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CONTENTS OF VOLUME 35 (1979)

SILVICULTURE

Quantity of Viable Seed Retained in Old Black Spruce Cones.— During the past few years the Newfoundland Department of Forest Resources and Lands has had difficulty in obtaining black spruce (*Picea mariana* [Mill.] B.S.P.) seed for its silvicultural programs. Cone crops in Newfoundland have been eliminated or greatly reduced throughout most black spruce stands by the spruce budworm and the spruce coneworm, which destroy the developing male and female strobili. In the nearby Maritime Provinces and in the State of Maine, seed of the major reforestation species is also in short supply (Pulp Pap. Can. 80(1):7, 1979). The cones from which seed is to be extracted are usually harvested in the fall of the year they are produced, before any seed has been shed. As black spruce cones usually persist on the trees, the number of cones on semimature and mature trees may be large even if few cones have been produced in recent years. Haavisto (pages 250-264 *in* Symp. Proc. O-P-4, Great Lakes Forest Res. Cent., Can. For. Serv., 1975) showed that in Ontario cones can retain more than half their seed for at least 5 yr without loss of viability. This study was conducted to determine if similar conditions exist in Newfoundland and whether a satisfactory seed supply can be ensured during the present budworm infestation.

In February 1979 the tops were collected from 8-15 cone-bearing black spruce trees from 13 seed production or seed collection areas. These tops comprised the previous 15 yr growth, but no cones were present from the growing seasons of 1976-78. Samples of cones were collected randomly from the large clusters of cones present on these tree tops. The age of the cones (year the cone was formed) was determined and the numbers of cones per cluster were estimated. A sample of cones was obtained from each location and crop year and combined for all trees. Seed was extracted, cleaned, and counted. For each crop year and location, germination tests were done according to the methods outlined in International Rules for Seed Testing, 1966 (Proc. Int. Seed Test. Assoc. [Wageningen, Neth.] 31[1]:1-152). Approximately 200 seeds were germinated on moist filter paper under 10 h day length at 20°C for each location and crop year. No presowing stratification was done. After 28 days ungerminated seeds were cut and the number with healthy-appearing endosperm was determined. The percentage of seed that germinated (germination capacity), the percentage of seed that germinated plus the percentage with healthy endosperm at the end of the germination period (% sound seed), and the percentage of sound seed to germinate (real germination) were calculated. Definitions are from Seeds of Woody Plants of the United States (USDA Agric. Handb. 450). Since differences among locations were small, the data were combined over all locations and are presented by crop year only (Table 1).

TABLE 1

Data on cone collection and seed from black spruce

Year cones produced	No. of locations	No. of trees sampled	Average no. cones per tree	No. cones collected	Average no. seed per cone	% sound seed	Germination capacity	Real germination
1963	3	3	50	68	3.2	4.7	2.7	57.1
1964	4	9	113	239	2.5	23.7	15.8	66.7
1965	9	18	75	449	2.2	25.9	20.3	78.3
1966	5	5	84	122	2.2	27.6	25.1	91.1
1967	9	13	73	369	2.5	38.6	34.9	90.3
1968	7	12	87	340	2.7	44.7	42.9	96.0
1969	9	20	80	512	2.9	42.9	40.1	93.5
1970	13	31	88	775	3.7	53.2	51.2	96.3
1971	9	17	99	458	2.9	60.1	56.1	93.3
1972	8	19	69	480	3.2	58.2	55.3	95.0
1973	3	4	78	98	2.6	65.5	65.4	100.0
1974	7	9	47	239	3.4	40.3	38.4	95.4
1975	2	5	84	140	3.7	78.0	74.4	95.4

The average total number of seed per cone was low over the whole period and ranged from 2.2 to 3.7. This is about one-tenth or less of the number normally extracted from new cones (Hall, unpublished data from another study). The percentage of sound seed was quite variable, but it was generally higher for the younger cones. Germination capacity had a similar trend with lower percentage germination for older cones—25% or less for cones produced before 1966 and generally more than 50% for cones produced since 1970. The 1974 crop year appears to be unusually poor in terms of seed quality, both the percentage of sound seed and the germination capacity being much lower than the previous and following years. The ability of full seed to germinate was excellent and was consistently above 90% for seed up to 12 yr of age (1966) but declined rather abruptly for older seed. Although black spruce cones are quite serotinous (compared with those of most other conifers) some opening of the cones does occur and the seeds which are the first to fall are those from the middle of the cone, where the better-quality seeds are normally found.

These data clearly show that in Newfoundland it is not practical to expect to obtain the large quantities of high-quality black spruce seed required by tree nursery and silvicultural programs from the old cones present on the trees. However, the small quantities of sound seed present in these cones are of excellent quality and could be used if the need for seed was great enough to justify its collection.—H.O. Schooley and J. Peter Hall, Newfoundland Forest Research Centre, and W. Burry, Newfoundland Department of Forest Resources and Lands, St. John's, Nfld.

ENTOMOLOGY

Reduction in Progeny Production in the Spruce Weevil, *Pissodes strobi* Peck, by Two Insect Growth Regulators.—Continuing investigations in pest management for diversifying control strategies and providing alternatives in the insecticidal arsenal have, for some years, involved laboratory and field work with a variety of insect growth regulators (IGR). This communication reports the results of experiments aimed at reducing progeny production in *Pissodes strobi* by using two IGR's, namely, Dimilin and precocene. Dimilin, a chitin inhibitor (Post et al., Pestic., Biol. Physiol. 4:473-483, 1974), has been effective against a variety of insects including the boll weevil, *Anthonomus grandis* (Taft and Hopkins, J. Econ. Entomol. 68:551-554, 1975), while precocenes are recently discovered compounds that inhibit reproduction by suppressing juvenile hormone effects (Bowers, *in* L.I. Gilbert, ed., Juvenile hormones, Plenum Press, New York., 1976).

Our experiments were designed to determine the effectiveness of these IGR's for inhibiting progeny production when they are delivered to *P. strobi* adults. Adult *P. strobi* were collected from a field population on Vancouver Island during their oviposition period. Large 1-yr-old lateral branches of Sitka spruce, *Picea sitchensis* (Bong). Carr., were used as host material. Dimilin was applied by dipping the branches in 1% Savol® (Thomson Hayward Chemical Co.) and water emulsion containing 200 ppm (a.i.) of Dimilin. Branches for controls were dipped in 1% Savol and water emulsion. Precocene II (supplied by Dr. W.S. Bowers, Cornell University, Geneva, N.Y.) was applied topically to the abdominal venters of females at 40μg/insect. This dose was delivered in 1.0μL of acetone. Control beetles were treated with 1.0μL of acetone. Two pairs of *P. strobi* were caged on each of the Dimilin treated and control branches. Precocene-treated adults and untreated controls were similarly caged on untreated branches. Each treatment and control was represented by 10 replicates. The bases of the branches were held in water to minimize drying. Oviposition was allowed to proceed in this setup for 4 days at room temperature. Subsequently, the adults were transferred to untreated branches and allowed to continue oviposition for 4 additional days. The branches were maintained at room temperature for an additional 10 days and then held at 0°C until examined. The numbers of oviposition punctures, eggs, and larvae on each branch were recorded.

Mortality of adults occurred during the experiments (Table 1).

TABLE 1

Effects of precocene II and Dimilin on progeny production by *P. strobi*

Treatment	Ovi-position period (days)	No. of females	Ovi-position punctures/ female	Progeny/ female	% hatch
Precocene	0 - 4	20	3.50	6.75	73.7**
	4 - 8	16	2.95**	4.10**	88.1*
Precocene control	0 - 4	20	7.75	14.20	87.3
	4 - 8	19	9.35	17.65	98.1
Dimilin	0 - 4	20	5.20	10.10	26.2**
	4 - 8	17	5.50	12.85	81.6*
Dimilin control	0 - 4	20	6.80	10.55	96.5
	4 - 8	17	8.45	12.85	93.2

*P <0.05
**P <0.01

However, at least one living female was present in all replicates at the beginning of the second 4-day period. Consequently, data on oviposition punctures and progeny were converted to numbers per female alive at the beginning of each of the 4-day periods. Means values of oviposition punctures and progeny per female for treated and control insects were compared by t-test (Freese, page 24 *in* Elementary statistical methods for foresters, USDA Agric. Handb. 317, 1967) and the use of transformed ($\sqrt{X+1}$) data. Percent hatch was analyzed by differences in proportion (Dixon and Massey, page 195 *in* Introduction to statistical analyses, McGraw Hill Book Co. Inc., New York, 1951).

Precocene treatment reduced the number of oviposition punctures and progeny per female (Table 1), but the reduction in progeny per female was not significant during the first 4 days. The reduction that occurred in these parameters owing to treatment was generally smaller in magnitude during the first than during the second 4-day period. This phenomenon could be expected, since the females used were already ovipositing and at the time of treatment presumably contained developed eggs deposited during the first 4 days. The differences in percent hatch, while significant, were of low magnitude.

The Dimilin treatment had no significant effect on the numbers of oviposition punctures or progeny. Nevertheless, the percentage of viable larvae was significantly reduced, though the effect appeared to be transitory, being much less pronounced during the second 4-day period.

Although both Dimilin and precocene significantly reduced progeny production in *P. strobi*, neither of the two materials appeared effective enough for testing in field trials as a potential practical tool. However, the effects of these IGR's appear complementary, for precocene inhibits egg maturation and oviposition, whereas Dimilin inhibits successful larval eclosion from the deposited eggs. The IGR's also complement each other temporarily. Thus simultaneous application of both IGR's warrants further laboratory testing.—T.S. Sahota and L.H. McMullen, Pacific Forest Research Centre, Victoria, B.C.

Comparison of Spruce Budworm Overwintering Populations with Emerged Populations (Peak L_2) in the Lower St. Lawrence Region of Quebec, 1978.—A study was conducted in 1978 in cooperation with Quebec's Department of Lands and Forests to determine the best timing of consecutive applications of aminocarb against spruce budworm in two sectors (La Pocatière and Rimouski) in the Lower St. Lawrence region of the province (Blais, Auger, and DeBoo, in preparation). Three spray blocks were earmarked for various treatments in each sector. In each block, 12 sample plots were established for population studies, and additional plots were established in nearby untreated stands for a total of 97 plots (Table 1). Each sample plot consisted of three trees averaging between 15 and 30 cm at breast height. Seven collections were made in each plot throughout larval development to measure the effects of treatment. Only the first two collections will be discussed here.

TABLE 1

Average overwintering budworm populations, and average populations on completion of emergence (peak L_2), for 75 cm and 45 cm branch tips from sample plots, by sector and study area, in the Lower St. Lawrence region of Quebec, 1978 (ratios shown in parentheses)

Sector	Study area	No. of sample plots	Average population: Overwintering 45 cm branch	Overwintering 75 cm branch	Emerged (peak L_2) 45 cm branch	Emerged (peak L_2) 75 cm branch
La Pocatière	Untreated	9	19	37	36 (1.9)	98 (2.7)
	Block 101	12	8	22	31 (3.9)	—
	Block 108	12	10	27	71 (7.1)	—
	Block 109	12	6	18	36 (6.0)	—
	$\bar{X}$	45	10	25	42 (4.2)	
Rimouski	Untreated	16	3	8	11 (3.7)	15 (1.9)
	Block 220	12	5	15	19 (3.8)	—
	Block 221	12	4	11	29 (7.3)	—
	Block 203	12	6	13	15 (2.5)	—
	$\bar{X}$	52	5	12	17 (3.4)	—

A pole pruner equipped with a basket was used to collect one branch tip from the midcrown of each tree. Certain collections consisted of 75 cm branch tips, while others consisted of 45 cm tips (Table 1). Seventy-five centimeters approaches the full-length of a branch at midcrown for the size of trees sampled; a 45 cm tip is the standard length of branch used for evaluating budworm larval and pupal populations. The branches were brought to a field laboratory for examination.

The first collection was to obtain an estimate of overwintering populations on 75 cm and 45 cm branch tips and was made a few days before the beginning of emergence from hibernation. For this purpose the branches were treated with NaOH, according to Miller et al. (Marit. Forest Res. Cent. Inf. Rep. M-X-25, 1971). The 75 cm branches were cut in two sections: a 45 cm distal and a 30 cm proximal section. Each section was treated separately to obtain the overwintering larval population for 45 cm tips and the full 75 cm branch lengths. The second collection was made when emergence was completed and while the majority of larvae were still in the second instar. The branches were examined visually and all larvae counted. In this case, 75 cm branches were obtained from plots in the untreated areas only, and again data were obtained for the 45 cm tips as well as for the full 75 cm lengths. In the blocks earmarked for treatment only, 45 cm branch tips were collected. The time required to examine branches for recovery of small larvae is considerable, and the personnel available for this work did not permit the examination of 75 cm branch lengths for all sample plots.

Two hundred and ninety-one branches of each length were sampled for the first collection. For the second collection, the same number of 45 cm branch tips were sampled, while data were obtained from a total of 75 branch lengths measuring 75 cm.

Overwintering populations and populations on completion of emergence, as well as the ratio between the two populations for 75 cm and 45 cm branch tips from sample plots for the various study areas, are shown in Table 1. Overwintering populations for 75 cm branch lengths were about three times those obtained for 45 cm tips in six of the study areas and were approximately twice those obtained for 45 cm tips in the two remaining study areas (untreated La Pocatière, and block 203 Rimouski). Emerged populations (peak L_2) on both 75 and 45 cm branch tips were always greater than overwintering populations, but the difference between the two populations was not constant. The ratio varied between 1.9 and 7.3 for different study areas, indicating that feeding populations of small larvae cannot be predicted accurately by monitoring overwintering populations. Adjusted overwintering population levels were used to estimate pretreatment populations when insecticides were first applied at the time of larval emergence in Quebec between 1974 and 1978. It was realized that the technique lacked accuracy, but the magnitude of the variability between overwintering and emerged populations was not known.

It is probable that only part of the overwintering population on a given branch actually feeds on that branch after emergence. It has been known for some time that extensive larval dispersal occurs upon emergence from hibernacula (Blais, Can. J. Zool. 30:1-29, 1952). At this time, the small larvae drop at the end of silk threads and thus reach lower portions of the crown or nearby trees. When the threads are broken, the larvae may be carried by air currents for considerable distances. This phenomenon results in a redistribution of population. Furthermore, many larvae hibernate in lichens on the trunk or on the proximal ends of branches; upon emerging, the larvae are attracted to light and so to the periphery of the crown. The redistribution of larvae upon emergence explains the differences observed between overwintering populations and feeding second-instar larvae.

Measuring overwintering populations on branches or parts of branches may be very useful in obtaining an approximation of population levels expected the following spring, but it should be remembered not only that the actual populations at peak L_2-L_3 are underestimated but that there appears to be no consistency between the number of overwintering larvae and feeding larvae for given branch lengths.—J.R. Blais, Laurentian Forest Research Centre, Sainte-Foy, Que.

ERRATUM

Johnstone, W.D. 1976. Variable-density yield tables for natural stands of lodgepole pine in Alberta. Can. Dep. Fish. Environ., Can. For. Serv. For. Tech. Rep. 20. Ottawa.

The following correction should be made to the b_7 regression of equation $Y_{(15)}$ in Table 4:

b_7 — 0.978931×10^{-1} *instead of* 0.978931×10^{1}

The tabular values for total cubic foot volume per acre (Appendices III-7 and IV-7) are correct and do not require adjustment.

RECENT PUBLICATIONS— NOVEMBER-DECEMBER 1979

4 **Beaubien, Jean. 1979.** Forest type mapping from Landsat digital data. Photogramm. Eng. Remote Sensing 45:1135-1144.

7 **Bloomberg, W.J. 1979.** A model of damping-off and root rot of Douglas-fir seedlings caused by *Fusarium oxysporum*. Phytopathology 69:74-81.

3 **Bonga, J.M. 1978.** New methods to prepare squashes to study microsporogenesis in *Pinus resinosa* Ait. I. Formulas based on glycerin, water and dimethylsulfoxide. Silvae Genet. 27:233-237.

3 **Bonga, J.M. 1979.** New methods to prepare squashes to study microsporogenesis in *Pinus resinosa* Ait. II. The effects of boiling tissue pieces in various fluids. Silvae Genet. 28:5-9.

5 **Cayford, J.H. 1978.** Forest regeneration in Canada—at the crossroads. Pages 5-10 *in* Proc. Symposium on Root Form of Planted Trees, Victoria, B.C., 16-19 May.

7 **Eis, S. 1978.** Natural root forms of western conifers. Pages 23-27 *in* Proc. Symposium on Root Form of Planted Trees, Victoria, B.C., 16-19 May.

4 **Gagnon, J.D., and H.S.D. Swan. 1979.** Réaction à la fertilisation, à l'éclaircie et à la combinaison des deux dans un peuplement de sapin âgé de 10-20 ans. Nat. can. 106:341-343.

7 **Hunt, Richard S., and Ernst von Rudloff. 1979.** Chemosystematic studies in the genus *Abies*. IV. Introgression in *Abies lasiocarpa* and *Abies bifolia*. Taxon 28(4):297-306.

3 **Little, C.H. Anthony, Donald M. Andrew, Peter J. Silk, and George M. Strunz. 1979.** Identification of cytokinins zeatin and zeatin riboside in *Abies balsamea*. Pages 1219-1220 *in* NRCC 17360.

3 **Magasi, L.P. 1979.** The impact of scleroderris canker in New Brunswick in 1978. Pages 309-311 *in* 1978 SAF Proc.

9 **Percy, Jean, and John A. George. 1979.** Abdominal musculature in relation to sex pheromone gland eversion in females of three species of Lepidoptera. Can. Entomol. 111: 817-825.

4 **Popovich, S. 1979.** Etude du matériel sur pied relatif et ses implications sur l'aménagement des plantations. For. Chron. 55:95-101.

2 **Raske, A.G., and M. Alvo. 1979.** Sampling systems for the birch casebearer (Lepidoptera: Coleophoridae). Can. Entomol. 111:875-882.

9 **Retnakaran, Arthur. 1979.** Effect of a new moult inhibitor (EL-494) on the spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae). Can. Entomol. 111:847-850.

9 **Retnakaran, Arthur, Larry Smith, and Bill Tomkins. 1979.** Control of forest tent caterpillar, *Malacosoma disstria* (Lepidoptera: Lasiocampidae), with dimilin®. Can. Entomol. 111:841-846.

7 **Safranyik Les. 1978.** Effects of climate and weather on mountain pine beetle populations. Pages 77-84 *in* Symp. Proc. Theory and Practice of Mountain Pine Beetle Management in Lodgepole Pine Forests, Pullman, Wash., 25-27 April.

3 **Salonius, P.O., and M.K. Mahendrappa. 1979.** Respiration and nitrogen immobilization in forest soil treated with sulfur and urea. Soil Sci. 127:358-364.

4 **Smirnoff, W.A., Jeremy N. McNeil, and Pierre Lamothe. 1979.** Safety tests for the baculovirus of *Thymelicus lineola* (Lepidoptera: Hespiriidae). Can. Entomol. 111:459-464.

5 **Sutton, R.F. 1978.** Root system development in young outplants, particularly white spruce. Pages 172-185 *in* Proc. Symposium on Root Form of Planted Trees, Victoria B.C., 16-19 May.

5 **Sutton, Roy F. 1979.** Planting stock quality and grading. Forest Ecol. Manage. 2:123-132.

2 **Thompson, L.K., S.S. Sidhu and B.A. Roberts. 1979.** Fluoride accumulations in soil and vegetation in the vicinity of a phosphorus plant. Environ. Pollut. 18:221-234.

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3 **Timmer, V.R. 1979.** Effect of fertilization on nutrient concentrations of white spruce foliage and bark. Forest Sci. 25(1):115-119.

7 **Whitney, Harvey S., Les Safranyik, S. John Muraro, and E. David A. Dyer. 1978.** In defense of the concept of direct control of mountain pine beetle populations in lodgepole pine: some modern approaches. Pages 159-164 *in* Symp. Proc. Theory and Practice of Mountain Pine Beetle Management in Lodgepole Pine Forests, Pullman, Wash., 25-27 April.

9 **Wilson, G.G. 1979.** Reduced spore production of *Nosema fumiferanae* (Microsporida) in spruce budworm (*Choristoneura fumiferana*) reared at elevated temperature. Can. J. Zool. 57:1167-1168.

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