ENTOMOLOGY

Natural Control of Larch Sawfly at Carleton, Bonaventure County, P.Q.—Larch sawfly (*Pristiphora erichsonii* Hartig) populations in the Province of Quebec have declined in recent years and were generally quite low in 1966 and 1967. However, a locally moderate infestation was located by the Forest Insect and Disease Survey near Carleton, Bonaventure County, P.Q., in 1966. The forest stand in the collection area consisted mostly of dense 40 to 50-year-old tamarack on dry humus soil covered with dead branches. Of the cocoons collected on 12 June 1967, 200 were dissected. Because the ground was difficult to search, it took a well-trained technician 2 days to find these cocoons.

At the date of collection, a portion of the sawflies had reached the pupal stage and were ready to emerge (Table I). At this time parasitism was 14.5%; total mortality in eonymphs was 31.5%. The predominant parasite species was

TABLE I

Results of dissection of 200 apparently sound cocoons of the larch sawfly at Carleton

Class of individuals	Numbers of individuals affected	Percent of total
Dead eonymphs		
unparasitized[1]	5	2.5
empty cocoons, host remains not found[2]	9	4.5
attacked by fungi	20	10.0
containing dead parasites[1]		
encapsulated *M. tenthredinis* eggs[3]	3	1.5
M. tenthredinis larvae	1	0.5
containing living parasites		
M. tenthredinis pupae	21	10.5
B. harveyi larvae	4	2.0
Living eonymphs		
unparasitized	29	14.5
containing dead parasites		
encapsulated *M. tenthredinis* eggs[4]	54	27.0
containing living parasites		
M. tenthredinis larvae	3	1.5
Living pupae		
unparasitized	18	9.0
containing encapsulated *M. tenthredinis* eggs[5]	33	16.5

[1]Cause of death unknown, probably microorganisms involved.
[2]Death probably resulting from microsporidae.
[3]Two individuals containing 2, and one containing 6, encapsulated *M. tenthredinis* eggs.
[4]Twenty-two individuals containing one, 21 containing two, 7 containing 4, and one containing 5 encapsulations.
[5]Fifteen individuals containing one, 14 having 2 and 4 having 3 encapsulations

Mesoleius tenthredinis (Morley) accounting for 57.5% parasitism. There was, however, only 12.5% total effective parasitism by this parasite, since 78% of the hosts succeeded in encapsulating *M. tenthredinis* eggs. This phenomenon was described in detail by Muldrew (Can. J. Zool. 31: 313-332, 1953). Except for the egg stage, little is known about mortality in other age intervals of *M. tenthredinis*, but it may be low since this parasite continues to heavily attack the host. Activity by the tachinid *Bessa harveyi* (Tnsd.) resulted in 2% parasitism only. Since other workers have observed that at the end of a larch sawfly outbreak *B. harveyi* tends to be rare and *M. tenthredinis* more abundant, one might believe that the infestation at Carleton is on the decline. Microorganisms were also contributing to some sawfly mortality. Entomophagous fungi of the genus *Beauveria* (identified by Dr. W. Smirnoff, of this laboratory) were found on 10% of the insects in the cocoons. Microsporidae were present on 14 eonymphs, causing black spots on the integument, which indicated that hypodermal areas were infected by spores of *Thelohania pristiphorae* (Smirnoff) (J. Invertebrate Pathol. 8: 360-364).—F. W. Quednau, Forest Research Laboratory, Quebec, P.Q.

Temperature in Relation to Development Rates of Two Bark Beetles.—Rates of development in broods of the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopk.) and the spruce beetle (*Dendroctonus obesus* (Mann.)) at four constant temperatures were investigated in logs from their respective hosts, Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and white spruce (*Picea glauca* (Moench) Voss).

Infested and freshly felled uninfested logs were obtained from the central interior of British Columbia. The mature beetles from the infested logs emerged at room temperature (70-74 F). These adults were allowed to attack the fresh host material at a density of four to six pairs per square foot. The logs were maintained at 74 F for 11 days, then separated into different groups for treatment at temperatures of 43 F, 49 F, 57 F and 62 F. Samples, taken at this time, showed that all galleries contained eggs and that a few in the Douglas-fir logs had hatched. Subsequent samples were obtained 22, 42 and 63 days after the temperature treatments began. In addition, logs at 43 F were examined after 296 days and the spruce logs again at 406 days.

An index, representing the stage of brood development, was based on the numbers of each of seven stages (eggs, four larval instars, pupae and young adults) in the samples. On this index, 100% eggs is represented by 100 and 100% adults by 700.

Development rates at the different temperatures are shown in Fig. 1. The two species showed similar development patterns, but the Douglas-fir beetle, showed a greater response to the highest temperature while the spruce beetle appeared better adapted to the lowest temperature. Moreover, some spruce beetle larvae at 43 F were still alive and developing after 406 days, whereas there was no development of Douglas-fir beetle brood at this temperature. Therefore, the threshold temperature for development of the spruce beetle was close to 43 F, while that for the Douglas-fir beetle lay between 43 and 49 F. Data presented by Vité and Rudinsky (Forest Sci. 3:156-167, 1957) indicated that for the Douglas-fir beetle the developmental threshold temperature is below 52 F and possibly 48 F. At 49 F almost 1800 degree-days above 43 F were required for the same development as reached with only 1100 to 1200 degree-days at 62 F.

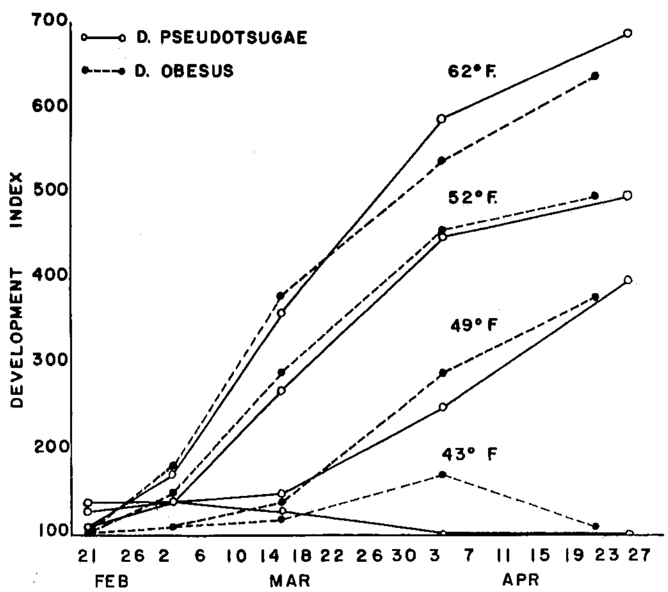

FIGURE 1. The rate of development for *Dendroctonus pseudotsugae* Hopk. and *Dendroctonus obesus* (Mann.) reared under four constant temperatures. The first samples were taken 11 days after gallery initiation.

These results indicate that the spruce beetle is better adapted to the lower temperatures than the Douglas-fir beetle. This is to be expected since the normal environmental conditions are cooler for the spruce beetle. Both species can survive and develop below 50 F, but require less degree-days at 62 F. Thus in nature a small increase in mean summer temperature might result in a relatively large increase in the number of beetles reaching maturity that season.—E. D. A. Dyer, J. P. Skovsgaard and L. H. McMullen, Forest Research Laboratory, Victoria, B.C.

FOREST MANAGEMENT

Tree Volume Estimates using an Upper Stem Diameter.—Tree section measurements from 923 red pine trees (*Pinus resinosa* Ait.) were used to evaluate the accuracy of tree volume estimation from regression equations which include an upper stem diameter measurement. The data included total cubic foot volume (V), calculated from the individual tree sections; stem diameter (outside bark) at breast height (D); total tree height (H) and outside bark diameters (d) at 30, 40, 50 and 60% of H (d_3, d_4, d_5, and d_6). The trees ranged between 0.5 and 138 ft^3 in volume, between 3 and 22 inches dbh, and between 22 and 102 ft in height.

Five step-wise multiple regressions were computed. The first four included D, H, d and 21 of their combinations as independent variables; the last one used only D, H and 15 of their combinations. To give a more equal weight to each tree, a weight of

$$\frac{1}{(D^2H)^2}$$

was used in the regression analyses.

Results of the five computations after selection of the first independent variable are shown in Table I.

TABLE I

Regression equations

Height of d	Equation	Standard Error
(% of H)		(% of V)
30	V=.04804+.002991 DHd	12.9
40	V=.05385+.003204 DHd	11.5
50	V=.06954+.003460 DHd	11.1
60	V=.09156+.003840 DHd	11.8
d excluded	V=.1499+.002483 D^2H	16.2

In each regression, the first variable selected accounted for more than 99% of the total variance. In each case, the next variable selected accounted for less than 0.2% of the total variance and did not reduce the standard errors appreciably. These variables were excluded from the equations.

In each of the first four equations, the first variable (DHd) selected (Table I) was the same. In the fifth equation, d being omitted from the analysis, the first variable selected was D^2H.

The standard errors in Table I indicate that the best height for the measurement of upper stem diameters is around 50% of the total tree height. Also, a comparison of the standard errors of the third and fifth equations shows the considerable reduction brought about by including an upper stem diameter.—G. M. Bonnor, Forest Management Institute, Ottawa, Ont.

Reliability of Standing Tree Volume Estimates Based on Upper Stem Measurements.—Volume estimates of standing trees in a forest are usually based on one or two measurements (either dbh alone, or diameter and height of the tree), and a tabular or graphical arrangement of average tree volumes. However, there are certain advantages in estimating individual tree volumes, e.g., in forest sampling where single trees are used as elementary sampling units (3P or sampling with probability proportional to prediction), in timber quality studies, etc. Recently, more and more emphasis has been placed on using dendrometers to estimate various parameters of interest (upper diameters, relative heights, volumes, etc.) on standing trees. Because of differences in tree form, more precise information can be obtained by this procedure than by the conventional volume table method.

There is a wide variety of dendrometers available today. Some, e.g., the Barr and Stroud, are rather sophisticated and relatively expensive. Others, e.g., the Spiegel Relascope, are simpler and cost less. The Barr and Stroud dendrometer permits indirect diameter measurements by rotating its prisms. The Spiegel Relascope only estimates diameters through its built-in, equal-width bands. Nonetheless, when the instrument is mounted on a tripod, these approximations can be very close to the values observed with more powerful dendrometers.

Total cubic foot volume estimates based on readings with the Barr and Stroud dendrometer and the Spiegel Relascope were compared with volume estimates computed from ground measurements of the trees after felling, for 29 white pines (*Pinus strobus* L.). These trees grew in average stand conditions; they ranged from 8 to 23 inches dbh, and from 54 to 95 feet in height.

Upper diameters and corresponding heights were measured on the standing trees with a Barr and Stroud dendrometer (model FP 12) and a Spiegel Relascope mounted on a tripod. For each tree, 4 to 8 readings were recorded to estimate section heights and diameters. The measurements were taken at convenient points (not necessarily the same ones for the two instruments) along the stem of each tree. Afterwards, the

TABLE I

Estimates of total volumes of individual trees, obtained with two instruments (standing trees) compared with those obtained from ground measurements (felled trees).

	Volume of the Entire Tree (ft^3)			
	Ground Measurements		Barr and Stroud, outside bark	Relascope, outside bark
	inside bark	outside bark		
	44.45	49.64	51.75	45.22
	23.57	24.83	26.19	26.24
	55.49	62.50	57.69	55.49
	50.71	57.95	57.78	51.19
	28.88	31.38	31.00	30.29
	42.16	46.68	48.46	44.18
	35.44	39.48	37.62	32.22
	55.04	62.22	65.07	56.89
	58.61	66.30	66.87	63.28
	76.31	83.96	82.32	88.23
	58.99	66.39	63.66	60.11
	25.40	29.13	28.14	28.00
	16.56	18.91	19.54	18.99
	63.89	71.28	71.33	64.46
	81.36	92.41	93.05	90.79
	22.03	25.38	27.44	23.42
	17.36	19.65	19.98	19.66
	18.68	21.09	21.10	20.19
	19.31	21.37	23.41	24.70
	26.71	28.92	28.04	26.67
	8.08	8.94	9.18	8.74
	18.40	20.10	20.35	19.52
	34.86	38.98	41.18	39.43
	54.71	63.27	63.88	62.76
	62.58	68.28	66.19	64.98
	34.55	37.51	38.17	31.94
	88.89	97.13	96.55	99.95
	31.40	34.67	34.46	33.47
	26.26	29.43	29.89	30.79
Mean	40.71	45.44	45.53	43.51
Standard Deviation	21.46	23.97	23.57	23.56
Standard error of mean	3.98	4.45	4.38	4.37