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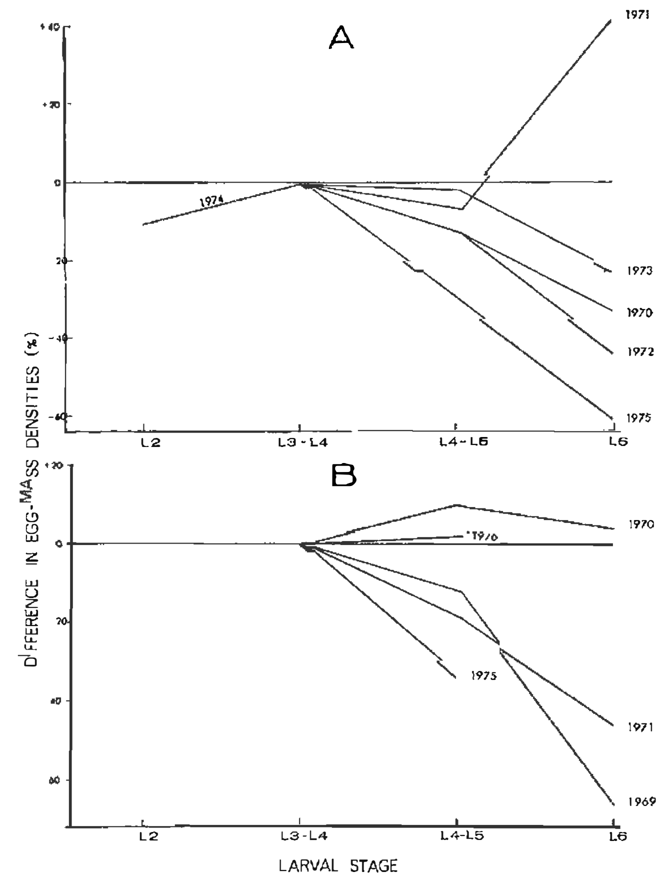

Figure 1. Differences (%) between egg-mass densities in areas sprayed at different times during the larval stage and densities in areas sprayed at L3-4. (A) Areas sprayed once. (B) Areas sprayed twice.

A Relationship between the Timing of Budworm Larval Spraying and Subsequent Egg-mass Densities.—In an operational spray program against spruce budworm larvae, *Choristoneura fumiferana* (Clem.), the objective dictates the preferred time to spray. It is generally conceded that early-larval spraying maximizes foliage protection while late-larval spraying maximizes larval mortality. Webb (For. Chron. 31:342-352, 1955) noted about a 50% population reduction when third-instar larvae (L3) were sprayed compared with a rate of kill of about 90% when older larvae were sprayed at a later date.

An analysis of egg-mass densities recorded in sprayed areas of New Brunswick in recent years suggests that there might be an added bonus to late-larval spraying. Each year in August, egg masses are counted on about 1,000 plots in the province to predict budworm populations in the following year. We used these data to measure, on a broad geographical scale, the effect that larval sprays had on the egg deposition of surviving female moths. (It was recognized that the eggs found in many plots would be laid by both resident and invading females, but it was also assumed that the impact of invasion would decrease as the size of the sprayed area increased.) The egg-mass counts were classified according to the number of sprays applied and the larval development at the time of spray application. Larval development was estimated by transposing the actual spray date to accumulated heat units, by means of the appropriate heat-unit curve for the year, and then transposing the accumulated heat units to larval development, by means of the known

TABLE I

Mean egg-mass densities in areas sprayed during different stages of larval development

	1969	1970		1971		1972	1973	1974	1975		1976
Number of applications	One Two	One	Two	One	Two	One	One	One	One	Two	Two
Hectares sprayed (millions)	1.0	0.8	0.8	1.7	0.6	1.7	1.5	1.5	0.5	1.7	3.1
Larval development at time of treatment[a]	Mean egg-mass density/10 m²										
L2								563			
L3-L4	447	570	558	420	631	241	373	629	447	292	87
L4-L5	395	496	613	391	509	210	366			194	89
L6	154	377	567	598	341	140	288		175		

[a]In two application areas timing refers to first application.

relationship between these two variables (Miller et al., Bi-mon. Res. Notes, 27:33-34, 1971). Some adjustments were made for late phenological areas. Thus, each egg-sampling point was classified according to: no spray; one, two, or three applications of spray; and larval development at the time of each application. Egg-mass densities for areas with similar spray histories were combined to give a mean density.

Table 1 shows the total number of hectares sprayed once and twice each year in New Brunswick from 1969 to 1976 and the mean egg-mass densities stratified by larval development at the time of treatment. These data were used to calculate the difference (%) between egg-mass densities in areas sprayed at different times during larval development and densities in areas sprayed at the L3-L4 stages. In general, fewer egg masses were found in late-spray areas (Fig. 1, A and B), doubtless because late sprays leave fewer surviving females to lay eggs.

This broad-brush analysis shows definite advantages for late-larval spraying except for one pitfall. As pointed out by Webb (1955), if spraying is too late in the larval period the amount of foliage saved by the treatment approaches zero. In other words, where foliage protection is critical late-larval spraying should be avoided. However, as a control strategy where foliage protection is not highly critical (early in an outbreak or during the collapse of an outbreak) the later a larval spray the more effective it will be as a population suppression technique when applied over relatively large areas.—C.A. Miller and R.A. Fisher, Maritimes Forest Research Centre, Fredericton, N.B.

Abnormal Wood Formation in the Tops of Aphid-damaged Balsam Fir.—Severe damage by balsam woolly aphid (*Adelges piceae* Ratz.) frequently kills the tops of young balsam fir trees in Newfoundland. Schooley (For. Chron. 52:143-144, 1976) outlined how subsequent recovery may allow such trees to produce new leaders and resume normal height growth. Remaining in these trees as evidence of

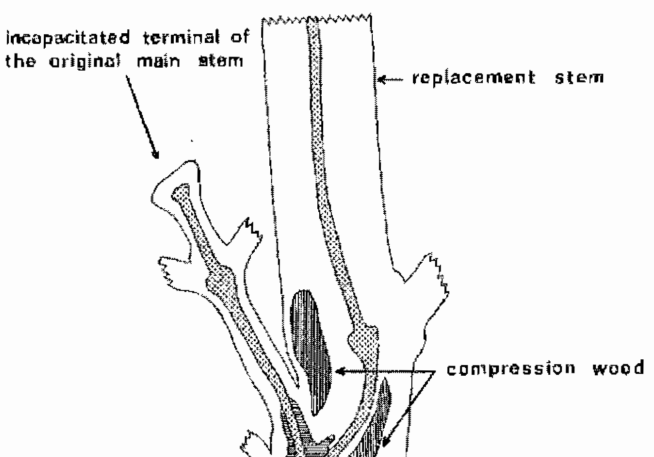

Figure 1. Midsectional view of a tree stem on which a whorl branch replaced the original leader. The locations of aphid-caused redwood and compression wood caused by branch reorientation are indicated.

aphid attack is abnormal xylem, called "redwood," that was formed as a result of aphid feeding (Balch, Can. Dep. Agric. Publ. 867, 1952). Compression wood is also formed during recovery when branches are reoriented to form new leaders. It is difficult to distinguish between these types of wood because both have the same appearance: they are highly lignified, reddish, hard, and brittle. This note describes how each type of abnormal wood can be distinguished from the other on the basis of its location in relation to the initiation of recovery growth.

The tops of ten 18-year-old trees, each with a lateral branch that had been reoriented to replace the leader killed by aphid attack, were bisected longitudinally. Average annual radial increments of the stem immediately below the point of origin of the replacement leader decreased from 2.0 to 1.0 to 0.7 mm during the 3 years prior to recovery. In the year of recovery and 3 years thereafter, increments were 0.9, 0.9, 1.1, and 1.2 mm. These data indicate growth recovery but do not show the unequal or eccentric radial growth that occurred on all trees as a result of leader replacement. This is illustrated in Fig. 1, which shows a longitudinal midsectional view of a typical aphid-damaged tree stem at the position where a whorl branch replaced the original leader and unequal growth occurred on the convex and concave sides of the slight crook formed during leader replacement. Immediately below the crook, radial growth was greater for several years on the side of the stem where the reoriented branch originated. Radial growth on the replacement stem above the crook was usually uniform.

The typical locations of redwood and compression wood are also shown in Fig. 1. Redwood was always concentrated at the nodes and produced in the wood formed before recovery of the tree from aphid attack. This was usually in the three or four annual rings adjacent to the pith. Compression wood was found in the annual rings formed after recovery. An elongated patch of compression wood developed along the stem beneath the crook formed by unturned branches. Also, a second patch usually developed in the concave side of the crooks, but this abnormal wood was initiated 1 or 2 years later than compression-wood formation beneath the crooks.

The information reported here will assist in planning studies to characterize the growth and development of young balsam fir trees that are periodically damaged by the balsam woolly aphid.—H.O. Schooley, Newfoundland Forest Research Centre, St. John's, Nfld.

Field Tests of NRDC 143 (Permethrin) against the Whitemarked Tussock Moth in Nova Scotia.—The experimental insecticide NRDC 143 25% EC (Permethrin) appears to be a highly effective control agent for the whitemarked tussock moth, *Orgyia leucostigma* (J.E. Smith), some geometrid species, and the balsam fir sawfly.

Tussock moth larvae are difficult to control with insecticides and, since the demise of DDT, no equally effective chemical has been found. This was argued by the United States Department of Agriculture in 1974 and, as a result, permission was granted to use DDT against the western species, the Douglas-fir tussock moth, *Orgyia pseudotsugata* (McD.) (Ellefson, J. For. 72:326-327, 1974).

The eastern species, the whitemarked tussock moth, is similar to the western species. It is about the same size and has a similar life cycle and feeding pattern. It has been a destructive pest of shade trees, balsam fir, and blueberries, particularly in Nova Scotia, and outbreaks covering a large portion of the province have occurred at intervals as short as 6 years. The principal damage in the forest has been to balsam fir, which can be killed in 1 year. After about 3 years, outbreaks usually collapse suddenly from a virus disease.

Over several years prior to 1976, the authors field-tested various insecticides and have failed to find any compound as effective as DDT. Of the compounds tested, Dylox appears to be the most effective chemical, but higher dosages are required to kill the tussock moth than to kill other insects, such as the spruce budworm, *Choristoneura fumiferana* (Clem.).

In July 1976 the insecticide NRDC 143 was evaluated in field tests on populations of the whitemarked tussock moth larvae feeding on balsam fir Christmas trees in northern Nova Scotia.

In the first set of trials, the dosages 18, 35, 52, and 70 ml active ingredient (a.i.) in 1 137 liters water/ha were applied with a hydraulic sprayer to runoff. Six trees were used per treatment. Once the effects of these treatments had become evident, a 9-ml treatment was applied 48 h