Spruce Needle Rust

Yukon Forest Health — Forest insect and disease

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Yukon

Energy, Mines and Resources
Forest Management Branch

Introduction

Small-spored spruce Labrador tea rust (*Chrysomyxa ledi*) and large-spored spruce Labrador tea rust (*Chyrsomyxa ledicola*) are fungal diseases affecting the current year's needles of white spruce. The range of spruce needle rust coincides with the ranges of the aecial (primary) host, white spruce (*Picea glauca*) and the telial (secondary) hosts, Labrador tea (*Ledum palustre* and *L. groenlandiculum*) and leatherleaf (*Chamaedaphne calyculata*). These complex rust fungi are heteroecious meaning that they require the presence of both spruce and Labrador tea to complete the disease cycle. Because both species of Labrador tea only occur in moist conifer woods and peatlands, disease incidence is limited to these areas. *Chrysomyxa spp.* rarely causes tree mortality and symptoms manifest as defoliation of current needles resulting in twig and branch dieback. In 2008, localized patches were observed along the Long Lake Road near Whitehorse and near the Morley River along the Alaska Highway. In general, wet and cool weather is conducive for spore formation and spore dispersal from Labrador tea, as well as infection of new spruce needles.

Host Range for Spruce Needle Rust

(Source data: Yukon Government Forest Inventory Data [2008] and U.S. Geological Survey [1999] Digital representation of "Atlas of United States Trees" by Elbert L. Little, Jr. (http://esp.cr.usgs.gov/data/little/)

Disclaimer: The data set for historic incidence is likely incomplete and only extends from 1994–2008. Endemic or outbreak populations may have occurred or may currently exist in non-mapped locations within the host range.

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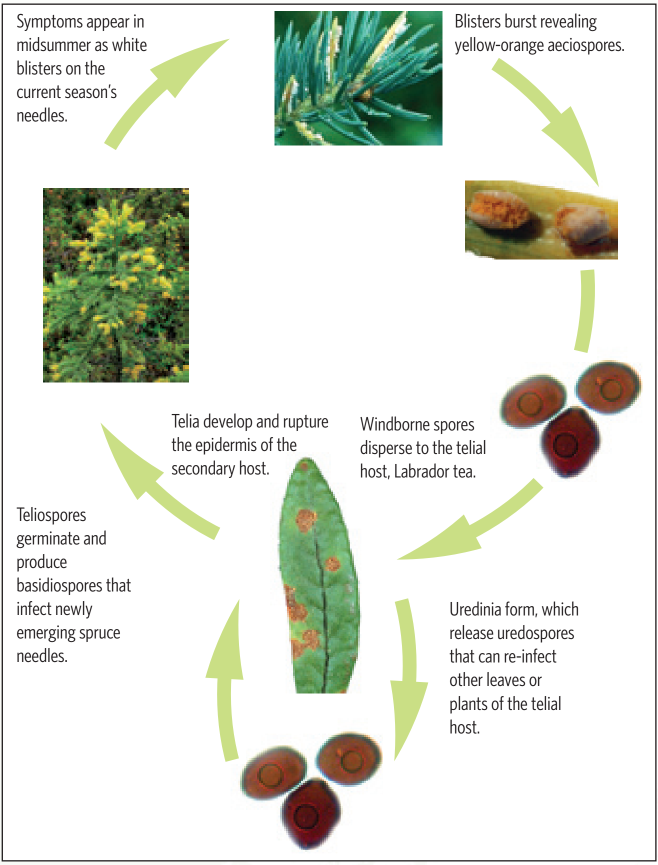
Disease Cycle



The general disease cycle of *C. ledicola* and *C. ledi* is as follows:

1. Symptoms on spruce appear in midsummer as white blisters (aecia) on the surface of the current season's needles and occasionally on cone scales.

2. The blisters burst revealing yellow-orange spores (aeciospores) which disperse on the wind to the alternate host in summer.

Definitions:

Uredinia: *a reddish pistule-like structure that is formed on the tissue of a plant infected by a rust fungus and produces uredospores.*

Chlorosis: *a condition in which leaves produce insufficient chlorophyll.*

3. Spores land on the alternate host, germinate and infect the leaves where they overwinter.

4. Uredinia are produced on the upper surface (*C. ledicola*) or underside (*C. ledi*) of the telial host and may develop under mild, moist conditions. Uredinia produce uredospores that can re-infect other leaves or plants of the telial hosts (Labrador tea). The existence of this cycle means that spruce is not essential for the rusts' survival.

5. Under certain conditions in spring, white blisters or pustules (telia) develop on the lower (*C. ledi*) or upper (*C. ledicola*) surface of infected leaves and rupture the epidermis. This characteristic allows for the identification of rust species on the telial host.

6. Yellow-orange spores (teliospores) germinate and produce another type of spore (basidiospore) that disperses on the wind and infects newly emerging and developing spruce needles.

7. By midsummer, symptoms can be seen as in step 1.

Host Species Attacked and Damage

Tree species attacked in Yukon: White spruce (*Picea glauca*) is highly susceptible. Black spruce (*Picea mariana*) has low susceptibility. Seedlings, saplings and pole-sized trees are more susceptible than mature timber.

On spruce, the fungus rarely causes tree mortality. The damage caused by the needle rust is for the most part cosmetic, resulting in varying degrees of defoliation ranging from single needles to the entire complement of current growth in young trees **(photo 5)**. In older trees, infections are normally limited to branches in the lower crown. Though little research has been done on the affects of the disease, repeated infection almost certainly impairs growth, especially in young trees where the current needles constitute a higher proportion of the entire crown. Initially, a portion of the needle is infected and it develops a yellow band parallel to the veins. As the disease progresses, infected foliage turns striking yellowish-orange then changes to reddish-brown. Needles infected the previous year appear straw coloured and are usually shed the year after infection **(photo 1)**. White blisters and orange aeciospores may be visible on the leaf surface **(photo 2a, b and photo 3)**.

On Labrador tea and leatherleaf, localized chlorosis of leaves occurs during the initial stages of the disease **(photo 4)**. As the fungal mycelia grow within the host tissue, and the telia form, leaves change to a yellowish colour. Eventually leaf death occurs and the leaves turn brown and are shed.

Definitive identification of the aecial (spruce) stage of the rust is only possible if spores are examined under a microscope. The aeciospores of *C. ledicola* are larger and shaped differently than those of the *C. ledi*. On the telial hosts (Labrador tea and leatherleaf) *C. ledicola* uredinia form on the upper surface of the leaves while *C. ledi* uredinia form on the lower surface of the leaves. The following signs are good indicators of spruce needle rusts:

***C. Ledicola*:**

- Small (<1.0 mm) orange aecia on the underside or upper side of spruce needle.
- Small orange uredinia on the upper leaf surface.
- Aeciospores are broadly ellipsoidal and 22–26 um in diameter.

***C. ledi*:**

- Small (<1.0 mm) orange aecia on the underside or upper side of spruce needle.
- Small orange uredinia on the lower leaf surface.
- Aeciospores are broadly ellipsoidal and 13–30 um in diameter.

Photo number:

1. **Tree discolouration.** Citation: Rod Garbutt, Canadian Forest Service.
2. **a) Blisters with spores appear orange from a distance.** Citation: Natural Resources Canada, Canadian Forest Service, **b) Blisters filled with orange spores.** Citation: Don Taylor, Canadian Forest Service.
3. **White blisters with spores close up.** Citation: Gaston Laflamme, Natural Resources Canada, Canadian Forest Service.
4. **Labrador tea plant.** Citation: Natural Resources Canada, Canadian Forest Service.
5. **Current-year damage on sapling stand.** Citation: Rod Garbutt, Canadian Forest Service.


1


2a


2b


3

Similar damage

Spruce needle rust damage may appear similar to that produced by spruce broom rust (*Chrysomyxa arctostaphyli*) and spruce needle cast (*Lirula macrospora*). The cast differs from the rusts in that it affects the previous year's needles as well as those of the current year. Infected needles are straw coloured with distinctive elongate black bands. The initial stages of the spruce broom rust can appear similar to the needle rust; however, as the broom rust progresses it produces a unique and conspicuous branching pattern, or "witches' broom."

Risk Assessment

The following tables summarize the likelihood of occurrence and magnitude of impact of an outbreak at the stand level. These tables are a coarse guide for estimating the risk of an outbreak when populations are at endemic levels.

Likelihood of Occurrence

Stand Infection Hazard:	High →	Low
Site moisture regime[1]	Wet	Dry
Labrador tea in, and adjacent to, stand[2]	<300 m	>300 m
Previous year's summer climate[3]	Wet, cool	Dry, hot

Notes:

1. Stands in bog and peatlands are more susceptible to infections of spruce needle rust.
2. Maximum dispersal distance is approximately 300 m so proximity to alternative host is required in order for infection to occur in spruce.
3. Wet and cool weather is conducive for spore formation and spore dispersal from Labrador tea, as well as infection of new spruce needles.

Magnitude of Consequence

The magnitude of consequence is a subjective assessment of the potential consequences of an outbreak. This list is not exhaustive and is intended to stimulate thought on potential impacts to consider over time.

Value	Impact							
	-				+			
Traditional Use[1]								
Comment:	No impact anticipated							
Visual Quality[2]				■				
Comment:	Discoloured needle period (-)							
Timber Productivity[3]				■				
Comment:	Growth reduction (-)							
Wildfire Hazard[4]								
Comment:	No impact anticipated							
Public Safety[5]								
Comment:	No impact anticipated							
Hydrology[6]								
Comment:	No impact anticipated							
Time Scale (years)	20+	15	10	0-5	0-5	10	15	20+
Comment:	Impact refers to a predicted, substantial positive (+) or negative (-) impact on a value for an estimated time period							

Notes:

1. In this context, traditional use values considered are hunting, trapping and understory shrub/plant use. Given that spruce needle rust outbreaks rarely cause mortality, no impact is anticipated.
2. Visual quality is negatively impacted in the two years following infection until infected needles are shed.
3. Infection rarely causes tree mortality but does kill the current year's needles, therefore growth could potentially be negatively impacted.
4. Given that spruce needle rust only affects the current year's foliage and therefore generates very little fine fuel input, no impact is anticipated.
5. Given that spruce needle rust outbreaks rarely cause mortality, no impact is anticipated.
6. Given that spruce needle rust outbreaks rarely cause mortality, no impact is anticipated.

Implications of Climate Change

General Circulation Model (GCM) results in the 2007 Intergovernmental Panel on Climate Change (IPCC) report indicate that warming in northern Canada is likely to be greatest in winter (up to 10°C) and warmer by 3–5°C in summer. Mean annual precipitation is also predicted to increase (particularly in fall and winter). More rainfall is expected on windward slopes of the mountains in the west, therefore the rain shadow effect of the St. Elias Mountains may mean that southern Yukon does not experience increased rainfall. High temperatures will increase levels of evaporation and transpiration, and ultimately lower soil moisture levels. Therefore, even if summer rainfall is maintained at current average levels, higher temperatures would result in limited soil water availability and cause moisture stress in trees. Currently, climate scenarios suggest that Yukon will experience a warmer climate that will be wetter or drier in the future depending on the region.

Temperature and precipitation are likely to be the dominant drivers of change in pathogen abundance and tree responses as it influences pathogen development, dispersal, survival, distribution and abundance. As with other pathogens, moisture is a critical factor for spore development, dispersal and infection. Increased precipitation during the summer months would mean more successful dispersal from Labrador tea and infection of new host material. However, if temperatures are too high, then this could negatively impact spore production. A warmer, drier scenario would reduce the success of spore development, dispersal and germination.

Management Options

Monitoring

This disturbance agent is best monitored with annual ground surveys. The best time of year for monitoring is mid- to late summer when the foliage of last year's attack is fully discoloured and the fruiting bodies on white spruce are most conspicuous. During this time, infected foliage should be turning to a striking yellowish-orange initially then change to reddish-brown. If foliage is straw coloured and being shed, then the damage is likely from the previous year.

Direct Control

Because the rust rarely causes significant damage to spruce stands, direct control is not generally recommended. Successive years of heavy levels of infection do not commonly occur and infected needles are usually shed. If treatment is required to protect high value trees, chemical control with fungicides can be effective if application is timed with spore production. Generally, the first application should be made when 10% of the trees have broken some buds. Applications should then be made at weekly intervals until needles are mature or until symptomatic needles have dropped to the ground. As a result, three applications of fungicide are usually required. However, up to five applications of fungicide may be required in years where bud break is slow, the weather is cool, and there is enough free moisture on the needles for infection. This form of treatment is not a viable option for commercially harvested stands, and the use of fungicides should be limited because fungi can develop resistance.

Harvesting Considerations

Harvesting of spruce may occur either as a by-product of private/industrial land clearing or if a commercial forestry operation is undertaken. Harvesting will not likely contribute to the spread of the disease.

Silvicultural Considerations

Silvicultural considerations are relevant if a stand is being managed for commercial forestry or if an area is being replanted. Consider managing for increased stand biodiversity by utilizing a range of preferred and acceptable species for planting and avoid planting spruce in areas with large populations of Labrador tea.

References

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