1970 Evaluations of a New Sampling Technique for Estimating Numerical Trends in Larval Populations of Insect Defoliators on Conifers

R. F. DeBoo and L. M. Campbell

Chemical Control Research Institute

Ottawa, Ontario

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by

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INTRODUCTION

A previous report on population sampling of the jack-pine[1] and spruce[2] budworms (DeBoo and Copeman, 1969) has indicated that several important aspects of estimating larval numbers can be significantly enhanced by the utilization of a simple branch-processing apparatus. The report indicated that the method provides (1) a high level of accuracy at (2) considerable savings in manpower, time, cost, and laboratory requirements. Briefly, the procedure involves the use of a closed chamber-funnel apparatus mounted in a pick-up truck for mobile sampling at field plot locations. Measured branches are beaten on a screen (1 x 1" wire mesh) over the funnel; larvae fall into a container at the bottom of the funnel after which the collection is identified, sorted and counted on an adjacent table. Thus, the major advantage is the greatly reduced volume of branch material for examination.

The study, initiated in Manitoba, was continued in New Brunswick during 1970 to:

(1) determine the efficacy of several fumigation and heat treatments to dislodge spruce budworm larvae from branch samples.

(2) compare population density curves based on standard Forest Insect and Disease Survey (F.I.D.S.) sampling techniques with curves for results from the experimental method.

(3) determine accuracy of recovery (%) for the experimental method for larval instars III to IV.

[1] Choristoneura pinus pinus Free.

[2] C. fumiferana (Clem.)

MATERIALS AND METHODS

In the previous report branch samples from jack pine (Pinus banksiana Lamb.) and spruce (Picea glauca (Moench) Voss, P. mariana (Mill.) BSP) were selected for population assessment. This year, sampling was restricted to balsam fir (Abies balsamea (L.) Mill.) where two 18" - branches were selected from mid-crown levels of infested trees. Sampling for evaluation of fumigation and heat treatments was conducted in a severely infested (i.e. >30 larvae/branch) stand at the Upper Blackville Picnic Site, 5 miles south of Blackville on Highway 8. Sampling for method comparison took place in two 2,500 acre mixed-forest blocks established for experimental aerial spray applications (Lannate Block 1 and Matacil Block 2, Can. Dept. of Fisheries & Forestry 1970).

Field headquarters were established at the Dunphy air strip at Upper Blackville, N.B. The project commenced on May 19 (2nd- and 3rd-instar budworm larvae) and terminated on June 17 (peak 5th-instar period, some 6th-instars).

All branches were selected randomly from the mid-crown region of firs 20-60 ft. tall. Data for (1) efficacy of fumigation and heat treatments were based on 277 samples collected at intervals from May 21 to June 16; (2) data for comparison of sampling methods at the experimental spray blocks was based on 232 samples for the experimental sampling method (on June 3, 5, 9, 10, 15), 376 samples for the standard F.I.D.S. method (May 28, 29, June 2, 9, 15, 16, 23, July 14), and 208 samples from 3 untreated check plots (June 4, 16, 25, July 7); (3) data for % recovery levels for III- to VI-instars was based on counts from 480 branches collected May 21 to June 16 at the picnic site and at the two spray blocks.

Techniques

A. Fumigation and heat treats. The efficiency of recovery of larvae was compared using 14 treatments (involving carbon dioxide, carbon monoxide, heat (39-44°C), pyrethrins (Flybane® aerosol bomb - 0.40% pyrethrins, 0.50% technical piperonyl butoxide, 0.50% N-Octyl bicloheptane Dicarboximide), vigor of branch beating, and duration of treatment) in various combinations (Fig 3). These treatments were based on field experiences and on suggestions received since the previous report. Treatments were

made for recovery of larvae during the peak occurrence of the 4th-instar, but all larval stadia were present to varying degrees during this time.

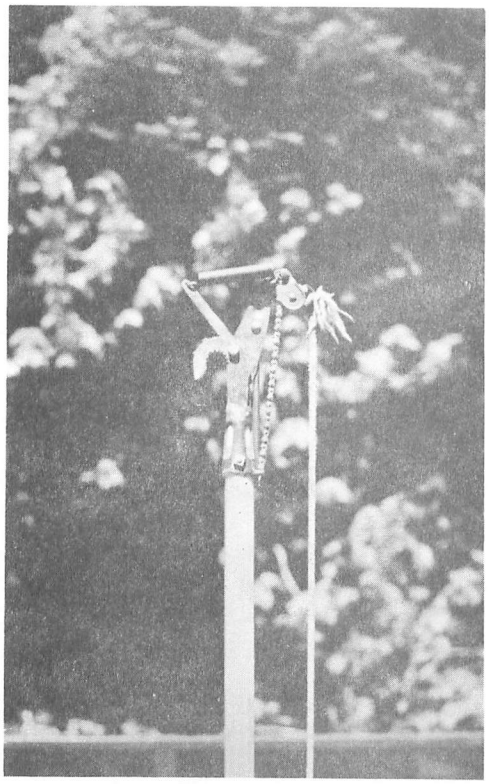
B. Comparison of sampling methods. Descriptions of the two sampling methods are given in Table I below, and are partially depicted in Figs 1 and 2.

Table I. Field sampling methods for estimating numbers of the spruce budworm.

N.B. F.I.D.S. METHOD	EXPERIMENTAL METHOD
1. Select 2 branches/tree by pole-pruner with clamp attachment.	1. Select 2 branches/tree by pole-pruner with basket attachment.
2. Release clamped branch and catch or drop to ground.	2. Disassemble pole and lower basket with branch to within reach of operator; count larvae in basket if any.
3. Clip each branch into 4-6 inch lengths at sample tree location or in vehicle.	3. Beat branches vigorously on wire screen of apparatus.
4. Locate and count larvae/branch.	4. Push out screen, brush down walls of upper chamber and funnel.
5. Discard branch samples, move to next station.	5. Remove container, dump collection on table.
	6. Sort and count larvae/2 branches.
	7. Discard branch samples, move to next station.

Curves were drawn based on data accumulated for each of the sampling methods and for the N.B. Forest Insect and Disease Survey's (F.I.D.S.) untreated check plots which were not sampled using the experimental apparatus (Figs 5, 6). The slopes of the curves for the experimental method are hypothetical after June 15 as the project was terminated shortly thereafter. The curve for the untreated areas was included for slope comparison with curves derived from sampling counts in each of the sprayed blocks.

C. Accuracy of the experimental sampling method. All branches processed by branch beating were checked by standard visual examinations. Larvae not



A

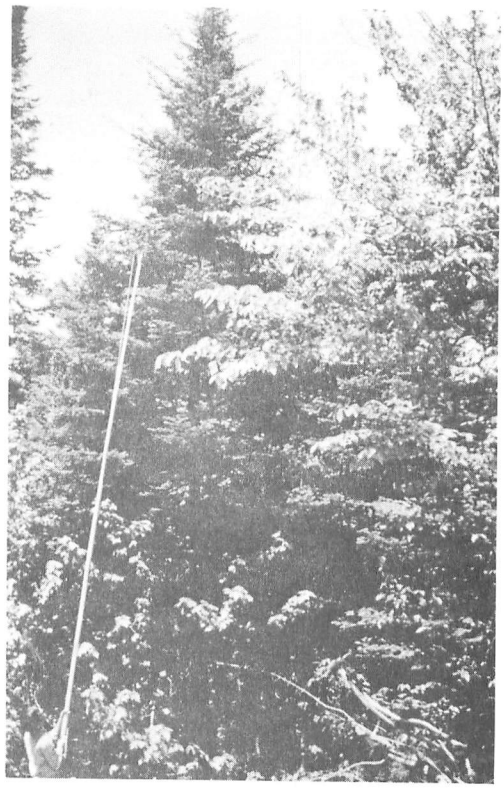


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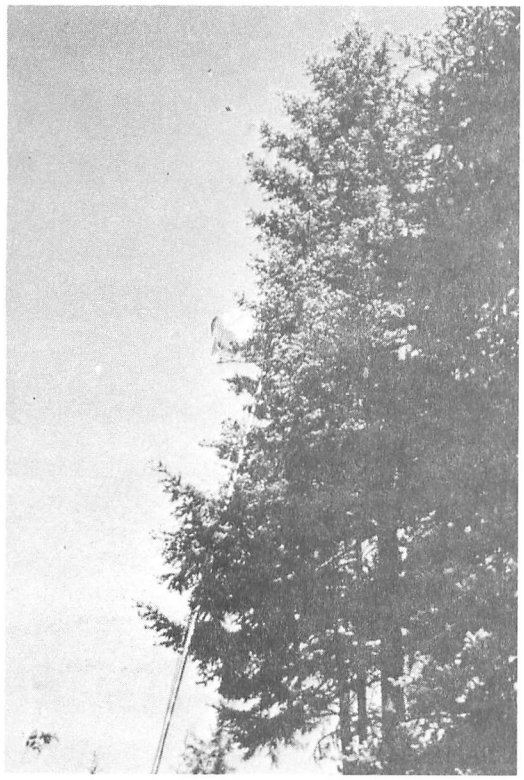
Figure 1. FIDS Method: A. pole pruner head with clamp attachment; B. selecting branch from mid-crown region of sample tree; C. pruner moved from tree, clamped sample then dropped; D. examining foliage and tallying no. of larvae at vehicle.



A

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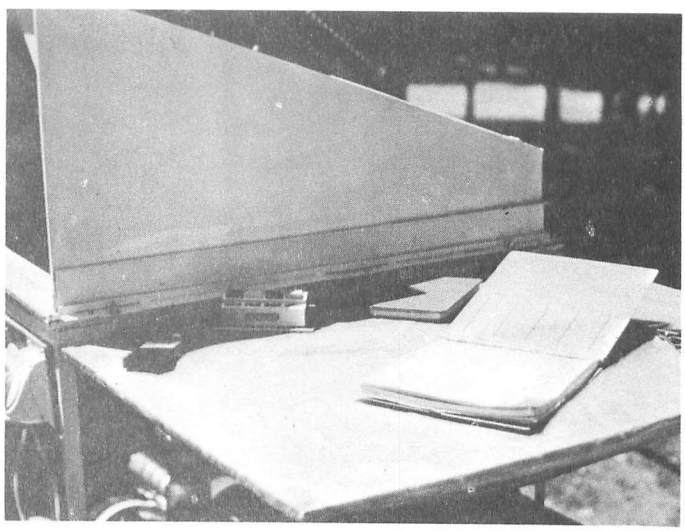


D

Figure 2. Experimental Method: A. selection of branch at mid-crown level; B. pruner disassembled and basket with branch is removed; C. sampling apparatus for processing branches in vehicle; D. table for sorting and counting.

recovered were counted for determination of error %

$$\left(\frac{\text{no. larvae missed}}{\text{no. larvae missed + no. larvae recovered}} \times 100\right)$$

at several intervals during the larval feeding period. The data were then compiled for comparison of error levels with the phenology of larval development.

RESULTS AND DISCUSSION

A. Fumigation and heat treatments. Generally, the most productive treatment of those evaluated was vigorous beating of the branches (Fig 3). Error (i.e. larvae not recovered) was due chiefly to those few larvae contained within only slightly elongated shoots and unopened buds, and to a few larvae being smashed during the beating operation. The use of carbon dioxide (as a relaxant) caused only very few larvae (< 5%) to drop from the branches while not many more were dislodged by treatments using either heat or pyrethrins (excitants).

The use of hot exhaust fumes (primarily carbon monoxide) directed over branches in the fume chamber caused about half of the larvae to drop off. However, the time required for this treatment (i.e. 10 min. or more) and the hazard while working with carbon monoxide, render its use in branch sampling mostly unacceptable. The treatment requires the use of a breathing-air life support system for the operator of the apparatus (Fig 4) which is an expensive addition in equipment.

Pyrethrins or exhaust fumes in combination with light to moderate branch beating did not differ significantly as treatments when compared with vigorous branch beating alone. The added time required (i.e. from 2 to 10 min.) reduced the efficiency of movement between sampling stations enough to outweigh the advantage of smaller amounts of debris accumulation in the container for subsequent sorting.

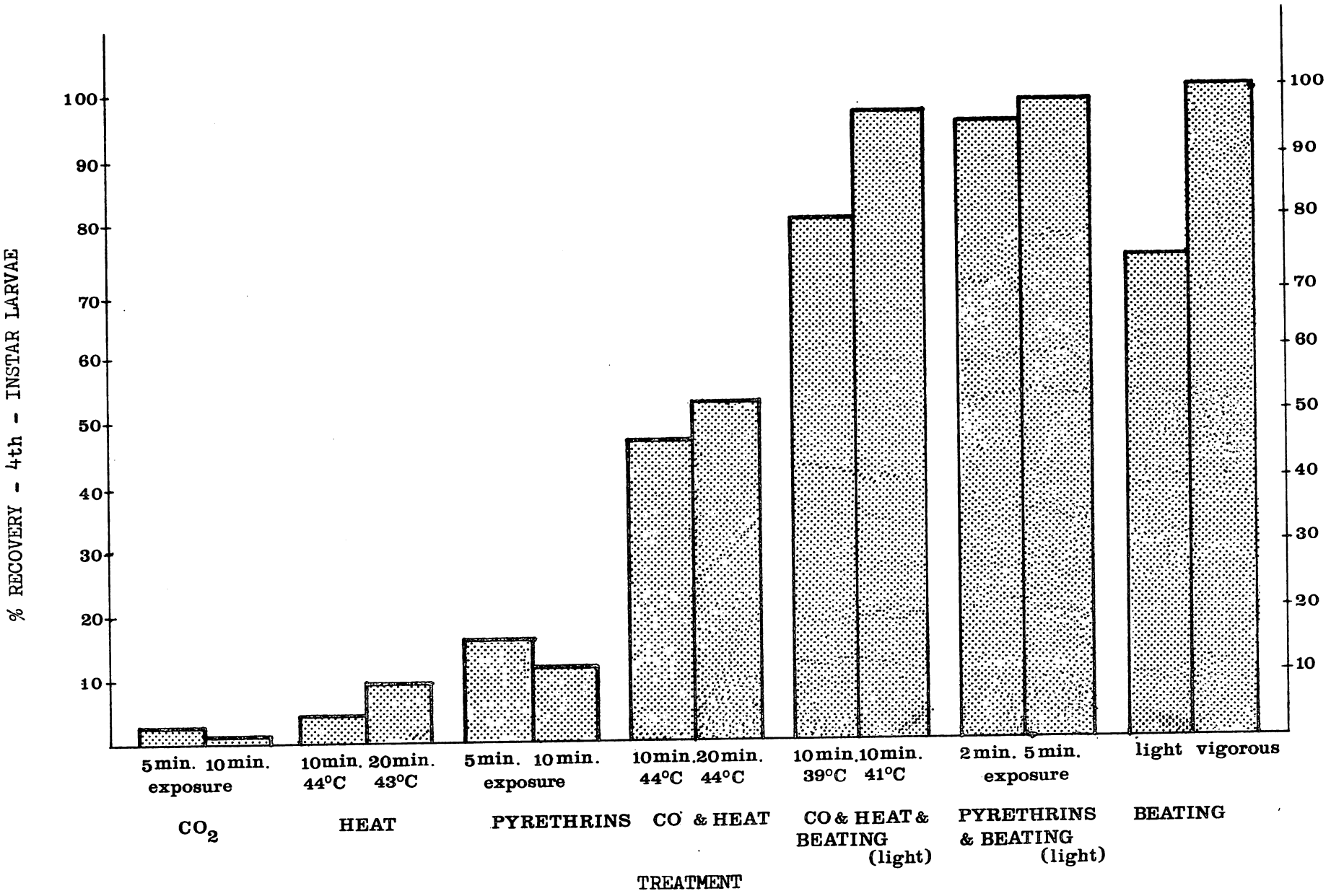
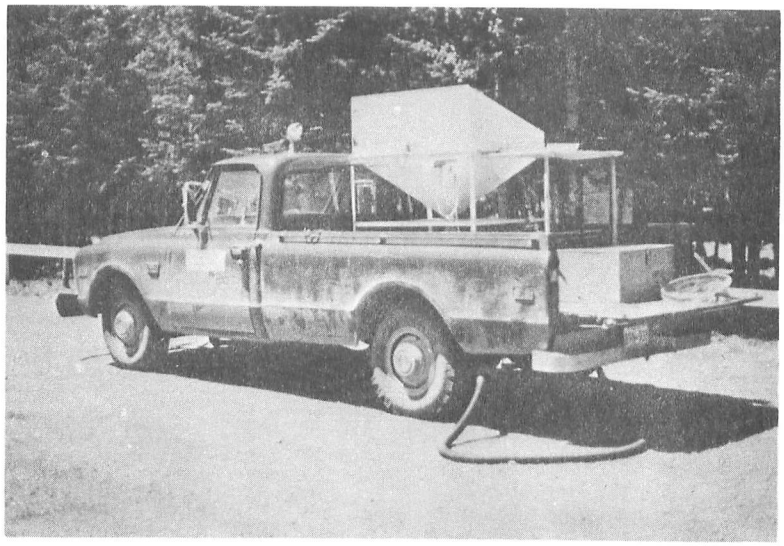


Fig. 3. Treatment Assessments for Efficacy in Dislodging SPRUCE BUDWORM Larvae from Balsam Fir Foliage (New Brunswick, 1970)



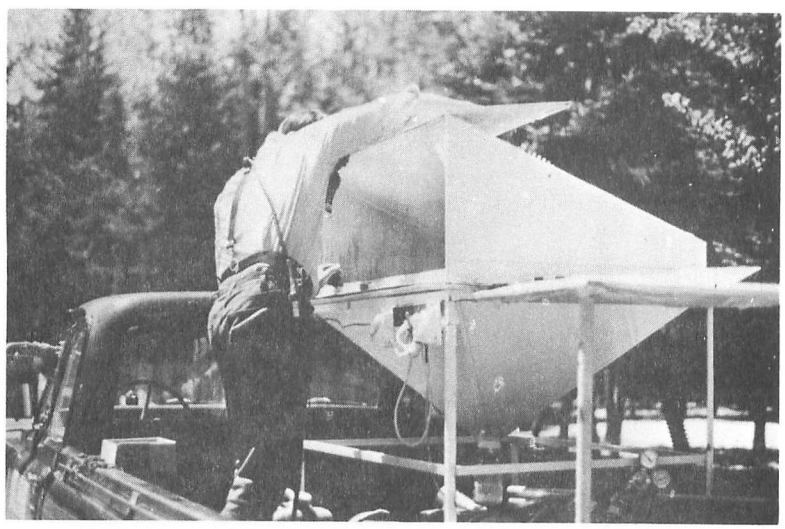


Figure 4. Fumigation of branch samples with hot exhaust fumes.

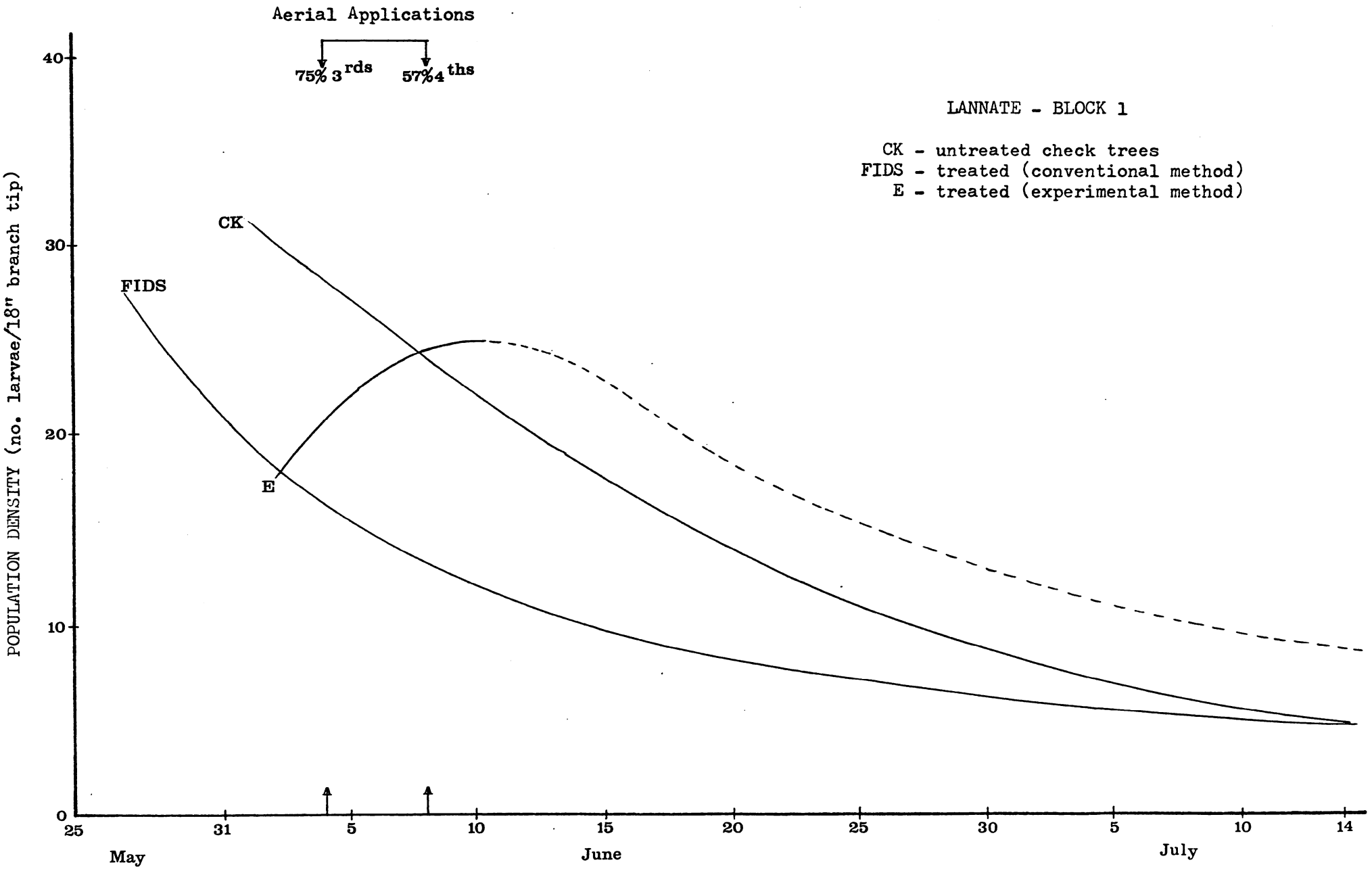


Fig. 5. SPRUCE BUDWORM Mortality, New Brunswick, 1970.
(Balsam fir)

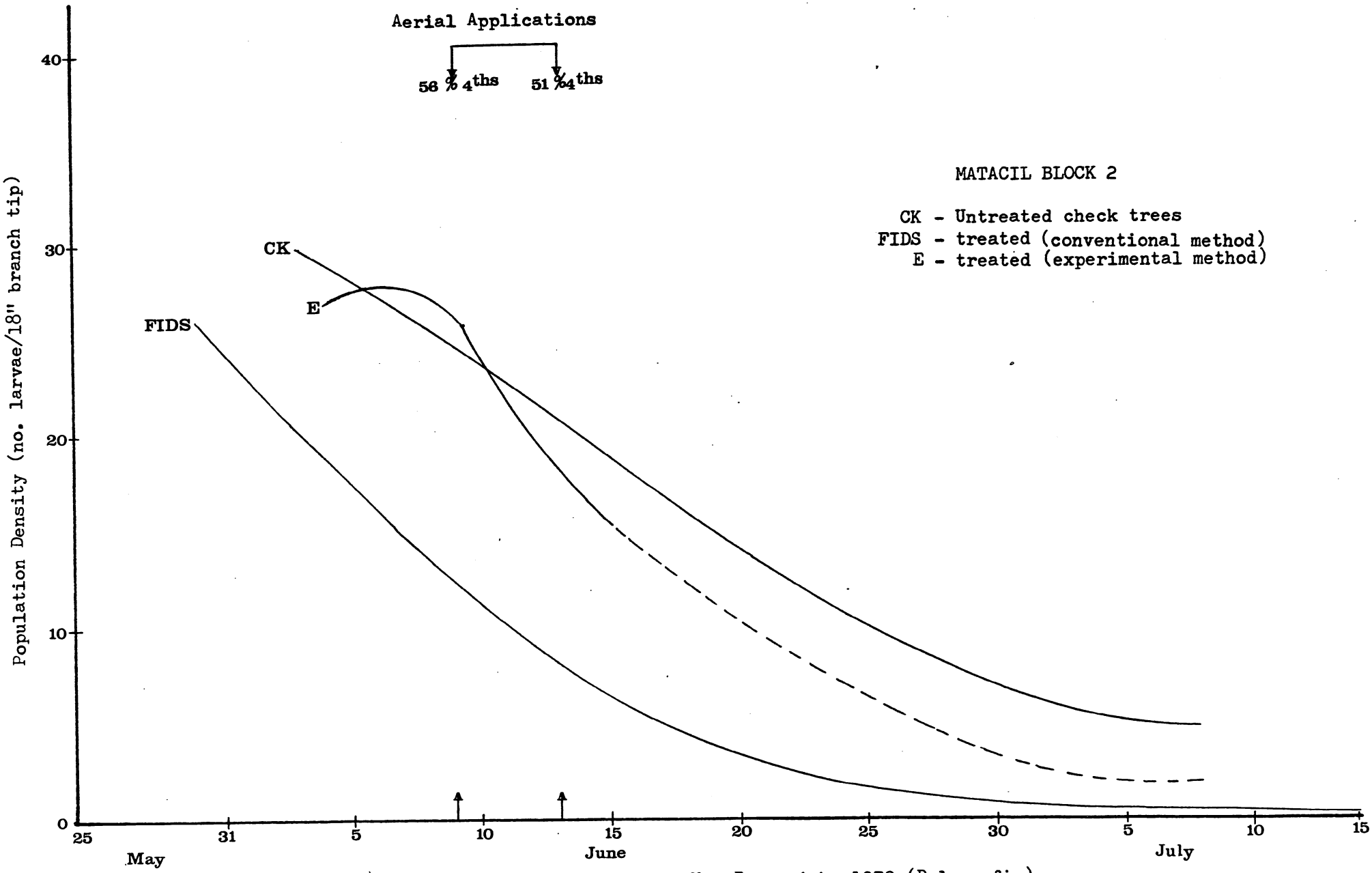


Fig. 6. SPRUCE BUDWORM Mortality, New Brunswick, 1970 (Balsam fir)

Table II. Spruce budworm population levels[1] on balsam fir in experimental spray blocks and in untreated check plots.

LANNATE - BLOCK 1			MATACIL - BLOCK 2			Untreated Check Plots	
DATE	FIDS	EXP	DATE	FIDS	EXP	DATE	(FIDS)
May 28, 29	25.3	--	June 2	21.8	--	June 4	29.2
June 3	--	19.2	June 5	--	27.6	June 16	15.8
June 9	16.6	--	June 9	--	26.2	June 25	12.4
June 10	--	25.9	June 15	6.6	15.2	July 7	4.8
June 16	9.2	--	June 23	2.3	--	--	--
July 14	4.8	--	July 14	0.4	--	--	--

[1] Ave. no. of live larvae/18" branch tip; averages in July are for pupae.

B. Comparison of sampling methods. Pre-spray counts, mostly based on 3rd-and 4th-instar larvae (Figs. 5 and 6, Table II), were similar for both sampling methods. The poor recovery of early-instar larvae by the experimental method was evident in the Lannate Block where more larvae were collected after the two aerial applications than before. The average number recovered on June 3 (19.2), was very close to the number at that date on the F.I.D.S. curve. A major divergence of curves, however, occurred after the 2nd aerial application where an average of 25.9 larvae were collected on June 10 by the experimental method while an average of 16.6 larvae were collected the previous day by the F.I.D.S. technique.

Similarly, greater recovery of larvae was achieved by the experimental method in the Matacil spray block. The difference is most evident on June 15 where only 6.6 larvae were recovered by the F.I.D.S. method whereas 15.2 larvae were collected using the experimental method.

Based only on the small amount of data taken for comparison, it appears that several obvious discrepancies between the sampling methods for arriving at indices of population abundance may be accounted for by:

(1) Pole-pruning bias in the selection of branch samples and the use of different sample trees.

(2) Poor recovery of 2nd-and early 3rd-instar larvae by the experimental method because of the feeding habits of the larvae (i.e. within needles and buds, or on tightly appressed foliage on elongating shoots).

(3) Poor recovery of instars IV to VI by the F.I.D.S. method because of the loss of larvae during the procurement of branch samples (i.e. a large proportion of the later-instar larvae will drop from branches when disturbed).

Theoretically, the use of a correction factor for the experimental method would provide an accurate index of population density for early-instar larvae since a known error may be calculated. It is not likely, however, that the method could be used for 2nd-instar larvae only (i.e. when the population is entirely mining needles). The loss of larvae due to the mechanics of taking samples by the F.I.D.S. method obviously could be prevented by the use of a basket attachment. Without the basket, an unknown and variable loss of larvae occurs as soon as they feed openly. Thus, a correction factor is incalculable and of no real use.

The comparison, as presented here, suggests that the apparent reliability of the F.I.D.S. methods decreases rapidly with larval development

to a position where possibly only half of the later-instar larvae are actually recovered. The method, therefore, provides unreliable data for computation of population mortality curves.

C. Accuracy of the experimental sampling method. Recovery of larvae on balsam fir branches was similar to previous experiences for spruce and jack pine. As larvae and branch shoots develop, accuracy of the method increases rapidly so that 90% or more of the larvae are retrieved by the time peak 4th-instar occurs (Fig. 7). Prior to the occurence of the 3rd-instar peak, however, accuracy of recovery may be 80% or less as very few of those individuals mining needles and buds can be removed from the branches.

SUMMARY AND RECOMMENDATIONS

The evaluations of the experimental sampling technique in New Brunswick during 1970 corroborated earlier studies in Manitoba. The studies have shown that the technique provides a high degree of accuracy in recovering larvae from branch samples by reducing human error in estimates of population density. Although time and cost factors were not assessed in New Brunswick, the previous study has shown that these factors also are greatly reduced when compared to conventional methods for obtaining indices of population density.

The method has application in several aspects of research in forest entomology where either quantitative or qualitative data is required. Two of the many areas where the method should enhance current sampling programs might be:

(1) where the number of sampling stations and/or the number of sample trees are limited because of manpower and time factors. The method could be used to permit either more intensive or extensive sampling by field crews in the time presently alloted.

(2) where error increases with larval development and accuracy is dependent entirely upon the ability of the field crew. The method standardizes error between crews and between sample plots and a correction factor may be used to adjust curves for populations of early-instar larvae.

Because many modifications of the experimental method are possible (e.g. Process branches in field but collect larvae in F.I.D.S. specimen tins for indoor sorting and counting when weather is adverse), it is recommended that it be used in an operational program to fully evaluate its potential in assessing population densities of coniferous defoliators.

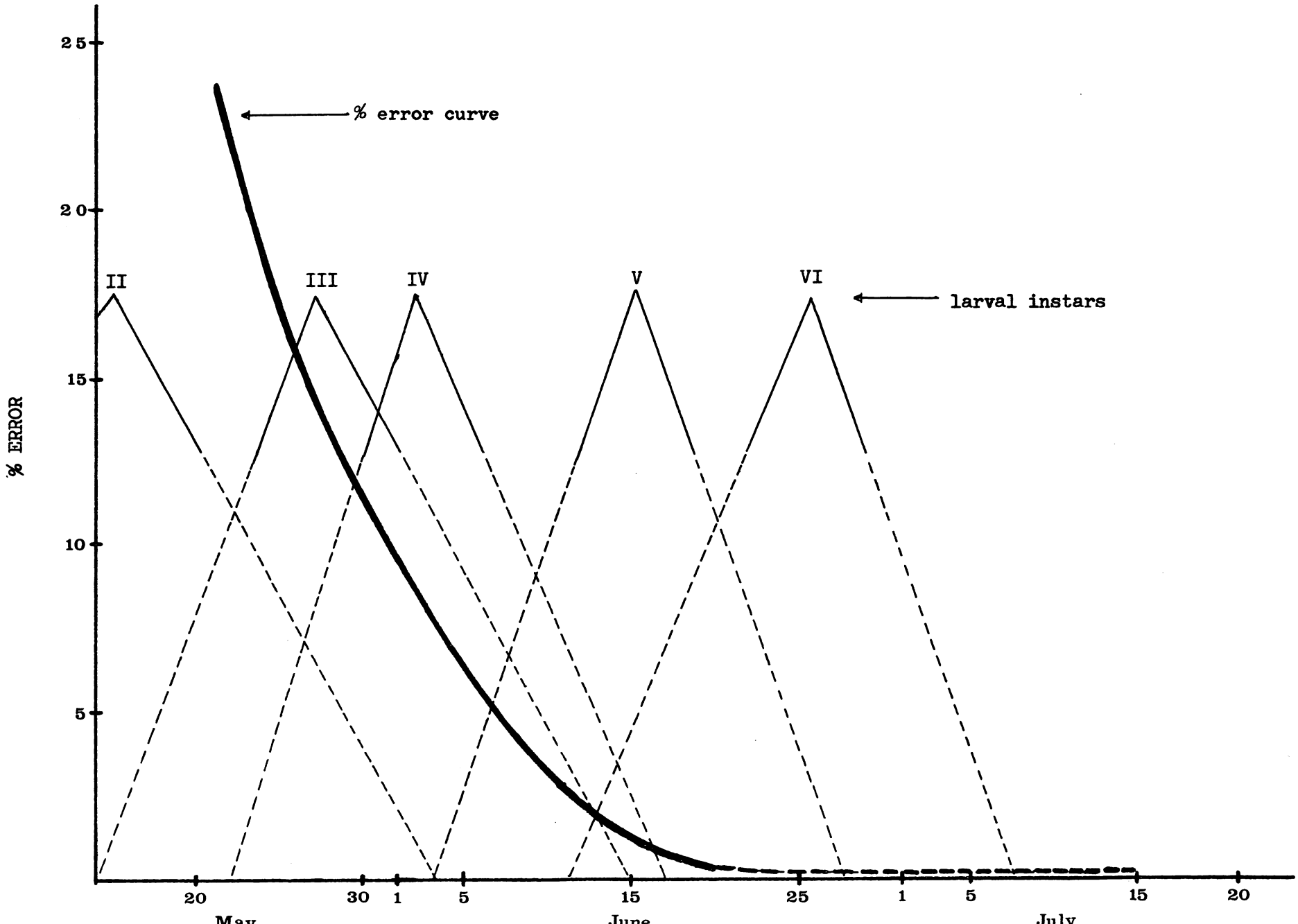


Fig. 7. Sampling Error for Experimental Sampling Method (Branch Beating Only) Compared with Larval Development of Balsam Fir at Dunphy, New Brunswick, 1970.

LITERATURE CITED

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