Pine Blister Rust

Yukon Forest Health — Forest insect and disease

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Yukon
Energy, Mines and Resources
Forest Management Branch

Introduction

Comandra blister rust (*Cronartium comandrae*) and stalactiform blister rust (*Cronartium coleosporioides*) are fungal diseases affecting the branches and stems of lodgepole pine (*Pinus contorta*). Both of these stem rusts are found throughout North America where the primary and secondary hosts occur. As with most rust fungi, the disease is heteroecious, requiring a primary and secondary host to complete its disease cycle. The primary (aecial) host for both stem rusts is lodgepole pine. The secondary (telial) hosts for Comandra blister rust are *Comandra spp* such as bastard toad flax (*Comandra umbellata*) and false toadflax (*Geocaulon lividum*). The telial hosts for stalactiform blister rust include Indian paintbrush (*Castilleja spp.*) and other members of the figwort family (*Scrophulareacea*). Both fungi take approximately three to five years to complete their life cycle.

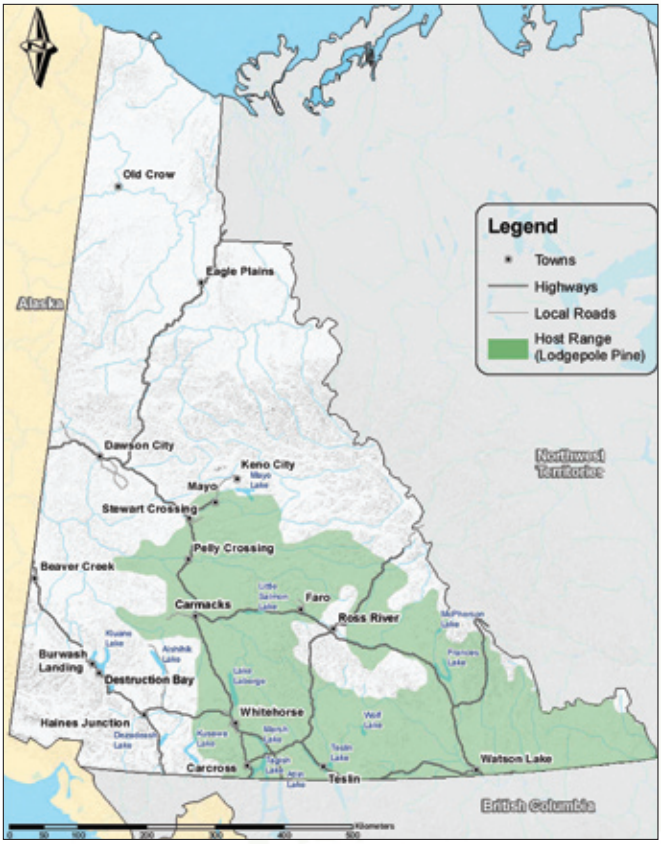
Most of the damage caused by both species occurs in nurseries, plantations and young, naturally regenerated stands. Most of the damage seen in Yukon has been in the southeast where pine has been planted. Comandra cankers have also caused mortality of young pine in the Takhini Forest Reserve just north of Whitehorse. Samples that have been diagnosed from Yukon have proven predominantly to be C. comandrae. The range of both diseases is limited by the occurrence of the alternate hosts.

Definitions:

Aecial: *belonging to an aecium (fruiting body of some rust fungi bearing chains of aeciospores).*

Telial: *final stage in the life cycle of the rust fungi.*

Host Range for Pine Blister 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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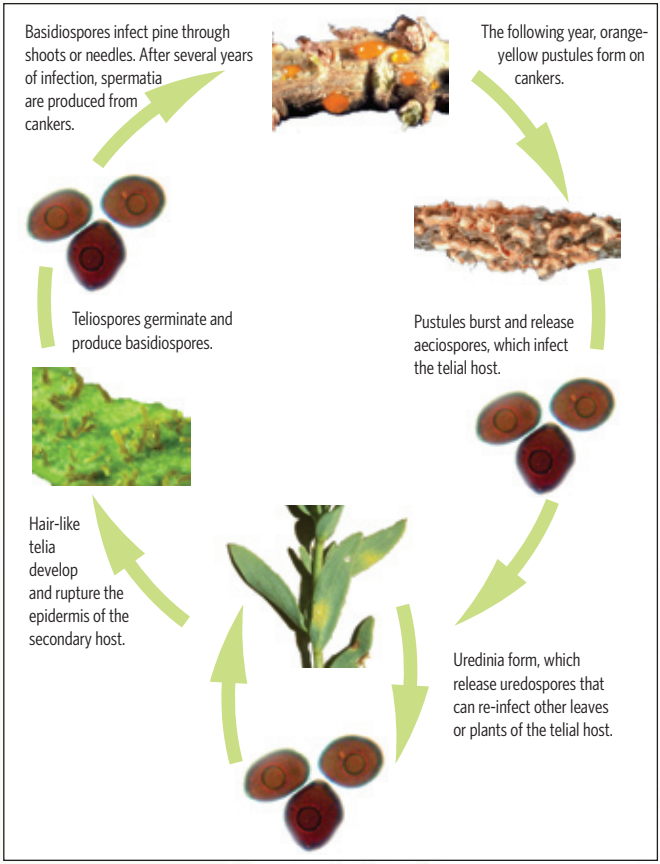
Life Cycle



All rusts are obligate parasites and have complex life cycles. Comandra and stalactiform blister rusts have very similar life cycles differing only in microscopic characteristics and secondary host species, thus their life cycles are outlined together. Generally, there are five separate fungal states; two of which occur on the primary host and three on the secondary host. The important developmental state on pine 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 uredinial, telial, and basidial states occur. The telial and basidial states are responsible for host-alteration infection (from secondary to primary host), and the uredinial state causes intensification of infection in the secondary hosts.

1. The stem rust grows perennially on the inner bark of lodgepole pine. After one to several years of infection, evidence of the disease will appear as small drops of thick, sticky, reddish-orange liquid on the diseased bark (spermatia produced from pycnia) **(photo 1)**. The following year, in the spring and early summer, orange-yellow pustules (aecia) form on stem or branch cankers.
2. Pustules burst and release orange aeciospores, which disperse on the wind to infect foliage of secondary hosts.
3. Spores land on the secondary host, germinate and infect the leaves.
4. Approximately 10–20 days later, yellow blister-like spots appear on the leaves of the secondary host. These spots produce uredinia on the leaves of the telial host and may develop under mild, moist conditions. Uredinia produce uredospores that can re-infect other leaves or plants of telial hosts. The existence of this cycle means that pine is not essential for the rusts' survival.
5. Approximately three weeks later, brown, hair-like telia develop and rupture the epidermis **(photo 2)**.
6. Under mild, wet weather conditions teliospores germinate and produce another type of spore (basidiospore) that disperses on the wind and infect the primary host's needles and shoots. The fungus then spreads to the inner bark where, after one to several years, it appears as per step 1.

Definitions:

Basidiospores: *a sexually produced fungal spore borne on a basidium.*

Spermatia: *non-motile sperm cells.*

Teliospore: *thick-walled resting spores of some fungi.*

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

Bole: *the main stem of a tree.*

Resinosis: *a flow of resin or pitch in a conifer, in response to infection, wounding or insect (often bark beetle) attack.*

Host Species Attacked and Damage

Tree species attacked in Yukon: All age classes and all diameter classes of lodgepole pine are highly susceptible.

The blister rusts cause cankers on the stems and branches of infected trees. Branch cankers are usually the original source of infection. During the first three years, branch flagging (discolouration of all needles to reddish brown) and localized swelling are the first symptoms of infection. The further the branch canker forms from the bole, the less likely a stem canker will form. The branch cankers are smaller and grow 2.5 cm per year toward the bole. Once the fungus reaches the stem, a stem canker will form as diamond-shaped, elongated swellings that are typically 10 times longer than they are wide **(photo 3)**. The margins of the canker exhibit hypertrophic growth as the tree attempts to compartmentalize the fungus. On secondary hosts, yellow blister-like spots appear on infected leaves. Telia (brown, hair-like fruiting bodies) may also be visible in the late summer.

Over time cankers can girdle the stem causing either branch-kill, top-kill or tree mortality depending on the location of the infection. Because the fungus grows so slowly, cankers can persist on the stem of some infected trees for 50 years. The growth rate of the tree and quality of the wood is diminished by stem cankers. The canker margins provide a source of food for porcupine (*Erithizon dorsatum*) and squirrel (*Tamiasciurus hudsonicus*). Resinosis and feeding damage from these animals is often an indicator of blister rusts. While individual tree mortality sometimes occurs, stand level disturbance as a result of blister rust infection is rare.

Identification of stem rusts is often difficult in the field. Laboratory testing through inoculation trials of secondary hosts is the most definitive method. Microscopic observations of spore morphology are also an effective means of identification. The following signs and symptoms are good indicators of the presence of stem blister rusts:

Key features for identification: *C. comadrae*

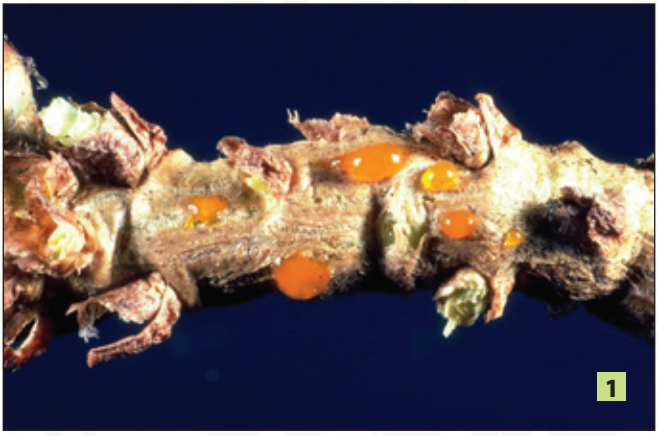
- Presence of elongate, stem cankers with orange yellow pustules **(photo 4)**.
- Pear-shaped aeciospores.
- Presence of infected secondary hosts — *Comandra spp* or **(photo 5)**.

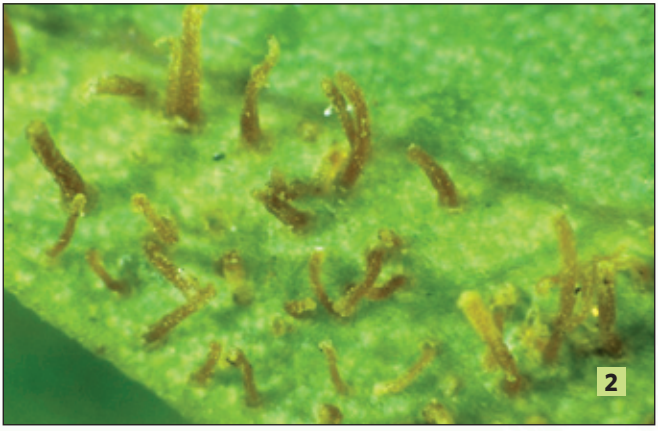
Key features for identification: *C. coleosporioides*

- Presence of elongate (more so than comandra) cankers with orange yellow pustules.
- Ellipsoid aeciospores.
- Presence of infected secondary host, e.g. *Castilleja spp.*

Photo number:

1. **Spermatia.** Citation: Eric Allen, Natural Resources Canada, Canadian Forest Service.
2. **Telial hairs on telial host.** Citation: Eric Allen, Natural Resources Canada, Canadian Forest Service.
3. **Cankers.** Citation: USDA Forest Service — Region 8 Archive, USDA Forest Service, Bugwood.org
4. **Pustules that release aeciospores.** Citation: Natural Resources Canada, Canadian Forest Service.
5. **Uredinia on toadflax.** Citation: Brian Geils, Natural Resources Canada, Canadian Forest Service.





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Similar damage

Both stalactiform and comandra blister rusts can be confused with western gall rust (*Endocronartium harknesii*). Western gall rust is distinguished by large galls forming on the branches and stems of infected pine. Also, western gall rust will occur in the absence of the secondary hosts associated with the other stem rusts. Atropellis canker (*Atropellis piniphila*) is often confused with stalactiform rust; however, atropellis causes blue-black staining of the sap wood. Abiotic health factors such as frost cracks or sunscald can often be confused with stem cankers.

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	
Adjacency to secondary host[1]	<300 m	>300 m
Previous year's summer climate[2]	Wet, cool	Dry, hot
Stand exposure[3]	Shaded	Full sun

Notes:

1. Dispersal distance of basidiospores is approximately 300 m so proximity to alternative host is required in order for infection to occur in pine.
2. Wet and cool weather is conducive for basidiospore formation and spore dispersal from secondary hosts, as well as infection of pine needles and shoots.
3. The successful completion of the disease cycle is dependent upon the dispersal and germination of the basiospores. This spore stage is not drought tolerant, thus stands on more southerly aspects tend to have a lower incidence of stem rusts.

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:	Cankers (-)							
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 for as long as the canker persists.
3. Infection rarely causes tree mortality but cankers can girdle the stem causing either branch-kill, top-kill or tree mortality depending on the location of the infection. The growth rate of the tree and quality of the wood is diminished by stem cankers.
4. Given that the blister rusts only affects the stem and rarely causes 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 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 during germination for the blister rusts. A warmer, drier climate would likely decrease the successful dispersal and germination of drought-susceptible basidiospores on pine. While, warmer wetter summers may increase the incidence and severity of rust infections.

Management Options

Monitoring

Stem blister rusts are best monitored from ground surveys due to their limited extent and damage. The best time of year for monitoring is in the late spring and early summer when the pustules are most apparent on the stem. An effective monitoring strategy would incorporate ground-based surveys of pine leading stands in the southern part of the territory.

Direct Control

Because the rust rarely causes significant damage to pine stands, direct control is not generally recommended. If treatment is required to protect high value trees, cut stem canker infected trees close to the bole, prune all branch cankers within 22 cm of the stem and destroy infected material.

Harvesting Considerations

Harvesting of pine 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 pine in areas with large populations of secondary hosts.

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