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Observations of the Spruce Budmoth and the Spruce Bud Midge on Black Spruce in Newfoundland

Impact of Defoliation Caused by the Spruce Budworm on Volume Growth in Three Fir Stands

Evaluation of Wound Dressing on Red Alder

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Vegetative buds infested by the midge swell and develop into pink, rosette-shaped galls. These galls are frequently fed upon by budmoth larvae. In 1981, galls were present on 46% of 150 trees examined and there was an average of six galls per affected tree. Budmoth larvae inhabited 36% of 400 galls collected but almost no larvae were present on ungalled buds (Table 1). The 400 galled buds were individually reared and then dissected after adult midge emergence. Midge mortality occurred in 53% of the galls in which the budmoth was present (Table 2). Clearly, the budmoth prefers to feed on midge-galled buds rather than healthy buds and, when present, is a major cause of bud midge mortality.

Neither the budmoth nor the bud midge appears to be a major problem on black spruce in Newfoundland at present but the budmoth could cause cone-flower damage at higher populations than those sampled. — **Hugh O. Schooley, Newfoundland Forest Research Centre, St. John's, Nfld.**

Impact of Defoliation Caused by the Spruce Budworm on Volume Growth in Three Fir Stands

Sustained defoliation over a few years by the spruce budworm, *Choristoneura fumiferana* (Clem.), results in reduced growth in diameter and volume in the attacked stands. Although these reductions may be appreciable, there are little data on the extent of losses according to different degrees of defoliation (Maclean, Mitt. Forst. Bundes-Oversuchsanst. Wein. 142: 293–306, 1981). This report gives an account of a study done in 1982 to assess growth loss of balsam fir, *Abies balsamea* (L.) Mill., in three fir stands that suffered different degrees of defoliation.

Sample plots were chosen in three stands in the Laurentides Reserve (50 km north of Quebec City) to assess the mortality caused by the budworm (Blais, Can. Dep. Environ., Laurentian Forest Res. Cent. Inf. Rep. LAU-X-43, 1979). This part of Quebec has been experiencing a budworm infestation since 1972. Stands A, B, and C, consisting mainly of balsam fir (Table 1), sustained severe defoliation for 2, 3, and 4 years respectively and then only very light defoliation from 1979 to 1981 (Table 2).

In stands A, B, and C respectively, 27, 25, and 25 balsam firs (dbh > 4 cm) were chosen at random according to a distribution proportional to ND^2 (N = number of stems per hectare by dbh class, D = dbh class) obtained by doing a complete inventory of each fir stand over an area of 0.25 ha. The current annual increment in volume for each tree was assessed for the 15 years previous to the outbreak of the infestation (1958–1973) and for the 8 years of infestation taken into account in this study (1974–1981). The volumes of the stems used to calculate the annual increments were established by taking disks 1 m apart along each selected stem. The volume of a tree for one particular year is the total of the volumes of each of these disks as calculated from the average measurement (accurate to 0.1 mm) of two radii (the longest and the shortest) taken from the corresponding disks. A linear equation of the form $y_1 = ax_1 + b$ was used to express the relationship between the current annual increment of the stem before the infestation and its age. The mean correlation coefficient of these 77 equations was 0.85. Theoretical growth (without infestation) between 1974 and 1981 was assessed by extrapolating this equation and the growth loss was obtained by subtracting observed growth from theoretical growth. Since the data thus gathered are valid only on an individual stem basis, the mean growth loss by dbh class was calculated and then applied to the stand table for each fir stand, thus making possible an estimate of loss for all firs in the stand.

TABLE 1
Forest mensuration characteristics of the three fir stands

Characteristic	Stand A	Stand B	Stand C
Age class	50	50	50
Marketable volume (m^3/ha)	134.1	102.5	98.4
Distribution of volume (%)			
Balsam fir	84.4	77.0	86.0
White spruce	13.6	1.5	8.8
Black spruce	0.0	20.1	0.4
Hardwoods	2.0	1.4	4.8
Stems/ha (4 cm+)	8336	8680	3800
Stems/ha (10 cm+)	2393	1800	2056
Mean dbh (4 cm+)	8.5	7.5	10.2
Mean dbh (10 cm+)	13.1	13.1	12.5

TABLE 2
Losses in annual growth (in percentage) in the three fir stands between 1974 and 1981

	Stand A		Stand B		Stand C	
Year	Defoliation*	Loss	Defoliation	Loss	Defoliation	Loss
74	L	−0.1	L	−17.0	L	−5.0
75	M	−6.3	M	−10.8	S	−8.9
76	S	2.4	S	7.7	S	−1.9
77	S	21.5	S	40.8	S	23.6
78	M	36.1	S	60.6	S	53.8
79	L	53.6	L	69.5	L	69.2
80	L	31.5	L	37.1	L	65.5
81	L	35.1	L	29.7	L	53.4

*Annual defoliation. L = Light (0–25%); M = Moderate (26–75%); S = Severe (76–100%).

An analysis of six control stems of balsam fir aged 76–94 years taken from Montmorency Forest, Laurentides Reserve, near the three fir stands being studied showed that, for this region, the maximum current annual increment in volume for this species did not seem to take place before the trees were 70 years old. Therefore, the probability of overestimating the theoretical increment and consequently the losses was greatly reduced since most of the 77 stems studied were less than 60 years old. In addition, the study of these six control stems showed that there is a very close linear relationship ($0.95 < R < 0.98$) between the age of the tree and its mean periodic increment (period of 2 years) for the period between 20 years of age and its age at its peak of mean periodic increment. This observation, therefore, justifies the use of the mathematical model applied in predicting theoretical growth.

Since this methodology was used only for firs that survived the infestation, it does not take into account the loss of growth resulting from stems that died during the epidemic. Although only the balsam fir was considered, the loss of growth (in percentage) that was assessed is only slightly less than total losses in the stands since this species represents approximately 90% of the trees most susceptible to the budworm, the other being white spruce, *Picea glauca* (Moench) Voss. (Table 1). It is also worth noting that, in 1981, mortality caused by the budworm was very low with only 1.7%, 12.7%, and 12.8% of the volume of stems larger than 10 cm in stands A, B, and C respectively being affected (Blais, Can. Dep. Environ, Laurentian Forest Res. Cent., pers. comm, 1983).

The loss of growth in stems according to their storey class indicates that the suppressed class was affected more (47.2%) than the other three storey classes (intermediate, codominant, and dominant) whose losses were 24.3%, 30.2%, and 29.9% respectively. In the case of the growth loss in terms of dbh classes, stems of 4 and 6 cm dbh were affected the most (39.9% and 38.8%).

TABLE 3
Losses in cumulative growth in the three fir stands

	1974–1981		Total losses*		1977–1981		Total losses**	
Stand	m^3/ha	%	m^3/ha	%	m^3/ha	%	m^3/ha	%
A†	17.9	23.1	19.9	19.8	18.3	35.7	20.3	27.4
B	15.8	28.8	15.8	25.2	17.0	47.2	17.0	38.7
C	15.7	33.5	17.9	29.4	16.6	53.6	18.7	41.8

*Losses in growth between 1974 and the year when the effects of the infestation will probably end.
**Losses in growth between 1977 and the year when the effects of the infestation will probably end.
†Stands A, B, and C suffered 2, 3, and 4 years of severe defoliation respectively.

These stems were generally in the suppressed storey class. The losses observed in firs with a dbh greater than 6 cm varied greatly, averaging 26%. These observations refer to all 77 stems but the tendency was the same for the three stands considered separately.

At the end of 1981, the three stands had not yet recovered their pre-epidemic rate of growth (Figs. 1, 2, and 3), although they had suffered only very light defoliation during the previous 3 years. An analysis of these figures gives the impression that if defoliation does not recur they wil need approximately 2 years to

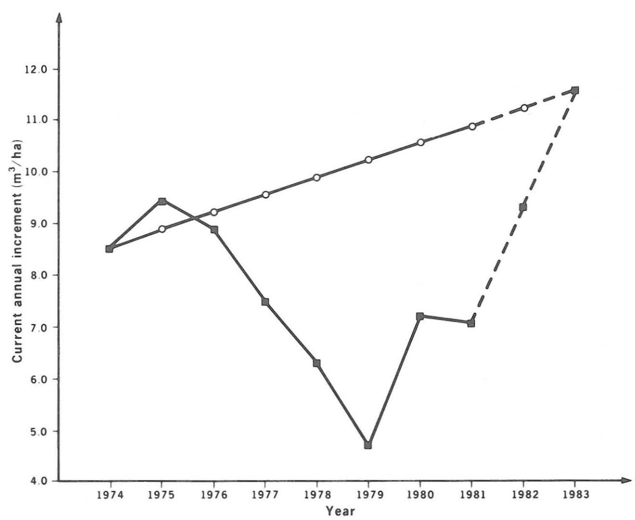

Figure 1. Real and theoretical current annual increment (CAI) during the epidemic period for Stand A: ■, real CAI; ○, theoretical CAI; – – –, projection of growth.

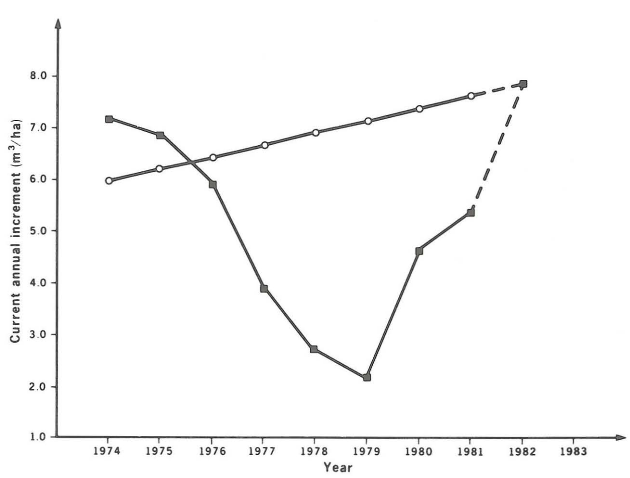

Figure 2. Real and theoretical current annual increment (CAI) during the epidemic period for Stand B: ■, real CAI; ○, theoretical CAI; – – –, projection of growth.

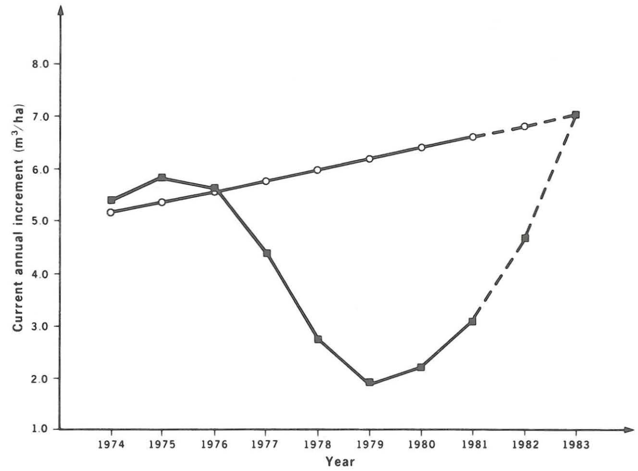

Figure 3. Real and theoretical current annual increment (CAI) during the epidemic period for Stand C: ■, real CAI; ○, theoretical CAI; – – –, projection of growth.

recover their original rate of growth. Therefore, if the years when growth was only slightly decreased are excluded, the increment will have been reduced for approximately 6 years.

A delay of 1 or 2 years was observed between the 1st year of severe defoliation and the appearance of the loss of growth in volume. Maximum decreases in annual growth were 53.6%, 69.5%, and 69.2% for stands A, B, and C respectively (Table 2). Table 3 summarizes the loss of growth in the three stands between 1974 and 1981 as well as for the period during which growth was effectively decreased (1977–1981). Using Figures 1, 2, and 3, growth was projected up to the probable end of the epidemic. Thus, the total loss of growth resulting from the defoliation was assessed for the periods beginning in 1974 and 1977 (Table 3).

These observations clearly show the decrease in growth that stands defoliated by the spruce budworm may suffer. Therefore, it is undeniable that defoliation is one of the factors that works to reduce significantly the potential productivity of forest ecosystems susceptible to this insect. — **L. Archambault, Laurentian Forest Research Centre, Ste. Foy, Que.**

NURSERY PRACTICES

Evaluation of Wound Dressing on Red Alder

Tree wound dressings are applied to prevent decay; however, they can be ineffective (Shigo, Int. Shade Tree Conf. Proc. 47:97–98, 1971) or even enhance decay resulting from moderate-sized wounds (Shigo and Wilson, J. Arboric. 3:81–87, 1977). Wound dressings containing fungitoxic chemicals are best for preventing decay (Dooley, Plant Dis. 64:465–468, 1980).

TABLE 1
Condition of wounded red alder 2 years after wound treatment

Treatment	Decay (% trees)	Mean stain column (cm)	Mean wound face callused (%)
Paint only	50	7.5 b*	54 a*
Ethanol and paint	53	8.8 b	44 b
$ZnCl_2$ and paint	17	7.2 b	54 a
Control (No treatment)	100	19.1 a	47 a

*Numbers followed by the same letter in the same column do not differ significantly ($p = 0.05$) as determined by Student-Newman-Keuls multiple range test. (Zar, Biostatistical analysis. Prentice-Hall, Inc. Englewood Cliffs, N.J., 1974).

The objective of the present experiment was to test the effect of a commercial wound paint on small wounds on red alder, *Alnus rubra* Bong., a species very prone to decay. In the fall, one wound per tree was made at breast height on 100 young trees 5–10 cm dbh by cutting around a 3 × 6 cm elliptical template. Of the 100 trees, 25 received wound paint alone, 25 had the paint applied after the wound surfaces were sterilized with 95% ethanol, 25 received applications of a mixture of paint and 10% zinc chloride, and the remaining 25 were untreated and acted as controls.

The area of callused face and the length of stain and decay columns were determined after 24 months (Table 1). Wound paint apparently did not promote healing as reported for similar dressings (Young and Tilford, Ohio Agric. Stn. Res. Bull. 22:83–87, 1937). In contrast to information provided by Shigo and Wilson (1975), wound paint reduced the incidence of decay and the amount of stain. Surface sterilization with ethanol did not reduce stain and decay compared with wound paint application without sterilization but it did inhibit callusing of the wound. The paint-zinc chloride treatment did not significantly affect callusing or length of the stain column but it reduced the incidence of decay more than the paint alone did.

As a result of weathering, about 15% of the painted face had exposed wood after 24 months. Annual or semi-annual applications of paint to keep wounds well covered might seal infection courts and prevent extensive decay. Results described here indicate that wound paint application may reduce stain and decay and may be especially useful on small wounds. Surface sterilization before paint application is unnecessary and it may be detrimental, at least with red alder. — **R. S. Hunt, Pacific Forest Research Centre, Victoria, B.C.**