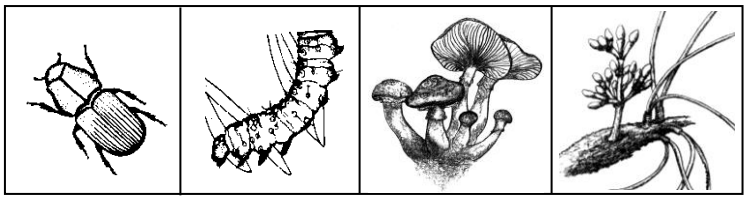
Forest Health Protection



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Pine Leaf Adelgid, *Pineus pinifoliae* (Fitch) Found Damaging Western White Pine Plantations on Kootenai and Idaho Panhandle NFs

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Abstract

Unique damage was noted on planted western white pine on the Kootenai and Idaho Panhandle National Forests in 2014. Damage was generally confined to the lower crown and included branch flagging, green branches with swollen abnormal growth on branch ends, multiple years of red needles remaining attached, and resin droplets on affected branches reminiscent of white pine blister rust (*Cronartium ribicola* Risch). Scale-like insects were noted on symptomatic branches. The agent involved was identified as pine leaf adelgid (*Pineus pinifoliae* (Fitch)). Historical outbreaks of this insect have been recorded in eastern and western white pines. Possible management to minimize the impacts from this insect include preferentially removing spruce from impacted western white pine stands and continuation of the western white pine pruning program as planned. Informal monitoring is planned for 2015.

Introduction

Unique damage was noted on planted western white pine (WWP: *Pinus monticola* Dougl. ex D. Don) during a site visit to evaluate pruning opportunities in WWP plantations on the Kootenai National Forest in August of 2014. This damage was noted in several plantations, but the worst damage observed was located in the Getner Creek drainage about 10 miles south of Libby, Montana on National Forest lands. Similar damage was also noted by Monika Wood and other personnel on the Idaho Panhandle National Forests. They coded the damage "14-046 Pine leaf adelgid (sucking insect)" during their surveys of recently pruned and thinned stands southeast of Bonners Ferry, Idaho. This area is approximately 30 air miles northwest from the damaged stands south of Libby, Montana, and less than a mile from the Idaho/Montana border.

Pruning is generally done in WWP trees 15 to 25 feet tall, so the sites visited were limited to stands of this approximate size. Damage appeared to be confined to planted WWP; natural regeneration seemed relatively unaffected. Damage was generally confined to the lower portion of the mid-crown of trees - the very bottom one or two branch whorls were almost always green and symptomless (Figure 1). Symptoms within this zone of the crown included significant branch flagging; green branches with swollen,

abnormal growth on the branch ends (Figure 1); red needles much like a needle disease, except multiple years involved and red needles remaining attached; and resin droplets on affected branches reminiscent of white pine blister rust (*Cronartium ribicola* Risch.; WPBR) branch cankers. Western white pine mortality was approximately 10 percent in the stands on the Idaho Panhandle NFs, and mortality was noted on the Kootenai NF. In both locations, it was difficult to determine the actual cause of mortality. An insect, much like a small scale (Figure 2), was noted along with these symptoms, and was assumed to be the responsible agent, or at least a contributing agent. These insects were visible on the green branches within the damaged zone of the crowns, and seemed concentrated at the axes of needle shoots. Galls were observed on the spruce regeneration in the Kootenai NF stands, but were not recognized as a significant part of the story at the time of the site visit. All spruce in the Idaho Panhandle NFs stands had some level of gall infections.

Figure 1. Western white pines on the Kootenai NF (top left) and Idaho Panhandle NFs (top right) with red flagging in the lower middle crown and swollen green branches within the flagged portion of the crown (bottom). Symptoms were found to be associated with heavy infestations of *Pineus pinifoliae*. (Photos: B. Lockman, USDA Forest Service, top left and bottom; T. Friebus top right).

Identification Process (for this report)

Green branch samples with attached insects were first sent to Dr. Laurie Kerzicnik, insect diagnostician at the Schutter Diagnostics Lab at Montana State University Extension. Dr. Kerzicnik then forwarded the samples on to an expert on insect scales, Dr. Ian Stocks, entomologist at Florida Department of Agriculture and Consumer Services in Gainesville, Florida. Dr. Stocks identified the insect as an adelgid, likely in the genus *Pineus*, rather than a scale. The sample was then forwarded to Dr. Susan Halbert, entomology taxonomist and an expert on adelgids, also at Florida Department of Agriculture and Consumer Services in Gainesville, Florida. Dr. Halbert confirmed it is an adelgid in the *Pineus* genus, but was unable to identify to the species, so forwarded the sample to Dr. Robert Foottit, research scientist with Agriculture and Agri-Food Canada in Ottawa, Ontario. Using DNA barcode verification, Dr. Foottit identified the adelgid as *Pineus pinifoliae* (Fitch), the pine leaf adelgid.

General Biology

The life cycle of *P. pinifoliae* has been described by several authors; the cycle as described here comes mostly from Balch and Underwood (1950) and Lowe (1966). *Pineus pinifoliae* requires two hosts to complete its life cycle, spruce as its primary host and white pine as its secondary host, with approximately one year on each host. In our local observation, these hosts are Engelmann spruce and western white pine. The overwintering stage on spruce is called fundatrix, which lays its eggs at the base of spruce buds. The eggs hatch to coincide with bud burst, and the larvae, now called gallicolae, develop within the swelling galls. The galls open and the winged adult gallicolae emerge about the middle of June and fly to the needles of white pine, apparently preferring the previous year's growth within the lower mid crown. They settle on the needles facing towards the base of the needles (Figure 3). The eggs are laid beneath their wings and the adult dies but may remain attached to the needles until late winter. The larvae hatch in early July and crawl to the base of the new pine shoots and insert their stylets (mouth parts). They turn a dark, purplish brown and become somewhat flattened, and scale-like. A fringe of white plates develops around the body and along the mid-line (Figure 2). It is thought they remain dormant in this stage until the following spring, though some growth may occur. This is the stage most apparent and damaging on the white pine host. In heavy infestations, they may be numerous enough to completely cover the shoot axes. In the spring, the larvae develop into wingless exules and winged sexpurae, and their offspring settle on the new shoots and produce a second generation of larvae by the middle of July. The wingless exules remain on the white pine host and can keep reproducing, while the adult winged sexpurae leave around the end of May and fly to the older needles of spruce. These winged adults settle on the needles facing the tip and lay their eggs under their wings. Larvae, now called sexuales, hatch in June and arrange themselves in a double row behind the body of the adult and insert their stylets into stomata and begin to feed. This stage is the only sexual stage of the insect. They molt four times and the two sexes become apparent by the end of June with mating occurring shortly thereafter. The resultant eggs hatch into the fundatrix stage in early- to mid-July and move to the base of the needles associated with terminal or lateral buds on spruce shoots. It overwinters there, and the life cycle has come full circle.

Figure 2. *Pineus pinifoliae* larvae on symptomatic branch of western white pine. Note the diagnostic white fringe of plates around the margin and along the mid-dorsal line of each insect. (Photo: Ian C. Stocks, FDACS- DPI)

Figure 3. Adult *Pineus* sp., assumed to be *P. pinifoliae*, attached to western white pine needle. Note that it is facing towards the base of the needle. (Photo: B. Lockman, USDA Forest Service)

Historical Presence- eastern white pine

An outbreak of pine leaf adelgid was recorded in New Brunswick and Nova Scotia on eastern white pine in the 1940's (Balch and Underwood 1950), and progressed into the northeastern US through the 1950's and 1960's (DeBoo et al. 1964, Dimond and Bishop 1968). Several assessments during this extended outbreak found 4% to 18% white pine mortality, confined to small trees, and 26% to 61% of the live trees with significant damage. Loss of growth was considerable in affected stands, allowing for the favor of other species, and threatening the reduction of the preferred white pines (Balch and Underwood 1950). Radial growth was found to be significantly reduced in damaged trees when compared to undamaged trees and internode growth alternated between long and short, depending on the year of infestation of the white pines (DeBoo et al. 1964). Underwood (1954) measured increment cores from 186 eastern white pines known to have been infested for over 5 years. The white pines showed an average reduction in ring width of about 60% over those 5 years. The pattern followed the biennial cycle of the insect between its two hosts; the growth decrease was confined to rings formed in the years following heavy attack on the white pine host. The leader and upper branches often survived, and the branches with killed shoots often developed adventitious shoots following damage. Although damage was notable in this outbreak in eastern white pine, pine leaf adelgid was not considered a serious mortality agent. It was determined that survival of white pines during an outbreak is more dependent on the duration of the outbreak (DeBoo et al. 1964).

Stand susceptibility occurs where both the primary and secondary hosts are significant components of the forest. Dimond and Bishop (1968) found the highest correlation to be the spruce to pine ratio of the stand. When the ratio reached 2.90 or higher, then mortality was observed in the co-dominant white pines. Damage and growth loss can be expected when the ratio equals 1.0 or greater. But, the stand might not be the appropriate scale for observing susceptibility factors, as the adelgid is apparently influenced by factors within its entire dispersal range, which could extend beyond the stand. Dimond and Bishop (1968) also noted soils played a role in the susceptibility of forests in Maine- areas of sandy soils derived from granitic till or soils derived from gravel deposits had higher susceptibility than areas with heavier loam soils.

Historical Presence- western white pine

In northwestern North America, *Pineus* spp. were found to be involved in needle blight and crown deterioration in the 1930's and again in the 1950's (Denton 1959; Denton and Leaphart 1959) in immature western white pine. The *Pineus* species described by Denton (1959) could very well have been *P. pinifoliae*, as he described it as being "…distinguished by the scale-like appearance of the nymphs". A needle disease may have also been involved in the crown decline as described in Denton and Leaphart (1959); the number of adelgids found on symptomatic trees was fairly low, but no pathogen was identified. Pine leaf adelgid is mentioned as a common adelgid on western white pine and spruce in seed orchards in British Columbia (Cone and Seed Insect Pest Leaflet No. 14; Duncan 1996 (PDF version 2000)). *Pineus pinifoliae* was also mentioned by Hoff and McDonald (1977), but their work focused on the apparent differential susceptibility of white pine species to *P. coloradensis*. Species most susceptible to white pine blister rust were observed to be quite susceptible to infestation by *P. coloradensis*, including both eastern and western white pines.

Potential Management and Monitoring

The pine leaf adelgid can maintain a truncated life cycle on white pine, but requires both primary and secondary hosts to complete its full life cycle, so decreasing the opportunities for adelgids to cycle between both hosts should help decrease the population (Forest Genetics Council of British Columbia). Previous outbreaks have indicated that damage to white pines increases with an increasing component of spruce (Dimond and Bishop 1968). Caution should be used when selecting sites for planting western white pine, and preference should be given to plant where spruce is a minimal component of the stand,

and/or spruce should be removed if it is a component of the stand. Thinning western white pine stands is often combined with pruning, so preferentially removing spruce during these thinning operations will help decrease the population of the adelgid, though it may take several seasons to see results.

Pruning western white pine should not exacerbate adelgid infestations, and may actually assist in decreasing the existing population. Pruning already infested branches may alter the adelgid's life stage on pine, leading to a decrease of adelgids that are able to mature and move to spruce to complete their life cycle. So, western white pine pruning operations should move forward as planned.
Pine leaf adelgids have been found causing damage on western white pine stands in the past, but there is no mention of its preference for planted trees, especially genetically improved stock. The presence of this insect should be noted in pre-pruning surveys, and should also be recorded in any exams done in western white pine stands. A common stand exam code exists for pine leaf adelgid, "14-046 Pine leaf adelgid (sucking insect)". Recording the presence of this insect will help in monitoring its impact over time. The damage observed in 2014 may be an anomaly, or it could be the precursor to an outbreak. It will be prudent to monitor this insect in 2015, at least informally, to document the impact on western white pine and determine if the population is increasing. It may become necessary to prioritize where genetically improved western white pine stock is planted and determine if resources should be directed towards minimizing the impact from this insect by preferentially removing spruce and pruning stands that are currently being impacted.

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