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FOREST Pest LEAFLET

Pacific Forestry Centre

Spruce foliage and broom rusts

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Introduction

Rusts affect many plants growing in British Columbia (B.C.). They affect not only the cones, foliage, branches and stems of trees, but also infect and deform numerous susceptible herbaceous plants. Numerous rusts have a significant impact on a variety of current reforestation and silvicultural practices. For example, white pine blister rust, caused by the fungus *Cronartium ribicola*, has greatly reduced the viability of white pine as a commercial tree species in B.C.

When warm, moist weather conditions prevail during the spore release periods, extensive foliage loss and shoot, branch and top mortality may occur. The type of damage varies with the rust species.

Six species of needle and broom rusts commonly occur on spruce in the Pacific Region. An additional five species have been collected only on the secondary host in the region. All belong to the genus *Chrysomyxa* of the rust order Uredinales.

Brooms in spruce caused by *Chrysomyxa arctostaphyli*

Canada-British Columbia Partnership Agreement on Forest Resource Development: FRDA II

Canada

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Distinguishing characteristics of spruce foliage rusts

Causal species	Primary hosts (spruce)	Secondary hosts
Chrysomyxa arctostaphyli	Forms brooms with stunted yellowish-green foliage on which aecial tubes occur. Foliage is shed in the fall. Has distinct smell.	Purple-brown spots on Kinnikinnick foliage.
C. ledicola	Foliage dropped during first season. Yellow-orange aecial tubes require microscopic examination to separate from *C. ledi* and *C. empetri*.	Uredinia and telia appear as brown spots on the *upper* surface of labrador-tea leaves.
C. ledi var. *ledi*	same as *C. ledicola*	Uredinia and telia appear as brown spots on *under* surface of Labrador-tea leaves.
C. empetri	same as *C. ledicola*	Uredinia and telia cause a blight on two-year-old crowberry foliage.
C. weirii	Current foliage has yellow bands, on which waxy-orange telia form the following spring. Foliage is shed in summer when 14 months old.	None
C. woroninii	Infected buds resemble small yellow cones.	Witches brooms on Labrador-tea. Telia form brown crust on under-surface of foliage.
C. chiogenis	same as *C. ledicola** Rare on spruce	The only known rust blight on creeping snowberry.
C. ledi var. *cassandrae*	same as *C. ledicola**	Causes brown leaf spots on cassandra.
C. ledi var. *rhododendri*	same as *C. ledicola**	Causes brown leaf spots on rhododendron.
C. ledi var. *vaccinii*	unknown, but probably spruce*	Purple-brown leaf spots on red huckleberry.
C. piperiana	same as *C. ledicola**	Yellow to brown leaf spots and blight on California rhododendron.

** not documented on spruce in B.C. to date.*

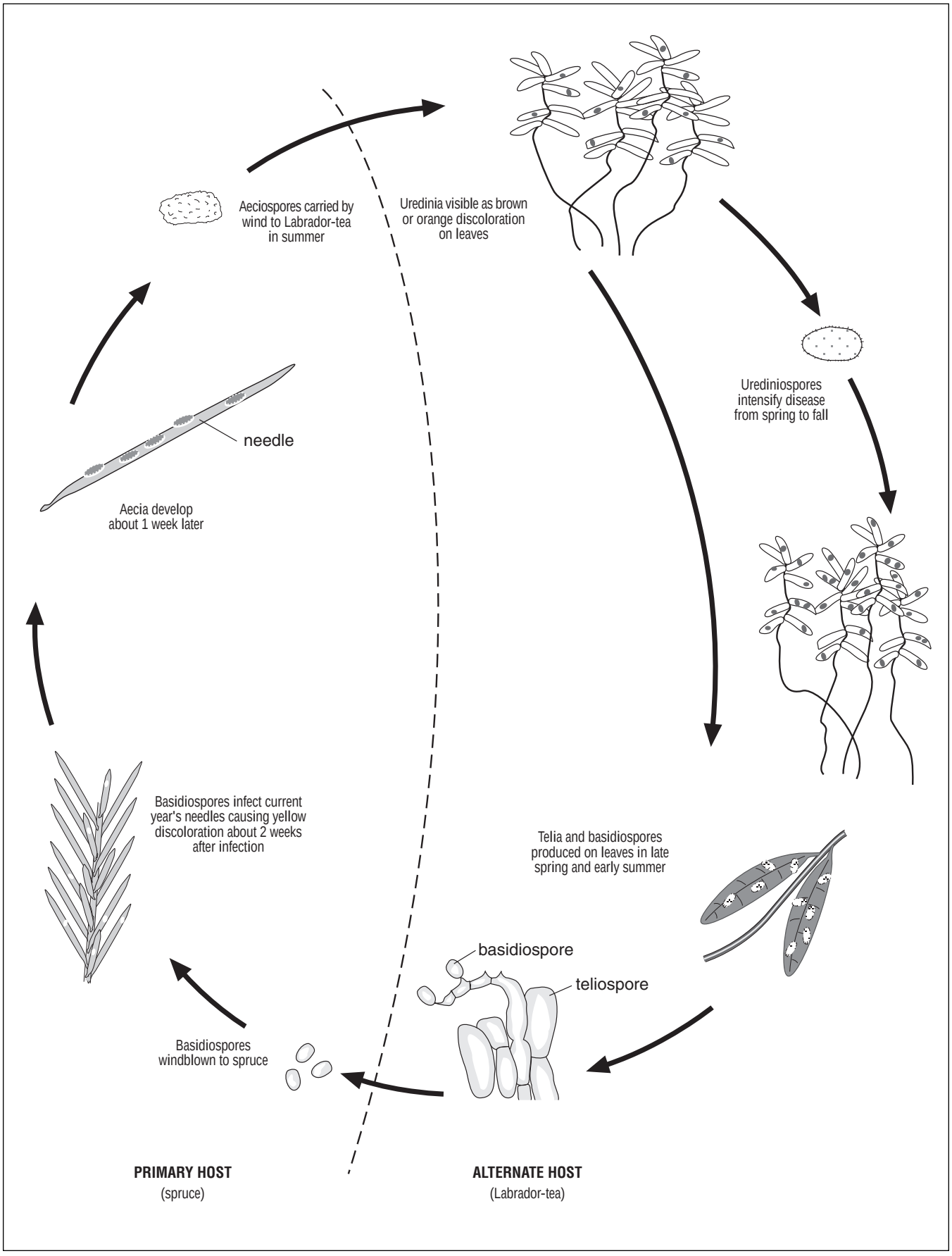
Recognition

The spruce foliage rusts produce yellow-orange aecial postules (or small tubes) on the current foliage, except for *Chrysomyxa weirii* which develops a yellowish band on current foliage and produces telia on two-year-old spruce foliage. *Chrysomyxa arctostaphyli* causes conspicuous systemic brooms, which are an abnormal bushy, local growth of part of a branch characterized by short internodes and proliferation of twigs. During severe rust outbreaks, trees and stands can assume an orangy tinge. Thin crowns can be an indication of recent rust infection but other diseases or insects cause similar symptoms. Actual aecial or telial pustules are required for verification that rusts are present.

Hosts and Distribution

Spruce rusts, with one exception, alternate between primary hosts (spruce trees) and secondary hosts (non-coniferous plants) in their complicated life cycle. Distribution of *Chrysomyxa arctostaphyli* and *C. woroninii* are limited to areas where both primary and secondary hosts occur in close proximity. With the other foliage rust species, infection of

An example of a life cycle: large-spored spruce — Labrador-tea rust, *C. ledicola*



Hosts and distribution of needle and broom rusts of spruce

Name	Primary (1°) hosts	Secondary (2°) hosts	Distribution
Spruce broom rust *C. arctostaphyli*	Engelmann, white, black Sitka spruce	Kinnikinnick (*Arctostaphylos uva-ursi)*	coast to coast in North America, both hosts
Large-spored spruce Labrador-tea rust *C. ledicola*	Engelmann, white, black, Sitka spruce	Labrador-tea (*Ledum* spp.)	1^{O}-coast to coast in North America, 2^{O}-as above and Japan
Small-spored spruce Labrador-tea rust *C. ledi* var. *ledi*	Engelmann, white, black spruce	Labrador-tea (*Ledum* spp.)	throughout northern hemisphere, all hosts
Spruce-crowberry rust *C. empetri*	Engelmann, white, Sitka spruce	Crowberry (*Empetrum nigrum)*	throughout northern hemisphere, both hosts
Weir's spruce cushion rust *C. weirii*	Engelmann, white, Sitka spruce	none	coast to coast in North America, south-central Asia
Spruce shoot rust *C. woroninii*	white, black spruce	Labrador-tea (*Ledum* spp.)	circumboreal, esp. northern transition, all hosts
The following species have only been found on the alternate host in B.C.			
Spruce-creeping snowberry rust *C. chiogenis*	white, black spruce	Creeping snowberry (*Gaultheria hispidula)*	1^{O}-eastern N. America from inoculations 2^{O}-B.C. and east N.A.
Spruce-cassandra rust *C. ledi* var. *cassandrae*	spruce	Cassandra (*Chamaedaphne calyculata)*	1^{O}-North temperate zone worldwide, except w. Canada 2^{O}-North temperate zone worldwide
Short-spored rhododendron rust *C. ledi* var. *rhododendri*	spruce	*Rhododendron* spp.	1^{O}-Eurasia, Japan 2^{O}-N.America, New Zealand, Eurasia, Japan
Red huckleberry rust *C. ledi* var. *vaccinii*	unknown, but probably spruce	Red huckleberry (*Vaccinium parvifolium)*	1^{O}-unknown 2^{O}-coastal B.C.
Long-spored rhododendron rust *C. piperiana*	Sitka spruce	*Rhododendron macrophyllum* and hybrids	1^{O}-Oregon, California 2^{O}-B.C. to California

the non-coniferous host is commonly found in the absence of spruce. Infection of spruce by some of these rusts has never been documented in B.C.

Life Histories

Most conifer rust fungi have relatively complex life histories. Rusts are obligate parasites, many of which require two botanically unrelated host plants to complete their life cycles. Rust species which alternate between two hosts are called heteroecious. Rusts may pass through five reproductive spore states called 1) spermagonial and 2) aecial states on primary hosts, and 3) *uredinial*, 4) *telial* and 5) *basidial* states on alternate hosts. Each state produces spores for a specific purpose. On the primary host, spermatiospores have a sexual function and are always followed by aeciospores, which only are capable of infecting the secondary host. On the secondary host, the rust is intensified on the alternate host through reinfection by urediniospores. Rusts typically overwinter as teliospores, which upon germination the following season produce basidiospores that reinfect the primary host.

The spruce foliage and broom rusts have three variations of this general life cycle, with the one-year cycle (page 3) being most common. Basic one-year cycle rusts include: *C. ledicola*, *C. ledi*, *C. empetri* and *C. woroninii*. In the spring and early summer, basidiospores from the secondary hosts infect the foliage or buds of spruce, the primary host. The rust on the infected needles develop spermagonia first, then later produce orange-yellow aecial pustules on the needles from June to August. During the summer the aeciospores infect the herbaceous secondary host's foliage or branches. The rust either overwinters vegetatively or develops uredinia and urediniospores (which are capable of reinfecting the secondary host

Spruce buds infected with *C. woroninii* produce stunted new growth resembling small cones.

many times during the growing season). The telial state, which produces thick-walled teliospores, develops before winter. The following spring the teliospores produce basidiospores which re-infect the primary host (spruce).

Chrysomyxa weirii also has a one-year cycle, but it is autoecious (does not require an alternate host), and the spermagonial, aecial and uredinial stages are lacking. Each spring, on the previous year's needles, teliospores germinate and produce basidiospores which re-infect the current year's spruce foliage.

The two-year-cycle rust is represented by *C. arctostaphyli*. In spring, basidiospores infect young needles on spruce and the infection spreads systemically in young shoots. The following year the infected buds give rise to a proliferation of short shoots bearing short yellowish-green needles. Spermagonia and aecia develop on these needles which are shed in the fall. The aeciospores infect the alternate host. In the spring the telia mature and produce basidiospores for re-infection of the primary host. The uredinial stage is missing in this rust.

Damage

Infected needles lose their functional purpose of photosynthesis and are cast prematurely. When a large percentage of the needles are infected for consecutive years, growth loss and twig mortality may occur; in addition, resistance to other pathogenic fungi or insect damage is reduced. *Chrysomyxa ledicola* can destroy up to 90% of the current year's needles. *Chrysomyxa arctostaphyli* is associated with stunted growth, dead tops, and occassionally with tree mortality. Deformities frequently lead to invasion by wood decay fungi. Annual volume increment in severely affected trees may be reduced to 70% of the potential increment, based on the pre-infection growth pattern.

Mature spore tubes (aecia) of *C. arctostaphyli* on current year's foliage

Uredinia of *C. ledicola* on the upper leaf surface of Labrador-tea, *Ledum* sp.

Control

Climate conditions are the major control mechanism, seldom allowing epidemics to occur. A rapid increase of rust incidence is highly dependent upon dry wind for spore dissemination followed by warm, humid conditions for germination at each spore production stage. Other forms of control have not been investigated and would seldom be warranted. Elimination of the alternate host in the immediate vicinity of a nursery would help to reduce infections.

References

Sinclair, W.A.; Lyon, H.H.; Johnson, W.T. 1987. Diseases of trees and shrubs. Cornell Univ. Press, Ithaca, N.Y., 574 p.

Ziller, W.G. 1974. The tree rusts of western Canada. Dep. Environ., Can. Forest. Serv., Pub. No. 1329, 272 p.

Mature spore tubes (aecia) of *C. ledicola* on current year's spruce foliage

Additional Information

Additional copies of this and other leaflets in this Forest Pest Leaflets series, as well as additional scientific details and information about identification services, are available by writing to:

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