

populations of *P. albicapitana* is the availability of suitable young host pines for several successive generations of this moth. The monoculture condition in plantations, seed orchards, and shelterbelts may also favor high populations of *P. albicapitana*. The mixing of pine hosts with non-host species appears to maintain relatively low populations of *Petrova*. Densely stocked stands with closed crowns may also discourage *Petrova* attacks.

Some protection of young planted trees may be provided when plantings occur several kilometres from the nearest *Petrova* population source. The moths of both species, however, are good fliers and may disperse widely, even without wind. On high-value trees such as ornamentals or genetically selected trees, effective direct control is provided by manual removal of each blister with its single larva. This method may also be economical where trees are relatively small. Trees brought in from an infested area should be checked for blisters with larvae. Some natural resistance of jack pine to successful northern pitch twig moth attacks has been demonstrated and may be operable with other hosts as well. It may therefore be possible to select resistant pine trees for planting.

Relative population abundance of the two *Petrova* species, seasonal flight periods, and distribution can be assessed with the use of traps baited with pheromone (male sex attractant). These can be deployed in the field in consecutive years and provide a convenient monitoring tool. In small isolated infestations, as in seed orchards or plantations, some control may be achieved through deployment of pheromone-baited traps to capture male moths and to disrupt mating.

Insecticidal treatments using both systemic and non-systemic chemicals have been field tested but have only partially controlled the

larval stage. Accurate timing of treatment applications is crucial for achieving effective control of exposed larvae with contact insecticides, while systemic insecticidal treatment applied to the soil around individual trees is labor intensive.

For the most recent information on chemicals available for control of these insects, call Agriculture and Agri-Food Canada's Plant Industry Directorate in Ottawa (toll-free) at 1-800-267-6315.

Chemical pesticides are toxic to humans, animals, birds, fish, and beneficial insects. Follow all instructions and precautions listed by the manufacturer.

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Pitch blister moths



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Distribution and Hosts

Pitch blister moths are small insects whose larvae bore into the shoots, twigs, branches, and stems of pine hosts and construct hollow blisters from resin as a protective shelter. Two species occur in the Canadian prairie provinces. The most common and widely distributed species is the northern pitch twig moth (*Petrova albicapitana* [Busck]). The second species, the metallic pitch blister moth (*P. metallica* [Busck]) is less well known. The distribution of the northern pitch twig moth in Canada extends from Nova Scotia to interior British Columbia and northward, probably into the southern parts of the Northwest Territories. In the United States it extends as far south as Montana and the Lake States. The primary hosts of the northern pitch twig moth include jack, lodgepole, and Scots pines, but this moth may also occasionally attack red, ponderosa, and mugho pines. The metallic pitch blister moth is distributed widely in western North America, from Minnesota, Colorado, and California in the south, northward throughout British Columbia and western Alberta to southern Yukon, and in the Cypress Hills of southwestern Saskatchewan. Its main hosts include lodgepole and ponderosa pines; other pine hosts may include Scots and mugho. Within their western range on lodgepole pine, both species may overlap; however, *P. metallica* seems to occur at higher elevations at least 800 m above sea level. Both species of *Petrova* attack young to mature trees, but most reported injury has occurred on 0.5- to 5.0-m-tall pine trees growing in natural stands, plantations, seed orchards, nurseries, and on planted shelterbelt and ornamental trees.

Symptoms and Damage

Tree injury caused by the two *Petrova* species is similar and results from larval feeding. In

the case of the northern pitch twig moth, the young larva begins feeding in July, usually near the tip of a lateral shoot formed in the current year. By September it has excavated a small circular feeding cavity in the bark, over which it constructs a protective nodule-like blister formed from silken webbing, frass, and resin. In the following spring both excavation and resinous blister are enlarged when larval feeding resumes. By early July the larva vacates this first feeding site and migrates toward the main stem where a new feeding site is established, usually at the junction of a branch whorl. A new resin blister, up to 2 cm long, is formed by the larva to cover its second feeding site. Injury caused by the first-year larva is mostly negligible but sometimes results in girdled or broken shoots. A second-year larva, however, feeds more deeply and extensively into the bark and wood. Injury caused during this feeding may weaken or kill the terminal leader. Partly girdled stems are prone to break in high winds and wet snow for up to 5 years after injury. Common defects resulting from broken leaders are weakened and crooked or multiple stems; occasionally, some height growth reduction also results. Stem deformities caused by the northern pitch twig moth are usually more severe and more commonly seen on jack pine than on other pine hosts. In the upper third of the tree crown, up to 33% of the shoots may be killed in a single year. Lodgepole pine growing outside its natural range may be more susceptible than jack or Scots pine to the northern pitch twig moth.

Young larvae of *P. metallica* begin feeding on current-year shoots of branches and sometimes on leaders. Each larva excavates only one feeding site and covers it with a resinous blister during its developmental period: it mines lengthwise within the twig or stem, frequently killing or injuring buds and some first-year cones. Injury may result in dead terminals, crooked or multiple leaders, height

reduction, and a less effective crown form on shelterbelt trees.

Populations of the northern pitch twig moth may fluctuate widely in different stand conditions and age classes. At high population levels, 60–70% of trees in 8- to 12-year-old lodgepole pine stands may be attacked during the same year, resulting in multiple attacks at the same stem level of a branch whorl. Plantations of a single species of host pine tree commonly support high population levels. Studies of a 50- to 60-year-old jack pine stand indicated an average current-attack density of 125 blisters per tree and that the numbers of both current and old blisters increased directly with tree size. A similar relationship between tree size and *P. metallica* attacks was observed in a ponderosa pine plantation.

Causal Agents

Adults of the northern pitch twig moth are small, mottled, rusty brown moths (metallic gray in the case of *P. metallica*) with a wingspan of 14–21 mm. They appear in the field during June and July (*P. metallica* may emerge several days before *P. albicapitana*). Eggs of *P. albicapitana* are deposited singly near terminal buds at the base of needle sheaths in July. The eggs are cream to yellow in color and about 0.5 mm long; they hatch as larvae after several weeks. After hatching each young larva excavates a separate cavity in the bark tissue where it feeds solitarily. A small resinous bubble is formed over the feeding site where the larva overwinters. It resumes feeding in the following spring, enlarging both blister and cavity. By early June the larva vacates the first feeding site, migrates down the branch, and establishes its second feeding site, usually at the base of a branch whorl. There it continues its solitary feeding during the second summer while enlarging its new feeding area under a

brown-colored blister. After overwintering a second time, the larva feeds for a brief period in the third year before pupation. A larva develops through about five growth (instar) stages and is yellow to orange-brown in color. When mature, it is 15–17 mm long and has a reddish brown head and thoracic shield. Its body is sparsely covered with short hairs, usually with dark spots at the base of the hairs. Pupation occurs within the blister, beginning after mid-May; pupae are spindle-shaped, dark brown, and 10–13 mm long.

The life cycle of the northern pitch twig moth requires 2 years to complete in the prairie provinces. In most areas two separate populations can be recognized, but they are not synchronized because moths are present every year. The life cycle of the metallic pitch blister moth, although less understood, appears to be 2 years in its northern range in Alberta and Saskatchewan and 1 year in its southern range. Moths of this species are also present each year.

Prevention and Control

Natural control agents of the two *Petrova* species include several insect parasitoids, some of which are common to both hosts. The combined effects of all known parasitoid species usually cause less than 10% mortality of larvae and pupae. Predation of *Petrova* larvae by insect predators while the larvae are exposed during migration on branches may be important, but this has not been investigated. Birds such as chickadees may also contribute as natural control agents by preying on larvae, pupae, and adults. Weather may also be a factor: hail may be detrimental to larvae, while wind or cool rainy conditions may affect moth flight and egg-laying.

The most important factor appearing to favor buildup and maintenance of high