Pathogenicity of *Chondrostereum purpureum* to Yellow Birch

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ABSTRACT

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Cultures of *Chondrostereum purpureum* isolated from sporophores on dead yellow birch (*Betula alleghaniensis*) grew at 5–35 C (maximally at 25 C) and caused elongated cankers on young yellow birch shortly after late-summer inoculations onto the active cambium. The fungus spread longitudinally and radially toward the pith and was quickly compartmentalized in many trees. Canker size was not measurably affected by source of inoculum, position of inoculation, diameter of trunk, or date of inoculation or by artificially raising temperature of the bark surface. There was considerable variation among trees in size of cankers, but all cankers on a given tree were of similar size regardless of source of inoculum or position of inoculation.

Chondrostereum purpureum (Fr.) Pouz. (= *Stereum purpureum* (Pers.) Fr.), causal agent of silver leaf disease, is found throughout the temperate regions of the world (1,8,9,13). Damage is infrequent in most regions but is usually severe when it does occur (9). The host range includes most broad-leaved tree species.

Past work on *C. purpureum* has been mainly with fruit trees (2,9,13), although the fungus has been reported to cause decay in forest trees (4) and in stored pulpwood (5). Münch (6) reported extensive sapwood discoloration in beech (*Fagus sylvatica* L.) after inoculation with *C. purpureum*. Its potential effects on commercial forest tree species are of interest, especially in managed stands where trees are wounded during thinning. Studies with fruit trees have shown that the fungus can invade fresh wounds and spread through living sapwood (3). In some host species, the fungus produces a toxin that is translocated to leaves and causes the silver leaf symptom (1). Williams and Cameron (12) found that warm summer temperatures retard the fungus.

During investigations of mortality of young yellow birch (*Betula alleghaniensis* Britton), fruiting bodies of *C. purpureum* were found on a few dead trees as well as on stumps left after thinning. Although *C. purpureum* is not seen as frequently as some other fungi on yellow birch, the effects of its well-known pathogenicity warranted study. The aim of this investigation was to determine if the fungus could readily invade young yellow birch in the summer months during active tree growth.

MATERIALS AND METHODS

Basidiocarps of *C. purpureum* collected from recently killed yellow birch saplings were placed in moist chambers containing water agar. Basidiospores were cast on the agar surface, and some germinated within 24 hr. Germinated spores were transferred to 2% malt-extract agar, and after 2 wk of growth the resulting multispore cultures were stored at 4 C. Identity of the fungus was confirmed by J. H. Ginns, Biosystematics Research Institute, Ottawa, Ontario.

To test the effects of temperature on mycelial growth, 9-cm petri dishes containing 2% malt-extract agar were inoculated at the edges with growing mycelium of one of the original cultures and incubated (in triplicate) at constant temperatures of 5, 10, 20, 25, 30, 33, 35, and 37 C in darkness. Colony radius was measured at 24-hr intervals.

Yellow birch saplings used for inoculation were located in the Nashwaak River watershed 20 km north of Fredericton, NB. This area was clear-cut in 1972 and had quickly regenerated to hardwoods with a predominance of yellow birch. In 1981, the stand was thinned to about 2,000 stems per hectare to favor yellow birch. When inoculated (1983), the trees were 10–12 yr old, 4–6 m high, and 4–7 cm diameter at breast height. Trees used for inoculation had visible injuries, were not adjacent to dead or dying trees, and were growing on well-drained soils that had previously supported good stands of yellow birch.

Eight isolates of *C. purpureum*, including two original cultures, two subcultures, and four cultures from previously inoculated trees, were used for inoculations. Inoculum consisted of 7-mm-diameter circular patches of yellow birch bark (phelloderm, cortex, and phloem) that had been collected from near the bases of 10- to 12-yr-old trees, autoclaved, and placed on actively growing fungus cultures for 3 wk. Controls consisted of autoclaved bark patches. All inoculation points were surface-disinfested with 95% ethanol and a hole 7 mm in diameter was made in the cambial region with a cork borer. Inoculations were made at heights of 0.4 and 1.7 m, on the north and south faces of the stem. After the infested bark patch was inserted, the inoculation points were covered with Parafilm M.

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Of the 216 inoculations (including controls), 60 were made on 18 July, 96 on 27 July, 24 on 10 August, and 36 on 19 August 1983. For the inoculations on 27 July, strips of black or white plastic were placed over the inoculation points 1 wk after inoculation in an attempt to affect bark temperatures and were removed 3 wk later.

During the autumn of 1983 and the growing season of 1984, electrical resistance of cambial tissues surrounding three representative inoculations was measured with an Osmose Oz-67 Shigometer (Osmose Wood Preserving Co., Buffalo, NY). At the end of the 1984 growing season, the lengths and widths of cankers associated with each inoculation were measured. After measurement, three trees were felled and sectioned to determine the extent of internal discoloration associated with cankers. Chips from discolored wood were cultured on 2% malt-extract agar to recover the fungus.

RESULTS

C. purpureum grew on 2% malt-extract agar at 5–35 C (maximally at 25 C) (Fig. 1). A temperature of 37 C for 7 days was lethal, but cultures incubated at 35 C resumed normal growth when restored to 25 C. There was negligible variation in growth at the various temperatures.

All of the 182 inoculations with *C. purpureum* resulted in elongated cankers 5–100 cm (av. 31 cm) long and 1–3 cm (av. 2 cm) wide after 15 mo. Cankers appeared as depressions in bark, occasionally with purple to black discoloration but usually with no external color changes (Fig. 2A). In some trees, cankers could be observed within 6 wk of inoculation. In the 34 controls, the inoculation wounds were enclosed by callus tissue after one growing season, whereas inoculation with *C. purpureum* prevented callus formation around the inoculation point. Cambial electrical resistance of the cankered areas was reduced to 1–10 kohms compared with 15–30 kohms outside the cankers and in control trees.

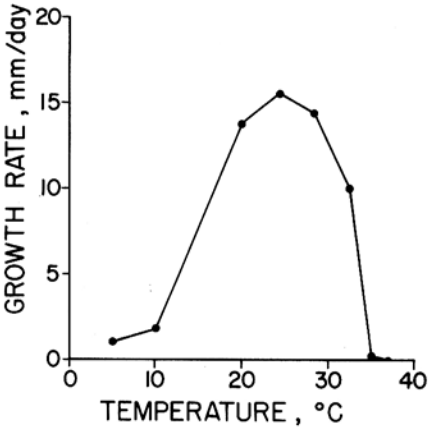

Fig. 1. Growth rate of *Chondrostereum purpureum* as affected by temperature. Each point is the mean of three replicates × 6 days on 2% malt-extract agar.

Dissection of inoculated trees revealed sapwood discoloration extending longitudinally two to three times the length of the externally visible cankers. Color of affected sapwood ranged from deep reddish brown near the inoculation point to faint tan or reddish brown at the extremities. Upward and downward spread were about equal. Near the inoculation point, discoloration extended inward for several annual rings, often to the pith (Fig. 2B). *C. purpureum* was recovered from the bark and wood of the canker face and from the entire column of discolored sapwood.

A ridge of callus formed above and below most inoculation points, and no discoloration was evident in the tissue formed after inoculation. No mortality or foliar symptoms have occurred to date in any of the inoculated trees.

There were no statistically significant effects ($P = 0.05$) on canker size (length or length × width) of any variables analyzed: inoculation date, fungus isolate, northerly or southerly aspect, height, or tree size. Placing black or white plastic over the inoculated portions of the tree had no significant effect.

Canker size varied considerably among trees. A positive correlation ($r = 0.69$) was found between lengths of cankers in the upper (1.7 m) and lower (0.4 m) positions. Both cankers on a given tree were of similar size, regardless of inoculum source or position of inoculation.

DISCUSSION

C. purpureum quickly invaded the cambial region and sapwood of yellow birch when introduced through fresh wounds on the cambial surface. Spread of the fungus was mainly longitudinal with some movement toward the pith. The fungus survived within inoculated trees for 15 mo but caused no noticeable foliar symptoms or mortality.

Whether significant natural infection takes place in yellow birch remains questionable, because *C. purpureum* was not detected in extensive isolations from dying birch (11) and was not reported in cull studies (10). Setliff and Wade (8) reported the fungus on yellow birch stumps in Wisconsin, and I found basidiocarps of *C. purpureum* on dead yellow birch as well as on stumps of trees that had been removed during thinning. The latter collections were made in the early summer, whereas research in Britain and Holland indicates fructification and spore release in late summer and autumn (7,13). It appears that *C. purpureum* can become established early in the growing season in eastern North America. Also, it can spread within infected tree trunks during the warm part of the summer in New Brunswick, because canker development was not retarded when trunks were covered with black plastic. Temperature studies of the fungus in culture, however, indicate a definite upper limit (35–37 C) for growth and survival of the fungus.

C. purpureum differs from most other hymenomycetes in its ability to invade the active cambium and underlying sapwood. It should therefore be included among suspect causes of cankers and premature mortality of deciduous forest trees, especially where wounding has occurred. There was considerable variation in extent of invasion of yellow birch by this fungus and subsequent enclosure of cankers by callus, a point that should be useful in studies of resistance. The long-

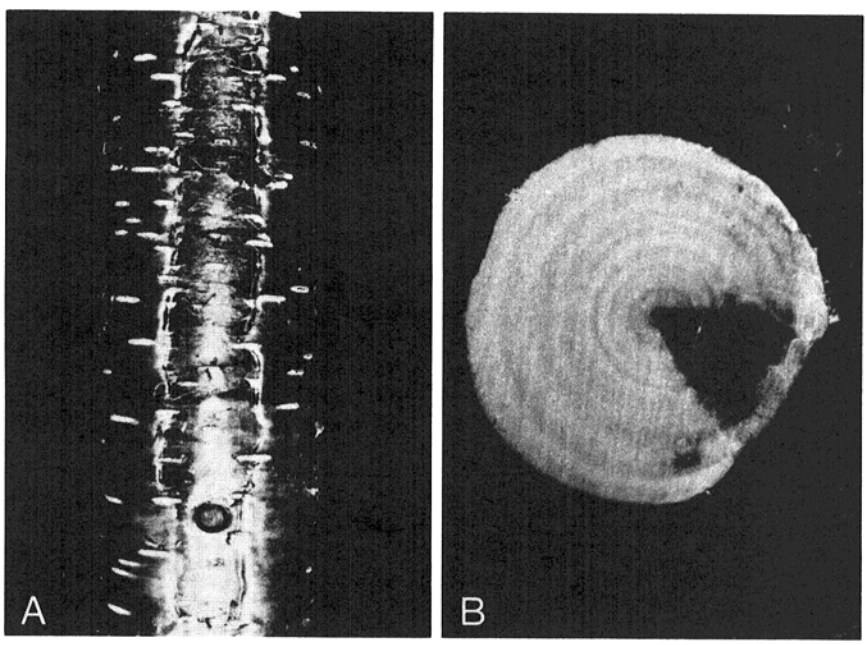

Fig. 2. External appearance of cankers and internal sapwood discoloration of yellow birch caused by inoculation with *Chondrostereum purpureum*. **(A)** External appearance of canker. **(B)** Internal discoloration extending to the pith near the point of inoculation.

term effects of *C. purpureum* on yellow birch and its effects on stressed trees remain to be determined.

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