The Balsam Woolly Adelgid and Pine Needle Mite as Potential Pests of Reforestation Nurseries in British Columbia[1]

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Abstract.--The Balsam Woolly adelgid, Adelges piceae, an introduced pest to B.C., is currently controlled by quarantine regulations. Life history, damage, pest potential in nurseries, and control trials are described. Life history, damage, pest potential and control of the pine needle mite, Trisetacus campnodus, a newly discovered pest, are also discussed.

THE BALSAM WOOLLY ADELGID: ADELGES PICEAE, (RATZ.)

The Balsam Woolly adelgid (BWA), of European origin, was initially discovered in B.C. near Vancouver in 1958. It is now known to be distributed over 10,000 sq. km. on Southern Vancouver Island and in the Fraser River Valley.

This adelgid infests the twigs and stems of all Abies spp. Alpine fir A. lasiocarpa is the most susceptible to damage although A. amabilis and grand firs A. grandis are most frequently infested in coastal B.C. The insect inserts its mouthparts into the living cells of the bark introducing substances that produce an interaction with the tree causing twigs to swell or "gout" at the nodes. Repeated gouting of the main terminal may produce a stunted top. Persistent crown infestation results in visible thinning of the foliage, top-killing and broken tops. Heavy attacks on the bole or stem often result in tree death after two or three years. Mortality in mature Abies stands is highly variable and patchy, and ranges from 5% to 95%.

Adult BWA's are wingless purplish-black insects less than 2mm long. During the summer, they are covered in white woolly wax threads. During the winter, they are black and flattened with little or no wool. All adults are females which may lay as many as 100 red-brown eggs. These hatch into tiny red-brown first stage nymphs or crawlers, the only mobile stage. The nymphs crawl to a new part of the stem or blow in the wind. Evidence suggests they were able to travel from mainland Canada to Newfoundland, a distance of 260 km. After selecting a feeding location on thin bark, branch nodes, or leaf and cone buds, the crawlers insert their mouth parts and remain at this location for the rest of their lives. After three moults they become adults and begin egg laying. There are two to three generations each year. Eggs and young crawlers are present from late April to October (Harris 1978).

In 1966, the British Columbia BWA regulations were drafted to prevent the spread of this imported pest throughout the range of its Abies hosts. Under the existing regulations all Abies spp. must be grown under permit regardless of nursery location. Nurseries located within the infested zone are not permitted to ship seedlings outside the zone. When stock is moved inside the zone, a spray program using Safers Insecticidal Soap at 1-2% is mandatory. Stock moved between April 1 and October 31, when reinfestation by crawlers is possible, must be treated twice. Cones and seeds, cut Christmas trees, boughs or wreaths when moved between Nov. 1 and Jan. 1, and logs when transported in water and promptly processed, are exempt from the regulations.

Privatization of B.C. reforestation nurseries has created a more competitive atmosphere within the industry. Nurseries inside the regulation area have expressed a desire to grow Abies for areas outside the zone. To develop a treatment that would permit growers to ship stock outside the quarantine zone a sequence of potential control methods was evaluated. Also, as this adelgid had never been detected on nursery stock, the potential for this species to infest seedlings, needed to be established.

In 1981, a trial was established to determine the ability of the BWA to infest and survive on seedlings; and if various insecticides could eradicate established BWA from seedlings. Two year old Abies amabilis seedlings were artificially infested with adelgids. In November, the following insecticides were applied to the overwintering stages using the recommended label rates for aphids: permethrin (100 ml in 1,000 L water/ha/), dimethoate (mix 4 ml in 1 L water, spray for good

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coverage) oxydemeton-methyl (3.75 L in 1,000 L water/ha),potassium salts of fatty acids or soap (mix a 2% solution and spray to run-off), soap plus pyrethroids or sap (500 ml in 11 L water and spray).

Each insecticide was applied to five 313 A container blocks half filled with Abies seedlings and interspersed with ten aphid infested trees. Sprays were applied using a specialized pesticide applicator designed to simulate operational conditions while applying small amounts of pest-cides for trial use. Due to the high density of nursery stock and the small size and cryptic nature of the aphids, high volumes and pressures were used. Permethrin, oxydemeton-methyl and dimethoate were applied at a volume of 3,000 L water per ha, the soap and sap were applied at 5,000 L water per ha. All sprays were applied using D2-23 nozzles and pressures of 150 PSI. Three weeks after the application, whole seedlings were carefully inspected for the presence of live aphids using a dissecting microscope. The legs of overwintering aphids atrophy and no movement is detectable. Aphids were considered to be alive if a drop of purplish fluid was exuded after they were squashed.

Treatments with soap were repeated on a further series of infested seedlings in August 1988, to determine potential control of the summer populations when eggs and crawlers are present. Applications of soap against the overwintering stages were repeated a second time in March 1989 in order to confirm the results of the 1987 trial. Also, the effectiveness of an extra application of soap two weeks later was evaluated.

Results of all three trials are presented in Table 1. Cygon and Metasystox-R failed to provide acceptable control. Both are organophosphates which become deactivated as the temperature drops. Also, at the time of their application there would have been little or no action of these systemics as the seedlings are dormant during the winter and not actively translocating. Although Permethrin provided the best control it was deemed unsuitable for nursery use because the quarantine regulations require applications just prior to seedling lift. Residues from this product would be too high for nursery workers to handle the stock during the lift safely. Applications of the soap during the summer provided very little control, probably because they were not effective against the eggs and crawlers. When applied during the winter, soap consistently provided about 80% control. However, this level of control was determined unacceptable for assuring that the BWA would not be transported on infested nursery stock.

Table 1.-Control of the Balsalm Woolly Adelgid in Conifer Seedling Nurseries

Treatment	# of trees Assessed	Avg # Adelgids per tree	% Reduction over Control
November 1987 Trial			
permethrin	49	.9	95.6
dimethoate	50	18.5	6.6
oxydemeton-methyl	48	7.8	62.0
soap spray	50	2.8	85.7
sap	50	2.3	90.5
control	50	19.9	0
overwintering counts	50	4.4	57.3
August 1988 Trial			
1 soap spray	49	34.3	13.9
control	25	77.6	0
2 soap sprays 2 weeks apart	50	18.5	33.5
control	25	55.6	0
March 1989 Trial			
1 soap spray	50	2.8	67.6
2 soap sprays 2 weeks apart	50	1.8	79.1
control	50	8.7	0

To date, the BWA has not been found infesting Abies seedlings in reforestation nurseries in B.C The ability to establish this adelgid on 2+0 container seedlings indicates that they could potentially become a nursery pest; however, survivorship was poor. Counts of adelgids on seedlings held over until March showed there was a 57% reduction in numbers compared to the control seedlings in November. This is possibly because this species is adapted to infesting the stems and twigs of mature trees surviving under humid protected conditions with little direct sunlight. On small seedlings the aphids would be exposed to much harsher environmental conditions.

In spite of the unsuccessful attempts at chemical control of the BWA, we are continuing to work with this pest. A program to gain information necessary for developing a nursery certification program has been initiated. Work to develop a passive trapping technique for the mobile crawler stage, to determine the potential for inoculation of seedlings from mature trees, to assess the 1evel and risk of BWA populations surrounding nurseries within the regulation area, and to develop reliable survey techniques to determine presence or absence of the BWA on nursery stock has been initiated.

THE PINE NEEDLE MITE: TRISETACUS CAMPNODUS (Keifer)

In 1987, the small pine needle mite Trisetacus campnodus was identified on pine seedlings from several B.C. reforestation nurseries. Mites have been collected from outplanting and bare-coot production stock at Chilliwack River Nursery, outplantings and bare-root production stock at Surrey Nursery, and outplantings at Green Timbers and Skimikin Nurseries.

T. campnodus occurs on scots pine, Pinus sylvestris, and lodgepole or shore pine, Pinus contorta. It has been a major pest in scots pine Christmas tree plantations, and is distributed throughout Washington, Oregon, and B.C.

This mite is probably a native pest of shore pine where it is not a large problem. However, it is a relatively new pest of lodgepole pine. Interior lodgepole pine planted on the coast is readily attacked and the mite can become a major debilitating problem. R. Hunt (1981) made observations of 70 provenances of P. contorta, ranging from California to the Yukon, growing in a five year old plantation near Cowichan, B.C. and found that damage varied according to provenance. Damage to coastal provenances was slight compared with interior provenances, and within the coastal provenances northern ones were damaged more than southern ones.

In B.C. reforestation nurseries this mite is of concern because interior lodgepole pine seedlings have been grown at coastal nurseries and then planted back in interior native habitats. It is possible that the mite could spread from native shore pine in and around the nursery site to the lodgepole pine in the nurseries, and then from the seedlings in reforestation sites to native lodgepole pine stands.

T. campnodus are extremely small mites that appear only as specks with the naked eye. A hand lens or microscope are necessary to see them, and they must be identified under high magnification. The mites are less than .3 mm long, light yellowish-white, translucent, wormlike & elongate. They are usually sedentary, but can move very slowly with their four legs.

Mite infestations occur at the base of the needles beneath the sheath. At first they occur at the interface where the needles meet, but as the population increases, the entire needle base covered by the sheath may be invaded. In heavy infestations, there can be up to 200 mites per needle base, but 10-20 can cause permanent damage. Eventually, the epidermis of the entire needle base is destroyed and appears necrotic, browned, and sometimes calloused.

Mite damage is often easily detected by the presence of discoloured and distorted needles. The needles become chlorotic, pale yellow, blotched, stippled or mottled. Needle growth can be reduced by up to 70%, and the needles are twisted or hooked, with the new growth being crinkled. Twigs where needles are attacked for several years may become twisted and deformed. Mites also cause premature needle drop. Severely infested trees retain only the current years needles, and in some instances even the current needles are sparse and greatly shortened.

Repeated infestation reduces vigour and may kill trees within a few years. Infested trees are chlorotic and generally appear unthrifty; they can be spotted by their thinner crown of paler foliage. Most pines infested for any length of time are noticeably stunted, and there can be a decrease in annual increment of up to 20%. There is some evidence that infested pines may be predisposed to bark beetle attack.

The opportunistic secondary imperfect fungus, Sclerophoma pithyophila, is commonly found fruiting on necrotic foliage and shoots. Dieback associated with the fungus may occur, resulting in bushy, stunted and broomy trees with an exceptional number of buds on each shoot.

The damage causes symptoms sometimes referred to as kinky disease. It is often misidentified by growers as the effects of poor site, needle cast diseases, air pollution, herbicides, poor drainage, and lack of fertility. Magnesium deficiency can produce similar symptoms, but this can be easily rectified with applications of magnesium sulfate. Kinky disease trees are not adversely low in magnesium, nor do applications solve the problem.

The mite population overwinters as both adults and eggs within the needle sheaths. During the time of candle elongation in the spring the mites move to the new growth, and lay several overlapping generations of eggs. It is at this time they cause considerable damage to the new needles, producing the symptoms of kinky disease. During the summer, as necrotic tissue begins to develop at the needle base, the mites often disappear; presumably they move on to other healthier needles.

Infested trees are often erratically distributed with a healthy tree growing next to a badly infested one. Also, the distribution doesn’t seem to follow wind patterns because there are often as many infested trees to the windward as there are in more sheltered places. Possibly these tiny mites are carried by birds, squirrels, or insects. Several species of mites attach themselves to insects for transportation.

T. campnodus does not seem to have a large number of natural parasites and predators. Due to its small size it is free from internal parasites, and its inaccessible hiding place protects it from most predators. When the needle sheath becomes loosened with age, or the mites are migrating to new needles they can be subject to predators of which the large mite Seius seems to be important.

Chemical control is also difficult. Pesticides will not readily penetrate into the base of the needle sheath in which the mites are enclosed. Studies have shown that the most effective time to control this pest is from April to early June, during the period after candle elongation but prior to needle elongation. The specific time when the mites migrate onto the new growth depends on the location and species of pine.

Carbaryl and oil has shown to provide the best control over other pesticides tested in several studies. It is recommended that growers use Carbaryl 80% WP at 0.55 - 1.2 kg (1.25 - 2.5 lbs) product with 7.5 liters (2 gals.) of 60 - 70 sec. superior oil per 375 liters (100 gals.) of water. A second application should be repeated 10 - 14 days later to kill newly hatched mites. The oil is necessary to penetrate through or around the sheath to the infested area. The length and tightness of the needle sheath can vary considerably and will affect the control achieved (Adams 1986).

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