Spruce Broom Rust

Yukon Forest Health — Forest insect and disease

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Yukon
Energy, Mines and Resources
Forest Management Branch

Introduction

Spruce broom rust (*Chrysomyxa arctostaphyli*) is a fungal disease affecting spruce foliage. Its name is derived from the conspicuous branching symptom caused by the disease; large branch clusters with short internodes and numerous twigs referred to as "witches' brooms" or "brooms." This disease is heteroecious, meaning it requires the presence of two different plant hosts to complete the disease cycle. The range of spruce broom rust coincides with the primary (aecial) host, spruce (*Picea spp.*) and the secondary (telial) host, kinnikinnick (*Arctostaphylos uva-ursi*). The disease causes deformation of the bole and overall reduced growth and vigour. In rare cases, it can cause tree mortality. In 2007, a forest health survey of the Teslin Tlingit Traditional Territory found a minor incidence (10% of mature spruce) of *C. arctostaphyli*, but the disease is prevalent in every stand where the alternate host grows and is the most common and conspicuous disease affecting white spruce within Yukon.

Definitions:

Bole: *the main stem of a tree.*

Host Range for Spruce Broom 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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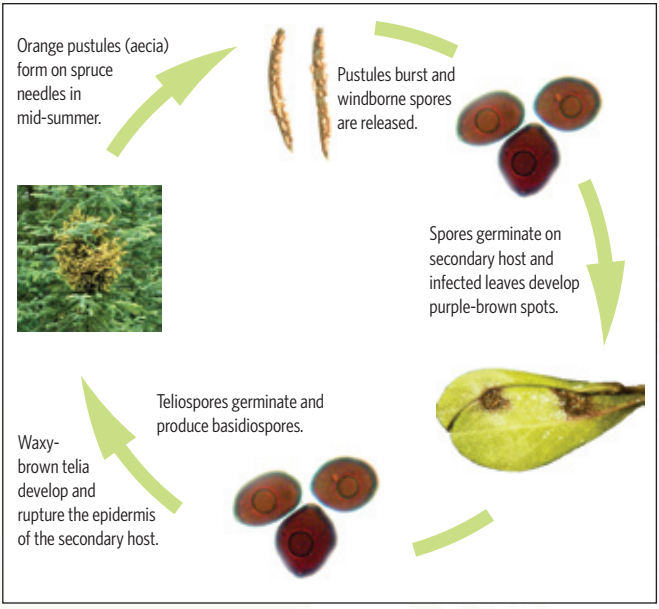
Disease Cycle



All rusts are obligate parasites and have complex life cycles. Spruce broom rust has four separate spore states; two of which occur on the primary host and two on the secondary host. The important developmental state on spruce is the aecial, as it is responsible for the production of spores that infect the secondary host. The pycnial state is a microscopic sexually reproductive form of the rust fungus, and is less relevant from a forest management perspective. On the secondary host the telial and basidial states occur. The telial and basidial states are responsible for host-alteration infection (from secondary to primary host). Spruce broom rust does not form uredinia, a fifth spore state common in many rust fungi.

Definitions:

Teliospore: *thick-walled resting spores of some fungi from which basidium arises.*

The spruce broom rust is a two-year cycle rust. The general disease cycle is as follows:

1. Symptoms on spruce appear in midsummer as orange pustules (aecia) on the surface of the current season's needle.
2. The pustules burst revealing yellow-orange spores (aeciospores) which disperse via the wind to the secondary host (kinnikinnick) in summer.
3. If the surface conditions of the host leaf are moist, the spores germinate on the secondary host and infect the leaves and overwinter. Infected leaves will develop small purple-brown spots.
4. In spring, orange-brown, waxy telia form in crowded groups on these spots on the underside of leaves and rupture the epidermis.
5. Teliospores germinate and produce another type of spore (basidiospore) that disperses on the wind and infect newly emerging and developing spruce needles.
6. 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 (*P. mariana*) has low susceptibility. Pole-sized, mature and over-mature stands are highly susceptible while younger stands are less susceptible.

Once a tree is infected, the witches' broom takes years to develop. Altered localized hormone production at the point of infection causes the deformed branching pattern. Brooms are perennial and shed their needles every year. In the spring, the new needles appear slightly chlorotic (yellow to light green), and by midsummer (as the aecia mature) the brooms are orange. When spore release is at a maximum, a sweet, earthy smell is emitted from the broom. By fall, the needles are shed and the brooms turns grey.

Brooms are located directly on the bole of the tree or on branches, and deformation of wood structure occurs at the point of contact **(photo 1)**. These structural defects can result in top kill, broken tops, and branch kill. Secondary pathogens such as decay fungi then use these injuries as infection courts. When infections are large, trees have reduced height and radial growth. The fungus causes all extra nutrients to be directed to the broom. Volume losses of 70% have been observed in stands with severe incidence of broom rust. The combined effect of the rust fungi and the decay fungi can sometimes cause tree death.

On kinnikinnick, the broom rust causes purple leaf spots on the upper leaf surface. In periods of outbreak, the leaves turn brown and senesce.

The following signs and symptoms are good indicators of spruce broom rust:

- Presence of large (up to 2 m in diameter) conspicuous, perennial brooms. Light green in spring, orange in mid-summer, grey in fall **(photo 2)**.
- Dead or spike top.
- Small orange, pustules on spruce needles of the broom **(photo 3)**.
- Small purple-brown spots on the leaves and orange-brown telia on the underside of kinnikinnick leaves **(photo 4)**.

Photo number:

1. **Broom.** Citation: Rod Garbutt, Canadian Forestry Service.
2. **Broom close-up.** Citation: Rod Garbutt, Canadian Forestry Service.
3. **Pustules on spruce needles.** Citation: William M. Ciesla, Forest Health Management International, Bugwood.org
4. **Infected kinnikinnick.** Citation: Eric Allen, Natural Resources Canada, Canadian Forest Service.

Definitions:

Senesce: *to reach later maturity.*


1


2

Similar damage

The distinctive broom is hard to confuse with damage from other disturbance agents.

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	
Kinnikinnick in, or adjacent to stand[1]	<300 m	>300 m
Previous year's summer climate[2]	Wet, cool	Dry, hot

Notes:

1. Dispersal distance of basidiospores is approximately 300 m so proximity to alternative host is required in order for infection to occur in spruce.
2. Wet and cool weather is conducive for basidiospore formation and spore dispersal from kinnikinnick, 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:	Small mammal nesting sites (+)							
Visual Quality[2]	■	■	■	■				
Comment:	Broom (-)							
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. Squirrels (*Tamiasciurus hudsonicus*) are a commercially harvested species and are known to nest in brooms, thus a positive impact is anticipated for traditional values.
2. Visual quality is negatively impacted for as long as the broom persists on the tree.
3. Infection rarely causes tree mortality but does redirect nutrients from the tree to the broom, therefore growth could potentially be negatively impacted for as long as the broom persists on the tree.
4. Given that spruce broom only affects a limited portion of the tree and therefore generates very little fine fuel input, no impact is anticipated.
5. Given that spruce broom rust outbreaks rarely cause mortality, no impact is anticipated.
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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 is potentially wetter or drier in the future.

Temperature and precipitation are likely to be the dominant drivers of change in pathogen abundance and tree responses as they influence pathogen development, dispersal, survival, distribution and abundance. As with other pathogens, moisture is a critical factor during germination for the spruce broom rust. Increased precipitation during the summer months would mean more successful germination and infection of new host material. If drier, warmer conditions persist in the future, then the dispersal of the spruce broom rust would be enhanced, but it would be detrimental to the germination. The opposite is true if a warmer, drier trend continues as spore dispersal and germination would be less successful.

Management Options

Monitoring

This disturbance agent is best monitored with annual ground surveys. The best time of year for monitoring is late spring/ early summer when the foliage of last year's attack is fully discoloured and the fruiting bodies are most conspicuous.

Direct Control

Because the brooms normally occur high in the crowns direct control is difficult and rarely attempted. If treatment is required to protect high value trees, the witches' broom can be pruned off the trees. However, if it occurs on the main bole, the top of the tree including the broom would have to be removed. Fungicides have not been effective at combating this disease.

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 kinnikinnick.

References

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