late spring frosts. Frost damage discolors whole needles, often killing the new shoots as well (11). Frost-killed needles are also retained by the tree for several weeks. Moreover, the effects of frost can usually be detected on more than one species of plant. Initially, *M. laricis* only discolors the portion of the needle around the point of infection, and most killed needles are quickly cast.

Damage

Neither *H. laricis* nor *M. laricis* are known to cause mortality in natural stands, and are not considered serious forest pests. Needle infections by *H. laricis* often cause entire crowns to discolor, and the resulting loss of growth potential may be significant in some severe cases; however, there is very little experimental data to support this (4). Among the more severe instances of reported damage was the death of spur shoots after repeated severe needle infection by *H. laricis* in Oregon (1). This type of damage has not been observed in B.C.

Meria laricis has long been recognized as a nursery pest in England and Europe on European larch (7), and more recently in B.C. and the northwestern United States where western larch has increasingly been sown in forest nurseries. Nursery seedlings are particularly susceptible to the disease because of the proximity of succulent young needles to infectious needles that have been cast. The risk of reinfection is increased by regular irrigation, which facilitates spore transfer and disease intensification (12). Though not normally life threatening, needle cast caused by *M. laricis* is the single most important disease of container-grown western larch in B.C. (12). Cooley reported a 32% decrease in stocking at an Oregon nursery in 1980 due to severely diseased, dead or stunted 2-year-old western larch, and most of the remaining stock was infected as well (3). The greatest hazard was recognized to be in the 2-year-old stock in which the disease had intensified. Similar damage occurred at the Skimikin Forest Nursery at Salmon Arm B.C. in July of 1981, and containerized seedlings were moderately to severely affected at three B.C. nurseries in 1995 (8). Diseased seedlings sometimes develop stem lesions which contain no pathogens, but are thought to result from fungus-produced toxins (12). Kooistra described how seedling stem lesions resulted in significant stem breakage during seedling lift. According to his guidelines, seedlings with stem lesions girdling more than one-third of the circumference are now culled (8).

Because of yearly moisture fluctuations, successive years of severe needle disease caused by either fungus are uncommon, and trees normally regain full vigour after a year of little or no infection.

Control

Chemical control has not been attempted in the forest environment because of the limited damage caused by either fungus. For control of *H. laricis* on ornamentals or in nurseries, Bordeaux mixture or lime sulphur is effective if applied from approximately one week before to three weeks after budbreak. Benomyl (Benlate 50 WP), Captan and Zineb[1] provide some control of *M. laricis*. First applications should be made at bud swell, with second and third applications at one-month intervals, and further applications at two-week intervals through July, or until dry weather prevails. Regular applications of fungicide in the first year may prevent sporulation and subsequent proliferation of the disease in the second year (10,2).

[1] All three are registered in Canada for field and greenhouse ornamentals, but not for use against *M. laricis* in forest situations.

Some cultural control of *M. laricis* can be obtained by transplanting stock at the end of the first year, to beds in a distant part of the nursery, and cultivating the old beds to bury infected needles (2). The most effective control for both diseases in forest nursery situations, however, is obtained by growing larch seedlings outside their natural range, where the disease does not occur.

In studies designed to determine the effects of improved growth and growth rhythm (the synchronization of growth with climate), genetically enhanced shoot elongation correlated with increased resistance to *M. laricis* infection (9). Selective breeding, therefore, could increase the disease resistance of nursery stock while improving growth.

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