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BUDWORMS AND CONEWORMS:

Larval Population Densities and Consequences of Simultaneous Defoliation to Host Trees.

by: S.A.Nicholson and R.F.DeBoo

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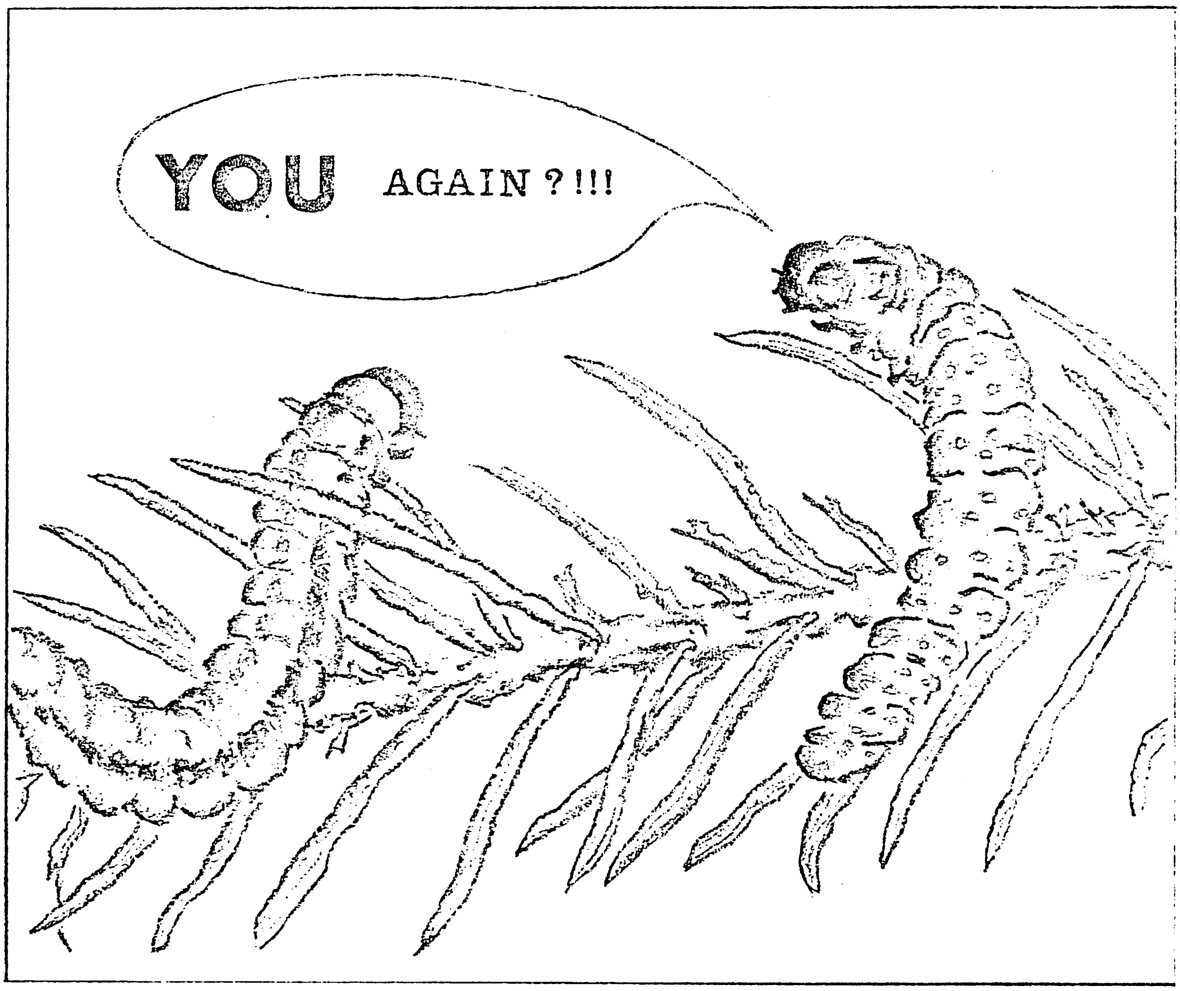
Chemical Control Research Institute, Ottawa, Ontario



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INTRODUCTION

During recent field research on control of the spruce budworm, Choristoneura fumiferana (Clem.), surprisingly high numbers of associated coniferous defoliators were observed after assessments of population density had been completed. These populations of associated species have raised several questions during both the field experimentation and subsequent data compilations and interpretations of results on spray treatment efficacy vs. the spruce budworm (DeBoo and Campbell 1975, Foisy et al 1975):

(1) What species of defoliators were present on host trees sampled for indices of budworm population densities, and what was known about the interactions of these species (either alone or combined) with the budworm as agents of tree depredation?

(2) What was the significance of damage caused by this ''secondary'' defoliator complex with respect to feeding impact usually attributed solely to the spruce budworm?

(3) How accurate were population density - defoliation correlations for the spruce budworm where no allowance was made for the impact of the associated defoliators?

(4) What was the relative susceptibility of these species (compared to spruce budworm) to insecticide treatments, and how can efficacy of treatment be assessed when the defoliator community is truly heterogenous?

As an attempt to answer these questions, at least in part, file data accumulated during the past three years were sorted for preliminary analysis. The data, as evaluated in this report, are presented solely to caution fellow members of the Spruce Budworm Working Committee of the inherent dangers of improper or only casual examination of larval specimens during field research on the eastern spruce budworm. In actual fact, the authors stress that data on host condition, gleaned from spray programs or other field studies where only minimal or no larval population sampling is undertaken (i.e. results based on egg and pupal densities, defoliation) may be quite difficult to properly interpret.

A handy guide to some of the species found on balsam fir (Miller and Bates 1959) indicates that about 12 major species compete ecologically for feeding niches with larvae of the spruce budworm. The authors estimate that a similar number compete on spruce hosts. The species which has been found most commonly during the recent field studies was *Dioryctria reniculelloides* (Mutuura and Monroe 1973), originally designated *D. reniculella* by Grote (1880), and commonly known as the spruce coneworm. As a first step, then, in sorting insect species, feeding impact, competition, and other aspects of defoliator interactions, this report is limited primarily to those numerical data on the spruce budworm - spruce coneworm larvae population samples acquired between 1973 and 1975. It is hoped that more sophisticated handling of routine field data will be possible during future studies to permit accurate interpretations of the interactions between insect defoliators and their host trees.

MATERIALS AND METHODS

Representative collections of larval specimens were submitted to the Biosystematics Research Institute, Agriculture Canada, Ottawa, for identification. Counts of larvae from branch samples during the period 1973 - 1975 at one location in Manitoba and at least 3 locations in Quebec were extracted from field tally forms used in chemical control studies of the spruce budworm. Separate tabulations were then available for *C. fumiferana* and *D. reniculelloides* according to year and geographic location.

RESULTS AND DISCUSSION

Identification of larvae other than spruce budworm indicated that the most prevalent species was *D. reniculelloides* (appendix 1). According to Dr. Eugene Monroe of the Biosystematics Research Institute (personal communication) D. reniculleloides is the proper scientific designation for the spruce coneworm; D. reniculella is a misnomer.

McLeod and Daviault (1963) have reported that the species is known primarily as a cone feeder and defoliator of most species of spruce. Annual reports of the Forest Insect and Disease Survey have recorded damaging infestations in seed crops for more than 50 years (MacKay 1943).

Although quite similar to the spruce budworm in larval development and feeding habits, the coneworm is noted for its distinctive behavioral characteristics. Unlike the spruce budworm, eggs of D. reniculelloides are inserted singly under bark and cone scales, in lichen growth, within the shoot axils, or in the frass-severed foliage-silk webbing tangles on infested branches. Larvae spend the first of five instars overwintering in hibernacula under bark scales. Later larval stadia may either feed in cones or feed on foliage, particularly during years of low cone production. Symptoms of feeding damage on foliage by D. reniculelloides may be distinguished from that of the spruce budworm by the greater accumulations of frass and webbing at the feeding sites (McLeod and Daviault, 1963). Also, larvae of D. reniculelloides are known to be predaceous on larvae and pupae of the spruce budworm (Warren 1954, Thomson 1957).

Analyses of data collected from Manitoba and Quebec indicated that slightly more than 20% of the total number of larval specimens (from white spruce) were D. reniculelloides (Fig. 1). Coneworm composition ranged from a high of 33% of the total defoliator complex on mature trees at the Spruce Woods Forest, Manitoba, in 1973 to a low of about 16% on 8 m tall plantation white spruce near Shawville, Quebec.

At average denities of from 20 defoliators per 45 cm branch tip at Shawville in 1974 to more than 100 defoliating larvae at the Spruce Woods in 1973 and at the Grand Mère Plantations during 1975, the role of D. reniculelloides and other associated defoliators must be considered during studies of the spruce budworm. On many branches examined during the course of these studies, D. reniculelloides comprised the majority of the defoliator community. Accordingly, estimates of defoliation (%) after pupation could easily have been attributed to the wrong species, and the so-called study on "spruce budworm" could very well be a scientific anomaly attributable to Murphy's third, fifth, and sixth Laws: "If there is any possibility of several things going wrong, the one that will go wrong is the one that will do the most damage; Mother Nature is a bitch; If everything seems to be going well you have obviously overlooked something."

The impact of coneworm populations was most evident in larval collections from insecticide-treated trees. When collections from sprayed forests (Fig. 2) were segregated from total collections (Fig. 1), the percentage composition for surviving D. reniculelloides increased from ca. 24% to ca. 43% while survivorship for the budworm decreased proportionately. The general implication is obvious: D. reniculelloides may (for reasons only speculative at present) better survive insecticide treatments than C. fumiferana, and for this reason the larger larvae (L_4, L_5) of the former species may cause most of the damage to infested trees. Likewise, the disparities between spruce budworm mortality and foliage protection reported by many researchers during recent years possibly may be partially due to the unaccounted-for complex of associated defoliatiors. The best examples of this to the authors' knowledge occurred after spray treatments in certain sectors of La Mauricie and Forillon National Parks (Foisy *et al.* 1975). Post-spray larval population assessments indicated that up to 100% of the surviving larvae were coneworms, not budworms. Although good mortality of spruce budworm was obtained, (>90%) defoliation in certain sectors of sprayed areas was as severe as in nearby untreated check areas. Considering the fact that insecticide treatments are rated not only by their immediate efficacy (insect mortality) but also by the amount of foliage conserved, these remnant populations of *D. reniculelloides* still actively feeding may become very significant with respect to correct treatement assessment. The surviving populations contribute to continuing defoliation, and if at high densities, may account for the major error in appraisal of spray results.

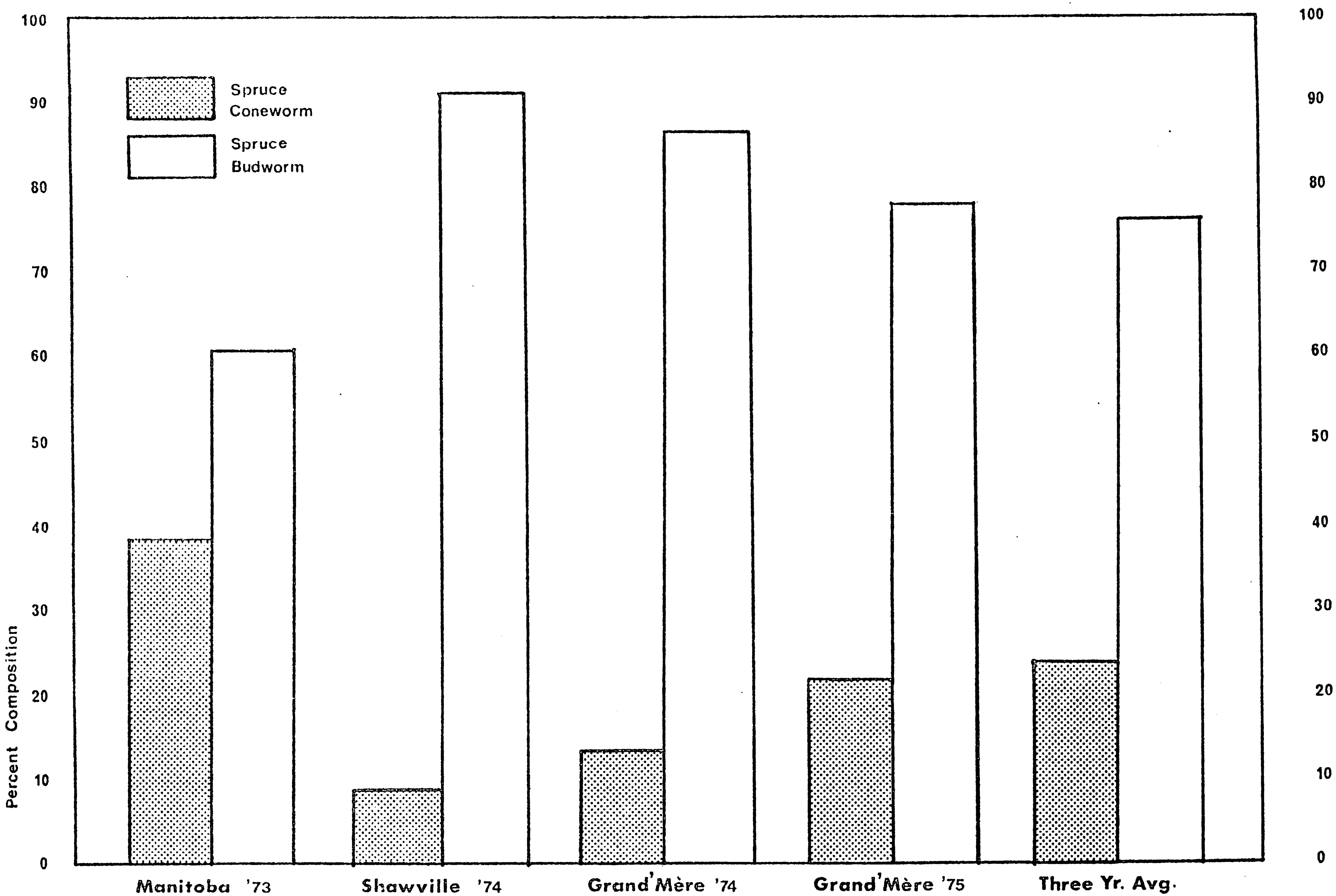

Figure 1. Percent composition of defoliator complex on white spruce at various locations, 1973 - 1975.

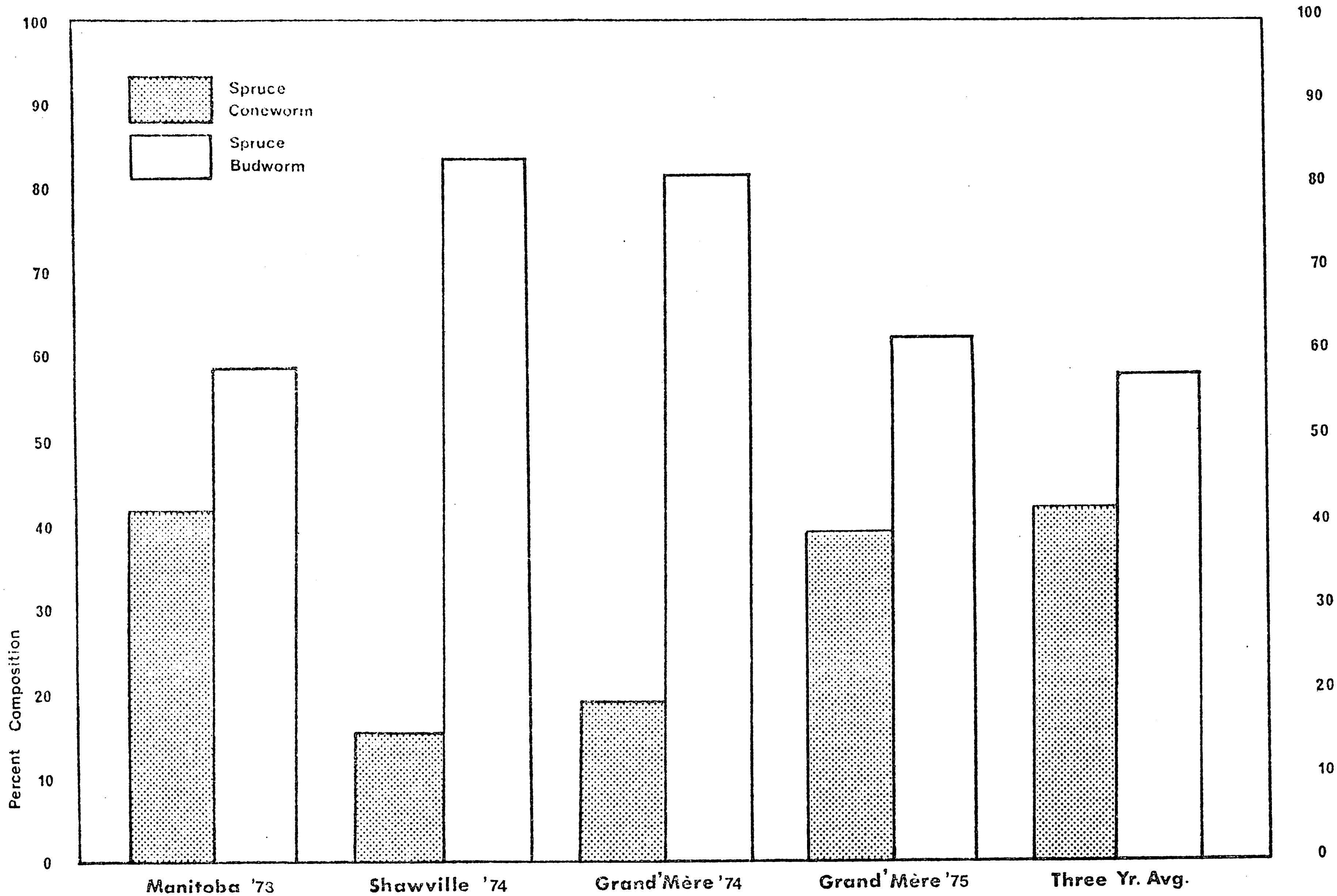

Figure 2. Percent composition of surviving defoliator complex after insecticide treatment.

SUMMARY AND CONCLUSIONS

The results of the preliminary evaluation of available data on *D. reniculelloides* as a coniferous defoliator suggest the need for a better understanding of the larval behavior and feeding habits as well as for more information on its significance during outbreaks of the spruce budworm. Several points for consideration by field researchers should be noted: (1) Numerical assessment of all species of defoliators from branch samples in the evaluation of experimental results.

(2) Careful interpretation of "cause" to "effect" when relating insect species (i.e. budworm) to tree condition.

(3) Scientific interpretation of ecological phenomena such as competition for food between species for the duration of their respective feeding periods.

(4) Expectancy of significant differentials in pest species composition between hosts (e.g. spruce and fir), between tree-age classes, and between the beginning and end of cyclical infestation periods of insect pest species.

(5) Changes in feeding habits under conditions of food shortage or larval size differences between pest species (i.e. cannibalism).

(6) True efficacy of operational or experimental insecticide sprays when toxicity of treatments may be significantly variable with respect to different defoliators occurring on the same host trees.

In conclusion, the authors wish to refer to a previous report on sampling procedures (DeBoo 1974) where caution was recommended in the procurement of branch samples for obtaining accurate indices of insect population density. The prime objectives of the present report, then, is to urge field researchers to identify and acknowledge the significance of all defoliating larvae collected from the branch samples: "Are you sure its the spruce budworm that's chewing up your trees, Charlie?"

ACKNOWLEDGEMENTS

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APPENDIX I

*   *D. reniculella* = *D. renicullelloides* n.sp. according to Dr. Eugene Munroe, Agriculture Canada, Ottawa (Mutuura and Munroe 1973).

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DIRECTION DE LA RECHERCHE INSTITUT DE RECHERCHES BIOSYSTÉMATIQUES

IDENTIFICATION REPORT
RAPPORT D'IDENTIFICATION

TO:/À
Dr. R.F. DeBoo
Chemical Control Research Institute
25 Pickering Place
Ottawa, Ontario
K1A 0H3

DATE	Feb. 9, 1976
LOT NO.	75-910
COMPLETED REPORT / *RAPPORT COMPLÉTÉ*	X
PARTIAL REPORT / *RAPPORT PARTIEL*	

CLASS, ORDER OR GROUP / *CLASSE, ORDRE OU GROUPE*	NOS. OF SPECIMENS/CULTURES / *NOS. DES SPÉCIMENS/CULTURES*	IDENTIFIED BY / *IDENTIFIÉ PAR*
Lepidoptera	260	S.Allyson
Hymenoptera	2	G.Gibson

REMARKS:/*REMARQUES:*

DIRECTOR, BIOSYSTEMATICS RESEARCH INSTITUTE
DIRECTEUR, INSTITUT DE RECHERCHES BIOSYSTÉMATIQUES

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IDENTIFICATION RECORD
FICHE D'IDENTIFICATION

B.R.I. / I.R.B. Lot No. 75-910

Your Number / Votre Nombre	Our Number / Notre Nombre	Identification: Remarks / Identification et Remarques	No. of specimens cultures / No de spécimens culture	Identification incomplete (see over) / verso	Retained / Retenus
		Choristoneura fumiferana Clem.	17 larvae,		
			2 pupae		
	*	Dioryctria reniculelella Grt.	219 larvae,		
			20 pupae		
		Gelechiidae larvae, possibly Recurvaria sp.	2 larvae		

IDENTIFIED BY: / IDENTIFIÉ PAR: Suzanne Allyson

DATE 28.1.76

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B.R.I.
I.R.B.
Lot No. 75-910

Your Number *Votre Nombre*	Our Number *Notre Nombre*	Identification: Remarks *Identification et Remarques*	No. of specimens cultures *Nº de spécimens culture*	Identification incomplete (see over) *verso*	Retained *Retenus*
		Neodiprion sp.	1 larva		
		Cephalciinae (larvae in this group cannot be separated	1 larva		
		below subfamily level)			

IDENTIFIED BY:
IDENTIFIÉ PAR: [signature] Gibson

DATE 28.1.76