Forest Insect and Disease Notes

Northwest Region

A-023

April 1993

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BALSAM FIR MORTALITY SURVEY

by

Ken Mallett and David Langor

Balsam fir mortality is found throughout Canada and has been recorded in the prairie provinces since 1952. There have been several attempts to indentify the cause of the mortality . Thomas (1953) noted that there was wide-spread balsam fir mortality in 30 to 100 year-old stands in Saskatchewan and Manitoba and that 50 - 60% of the trees had Armillaria root rot. In Ontario, dieback of balsam fir was associated with three canker causing species of fungi, Thyronectria balsamea (Cke. and Pk.) Seeler, Derma balsamea (Pk.) Seav. and a Cytospora species (Reid, 1958). Cayford et al. (1959) reported that there was widespread winter drying and frost injury to trees, including balsam fir, in Manitoba and Saskatchewan in 1958. Riley and Hildahl (1963) reported that in some areas of Saskatchewan and Manitoba up to 80% of the balsam fir were affected. They attributed the damage to frost injury and a severe drought that occurred in 1961 although Armillaria root rot and T. balsamea were found associated with the dead and dying trees. Balsam fir mortality was noted in some locations in Ontario in 1962 and was associated with several pathogenic organisms but there was no conclusive proof that any of the pathogens were responsible for the damage (Dance and Lynn 1963). In New Brunswick balsam fir tree foliage that had been infested with spruce budworm, but not severely defoliated, were found in some cases to turn bright red and die. This phenomenon is now known as Stillwell's syndrome (Kondo and Moody 1987). Mortality from Stillwell's syndrome can be brought about by Armillaria root rot, bark weevils, and bark beetles (Kondo and Moody 1987).

During the past five years balsam fir mortality has been noted by the Alberta Forest Service in the Lac la Biche, Athabasca and Slave Lake Forests of Alberta. The damage was widespread, affecting single trees or patches of trees. In the fall of 1991, the Alberta Forest Service (AFS) requested Forestry Canada's Forest Insect and Disease Management Systems and Survey personnel to investigate the cause of balsam fir mortality. This report summarizes information obtained from a survey, conducted in 1992, of the balsam fir mortality in the Slave Lake forest and Sir Winston Churchill Provincial Park.

Methodology

Dead and dying balsam fir in the Slave Lake Forest were examined several times throughout the summer of 1992. Permanent plots were established at four sites in the Slave Lake forest and one site in the Lac La Biche Forest in Sir Winston Churchill Park. All tree species in these plots were examined for insect and disease injury, and mortality. In addition to the permanent sample plots, dead and dying balsam fir at three other locations (North Shore picnic area, Mitsue Lake campground, and Wagner) near Slave Lake and one additional site in Sir Winston Churchill Park (Campground) dead and dying balsam fir were examined for insect and disease damage.

Results.

The survey results indicate that the majority of the damage occurred to balsam fir on these sites as there was relatively little damage to white spruce or poplar. The average mortality for balsam fir for the 5 sites was 57% as opposed to 7% for white spruce and 0% for hardwood species. None of the trees showed any signs or symptoms of defoliation by insects or infestation of the upper boles by boring insects. There was no evidence of fungi on the foliage or in the upper bole. Dead trees often had a reddish-brown stain in the structural roots. The characteristic mycelial fan of *Armillaria* species was frequently found either in the root collar or in the structural roots. Often the fan could be found in only one root and sometimes quite far from the root collar.

At one site fungal mycelia were observed growing in many tree roots. This fungus was not thought to be an *Armillaria* species and isolation from the decayed wood has confirmed this. This fungus has not been identified yet. A black stain was observed in several of the tree roots. A known wood staining fungus, *Hormonema* sp., was isolated from these roots. Bark beetles and bark weevils (*Pissodes* sp.) were found in the lower boles of a few of the recently dead balsam fir but these were thought to be secondary in nature.

Damage at all of the sites was typical of root rot disease centers. These are openings in forest stands that are variable in size and are caused by root disease fungi decaying tree roots and killing trees. Fallen trees typically lay crisscrossed within the center. Apparently healthy trees can be found scattered throughout the center and at the center's edge. Some of the sites had relatively small centers, others were relatively large.

Armillaria root rot was the principal disease found at all of the sites. Eighty six percent of the dead or dying balsam fir in the non-plot sites had Armillaria root rot as compared to plot sites where an average of 62.2% of the dead or dying trees had Armillaria root rot. Two species of Armillaria root rot pathogens were found in the survey, *A. sinapina* Berube & Desserault and *A. ostoyae* (Romag.) Herink. *Armillaria sinapina* was the only species of *Armillaria* found in the sites at Slave Lake. *Armillaria ostoyae* and *A. sinapina* were both found at the site in Sir Winston Churchill Park and in one case they were both found on the same tree. Mallett (1990) has found three species of *Armillaria* (*A. ostoyae, A. sinapina*, and *A. calvescens* Berube & Desserault) in the prairie provinces on a wide variety of host species. *Armillaria ostoyae* is the most common species attacking conifers; however, *A. sinapina* has been found to be pathogenic to white spruce and balsam fir.

Although Armillaria root rot was commonly associated with the dead balsam fir examined in this survey it is uncertain whether it is primarily responsible for the mortality or whether there are other contributing factors such as drought. Tree cores examined did not show any evidence of increment growth loss in the past several years. Whitney (1989) found that balsam fir in Ontario had more root rot damage than black spruce or white spruce. He estimated that 16% of dominant and co-dominant balsam fir are killed or are prematurely windthrown because of root disease. Furthermore, he has shown that 87% of the living dominant and co-dominant balsam fir had some advanced root rot and that mortality and windthrow increased with age. At ages 71-80 years an average of 13% of the trees were dead and at ages 101-110 years an average of 26% were dead. In the current balsam fir mortality survey there was far greater mortality than that found by Whitney (1989). This could be due to climatic factors (eg. drought) which may have hastened death in trees that have Armillaria root rot. The alternate hypothesis would be that the *Armillaria* species are infecting and killing trees weakened by environmental factors. We reject this hypothesis because if this were the case we would expect the other tree species to show similar mortality rates as they too are hosts and should have been affected by the adverse environmental conditions.

Conclusions

1) A survey of 163 dead or dying balsam fir trees showed that Armillaria root rot was the principal pest associated with balsam fir mortality. Two species of *Armillaria* were found in dead and dying trees, *A. sinapina* and *A. ostoyae.*
2) In study plots at 5 different locations, balsam fir, 60-100 years-old, has a high mortality incidence compared to the other tree species at these sites. The rate of mortality is currently under investigation.
3) It is unknown whether other factors such as inadequate precipitation have an affect on balsam fir mortality.

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THE STRAWBERRY ROOT WEEVIL, *OTIORHYNCHUS OVATUS* (L.) AND OTHER IMPORTANT ROOT WEEVILS

by
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Root weevils are serious pests of nursery seedlings and young plantation trees. There are a number of species, the most prevalent being the strawberry root weevil (SRW), *Otiorhynchus ovatus*, but other notable species include: the black vine weevil (BVW), *O. sulcatus* (F.), the snout weevil, *O. raucus* (F.), and *Barypeithes pellucidus* (Boh.). Warner and Negley (1976) provide keys to identify adults within the genus *Otiorhynchus*. The SRW and BVW are thought to have been introduced from Europe.

Adults feed on twigs and needles at night and move to the soil litter layer or other sheltered places during the day. Adults cannot fly and disperse by walking. Only females occur, there are no males. Larvae feed on fine roots or the bark of larger roots, inhibiting the host plant's ability to uptake water and nutrients. Root feeding often leads to mortality of the host plant. Because of its root feeding and nocturnal behaviour, SRW is often difficult to detect until substantial damage has occurred to the host plant.

In the Northwest Region and adjacent areas (British Columbia and northwestern Ontario), reports of SRW and BVW were made in tree nurseries between 1940 to 1970 at Indian Head, Saskatchewan; in 1966 at Oliver, Alberta; in 1977 at Victoria, British Columbia; in 1978 at Thunder Bay, Ontario; in 1980 at Big River, Saskatchewan; and from 1990 to 1992 near Smoky Lake, Alberta. In all cases, SRW and, in some cases, BVW were found causing damage or mortality to seedlings within the nurseries. In a nursery plantation in southern Ontario, the larval stages of SRW caused 50-60% mortality of conifer stock. In other plantations within this same nursery, *O. raucus* and *B. pellucidus* caused severe reduction in stock quality.

The following is an overview of the SRW's biology based on several studies including the author's work (Brandt 1992).

Biology of SRW

The adult is dark brown to black in colour and about 6.25 mm in length by 3.00 mm in width. The thorax is deeply pitted, with the elytra fused and marked with fine parallel lines. The eggs of SRW are 0.25 mm in width, spherical, milky white when freshly laid, and change to a pale brown as they age. Newly hatched larvae are 0.5 mm long and off-white in colour. Fully grown larvae are up to 10.0 mm long by 3.0 mm wide, C-shaped, and covered by minute hairs. The head is pale brown. Larvae of root weevils are difficult to distinguish from one another and from other grubs commonly found in the soil. Pupae are off-white and their size approximates that of the adult. The pupae appear quite similar to adults having wing pads, legs, and antennae. When disturbed in the soil, pupae will move by twisting their caudal segments.

In British Columbia, adult SRWs emerge from the soil between late May and early June following pupation (Downes 1922). In the prairie provinces, adults emerge in mid to late June. The lifespan of adults is highly variable. Most adults live between 40 and 60 days but some may live as long as four months. A small percentage of adults may survive a moderate winter and lay eggs in early spring (Gambrell 1938). My studies in Ontario indicated that adults lived between 60 and 80 days, but a small proportion (less than 1%) survive the winter and lay eggs in the spring. Adult longevity in the prairie provinces may be slightly shorter than that of Ontario but some adults should survive the winter.

Before adults begin ovipositing, they feed for a period of time. My studies of SRW in Ontario indicate that the preoviposition period is 31 days. Oviposition begins about mid-July in British Columbia and Ontario, and, for the majority of weevils, lasts until the beginning of September. Oviposition in the prairie provinces probably begins in late July or early August. Females lay, on average, about 62 eggs. Egg hatch occurs about 14 days after oviposition. Viability of eggs laid by SRW is between 70-80% for adults feeding on conifer nursery stock.

The majority of SRW larvae can be found in the soil from August to May but a small percentage may be found in the soil at any time. Larvae are predominantly found in the soil at depths from 10 to 30 cm. There are five larval instars; the first three are completed in the fall and the last two occur in the spring. Fully grown larvae pupate in May. The pupation period lasts 20-22 days.

Management

Any management strategy is dependent on detecting weevils before damage is severe. Adults can be detected in June and July using pieces of burlap placed under seedlings. This technique takes advantage of the adults habit of seeking sheltered places during the day. Bait stations or pit-fall traps can also be used to detect adults. Detecting immature stages is difficult due to their size but can be accomplished by sifting and washing soil collected from beneath the host.

Weevil control can be aimed at either the adult (to prevent oviposition) or larval stage. Traditionally, control strategies have been aimed primarily at the larval stage. During the period 1950 to 1975, soil insecticides were used very effectively to control the adult and larval stages of SRW. Concern over the detrimental effects of these pesticides, government restrictions, and evidence indicating the development of insecticide resistance led researchers to test alternatives for management.

Presently, the only alternative to chemical insecticides is entomophagous nematodes. Effective control of SRW and BVW has been achieved using Heterorhabditid and Steinernematid nematodes on potted plants or plants in the greenhouse and recently field applications of nematodes have been successful as well (Rutherford *et al.* 1987, Dorschener *et al.* 1989).

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1993 PREDICTIONS OF MAJOR FOREST PESTS IN THE NORTHWEST REGION

by
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In the December issue of Forest Insect and Disease Notes a review was given on the status of major forest pests in the Northwest Region. The following discusses defoliation predictions for the 1993 season.

Spruce budworm

Table 1 shows spruce budworm defoliation history in the three prairie provinces and the Northwest Territories from 1987 to 1992. Area of defoliation has increased almost every year since 1987. To predict defoliation in the coming year, egg-mass or second instar larval (L_2) surveys must be undertaken. In Alberta, L_2 surveys were completed by the Alberta Forest Protection Branch, Alberta Forest Service, in the Footner, Lac La Biche, Athabasca, and Grande Prairie Forests. Results based on these surveys indicate that moderate to severe defoliation is expected on 11 000 ha in the Footner Forest, 1000 ha in the Lac La Biche Forest, and 2000 ha in the Athabasca Forest. The spruce budworm population has collapsed in the Grande Prairie Forest.

In Saskatchewan, L_2 surveys were undertaken by the Saskatchewan Department of Natural Resources. In the Big River - Dore Lake area, L_2 surveys at 94 plots indicated at least moderate defoliation in the immediate vicinity of the plots. North and east of Prince Albert National Park, L_2 surveys at 23 plots indicated nil to light defoliation. Ten plots were surveyed near the town of Hudson Bay and of these, three plots southwest of Hudson Bay had larval densities indicating severe defoliation in the areas of the plots in 1993. The seven other plots had low larval densities.In Manitoba, egg-mass surveys were carried out by Manitoba Natural Resources and by Forestry Canada. Results indicate that defoliation will be generally lower throughout the province of Manitoba.

Table 1. Summary of spruce budworm defoliation in the Northwest Region, sketch-mapped from aerial and ground surveys in 1987 through to 1992

Location	Areas of defoliation (ha)					
	1987	1988	1989	1990	1991	1992
Alberta	9 480	61 050	85 850	109 150	141 000	142 650
Saskatchewan	31 600	31 600	34 650	18 780	15 600	87 000
Manitoba	15 540	30 821	58 016	18 985	30 500	26 256
Northwest Territories	11 200	14 350	98 600	113 625	130 000	90 000
Total	67 820	137 821	277 116	260 540	317 000	345 906

Forest Tent Caterpillar and Other Aspen Defoliators

In Alberta and Saskatchewan, no defoliation occurred in 1992 (Table 2) and only minor defoliation is expected in 1993. No egg-band surveys were carried out by either Alberta or Saskatchewan or Forestry Canada. In Manitoba, egg-band surveys were completed but counts were low and negligible defoliation is expected in 1993. Bruce spanworm and large aspen tortrix defoliation was low throughout the Northwest Region in 1992 and should remain low in 1993.

Jack Pine Budworm

The jack pine budworm population collapsed in the Northwest Region in 1988 and has remained low since then. Little or no defoliation is expected in 1993. Pheromone traps were placed at nine locations in Saskatchewan to trap moths during their flight season. The number of captured moths was insignificant and little or no defoliation is expected in Saskatchewan in 1993. Manitoba Natural Resources conducted egg-mass surveys at a number of locations in that province. No egg masses were collected so defoliation is expected to be minor in 1993.

Table 2. Summary of moderate-to-severe defoliation by forest tent caterpillar in the Northwest Region, sketch-mapped from aerial and ground surveys in 1987 through to 1992

Location	Areas of defoliation (ha)				
	1988	1989	1990	1991	1992
Alberta	2 766 000	1 179 800	609 272	129 200	-
Saskatchewan	932 040	790 740	260 922	-	-
Manitoba	52 836	325 045	15 178	58 082	51 153
Total	3 750 876	2 295 585	885 372	187 282	51 153

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