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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