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NOTES ON THE FEEDING OF LARVAE OF THE LARCH SAWFLY,
PRISTIPHORA ERICHSONII (HTG.) (HYMENOPTERA:
TENTHREDINIDAE)¹

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INTRODUCTION

The larch sawfly, *Pristiphora erichsonii* (Htg.), is an oligophagous insect which feeds upon foliage of *Larix*. Currently this insect is present in populations of outbreak proportions in forested areas of Ontario, Manitoba, and Saskatchewan, and neighbouring regions of the United States. In this part of its range, the native host species is *Larix laricina* (Du Roi) K. Koch.

General accounts of the biology of the larch sawfly can be found in the writings of Hewitt (3), Lejeune (5), Packard (8), and Watson (9). This paper is an account of the larval feeding habits and related factors affecting the defoliation pattern, and a consideration of the quantitative aspects of feeding as revealed by frass studies.

FEEDING CHARACTERISTICS AND DEFOLIATION PATTERN

The feeding characteristics of larch sawfly larvae and the resulting defoliation pattern are conditioned primarily by the following factors: the oviposition habits of the adults; the distribution of new terminals in the tree crown; and the light reactions and related behaviour of the feeding larvae.

The ovipositing adult inserts its eggs in the tissues of the newly developing terminal shoots at the bases of the soft, partly formed needles. A study of the distribution of the terminal tips in the crown (6) has revealed that the largest number of these are found in the central third of the crown. A somewhat smaller number of shoots occur in the upper third while the fewest are located in the lower third of the crown.

The numbers of utilized oviposition sites, as revealed by the persistent curled tips, were found to have the same distribution. The percentage of available terminals that were selected as oviposition sites showed a different distribution however. This percentage was found to in-

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crease from the bottom to the top. Hence, at the time of hatching the larvae tend to be distributed peripherally in the crown with the greatest concentration being found in the comparatively thinly foliated distal third of the crown.

The newly hatched larvae do not feed on the needles of the terminal shoot in most cases, but move to the whorls of needles on the woody twig proximal to the terminal. The initial feeding is confined to the edges of the needles but after the first stadium they consume whole needles, working from the tip to the base. The larvae are gregarious feeders, several individuals from a given egg cluster usually feeding together on a single verticil. During the first four stadia, movement from the site of oviposition is restricted. Such movement as does occur is directly associated with feeding activity and this constitutes a migration along the branch toward the main axis with the destruction of each verticil of needles contacted. The fifth instar larva is more active and its greater foliage consumption necessitates increased foraging.

The movements of larvae on the tree are conditioned to a considerable extent by their photic responses. This is especially true of the more active fifth stage larvae. Under the conditions of a two-light experiment, fifth stage larvae were found to exhibit a strong photo-positive behaviour. This was true of larvae preconditioned in either the dark or light and of both fully fed and partially starved individuals. The reactions of larvae of the earlier stadia could not be reliably determined due to their restricted movement particularly when on a plane surface. When fifth stage larvae were placed individually on the proximal portion of a branch, in almost all cases, they moved distally to the extremity of the woody twig. If this was stripped of needles, they retraced their paths and proceeded out on one of the laterals, invariably toward the light source. Feeding did not commence until the larvae reached the peripheral whorl of the lateral.

As a consequence of the ovipositional habits of the adult and of the photo-positive behaviour of the larvae, the extremities of the individual branches and of the crown are always defoliated first. Defoliation in a larch stand is first evidenced by the appearance of the stripped upper crowns. The extent of feeding within a given stand often appears exaggerated due to the conspicuous bare tops. Actually only a relatively small portion of the foliage may have been destroyed.

FRASS STUDIES

Larch sawfly feeding was studied quantitatively by measuring the frass yield throughout development. Groups of larvae, each from an individual egg cluster, were reared separately. They were reared under insectary conditions and were provided with a continual supply of fresh foliage. The frass produced was collected at intervals of two days or less, oven-dried, and weighed.

In Table I are presented the data on the relative frass yields of each instar. It was necessary to bulk the frass of the first two instars due to the limited sensitivity of the balance used. The data in this table are based on rearings of fourteen groups of larvae. Initially these groups comprised about thirty larvae. During the last two larval stadia this number was reduced to approximately ten larvae per group.

Table I
RELATIVE FRASS YIELD OF EACH LARVAL INSTAR

Instar	Duration of Stadium in Days		o/o of Total Frass Yield - Dry Wt. (Mg.)	
	Mean	Range	Mean	S.D. of Groups
I & II	5	2-8	1.3	0.5
III	3	2-6	2.4	1.4
IV	3	2-7	15.3	10.8
V	9	4-14	81.0	10.8

It is apparent from these data that by far the greatest amount of feeding occurs during the final larval stadium. This is due in part to the longer duration of the stadium but it is also a result of the accelerated rate of foliage consumption. This is illustrated by the information in Table II where figures for the absolute frass yields are presented.

Table II
ABSOLUTE FRASS YIELD OF EACH LARVAL INSTAR

Instar	<i>P. erichsonii</i> (Htg.)				<i>D. hercyniae</i> (Htg.) (Data of Morris, 1949)	
	Total Dry Wt./larva (mg.)	S.D. of Groups	Dry Wt./ larva/day (mg.)	S. D. of Groups	Total Dry Wt./larva (mg.)	Dry Wt./ larva/day (mg.)
I & II	3.6	1.8	0.8	0.9	9	2.5
III	6.3	2.8	2.2	0.8	18	6.0
IV	38.5	23.4	8.9	2.8	56	12.4
V	222.9	65.9	26.6	6.1	292	32.4
Total	271.3	—	—	—	375	—

As a consequence of this disproportionate distribution of activity, defoliation does not become apparent, even in a heavy infestation, until the larvae are near maturity. Reports on other defoliating insects, (*Diprion hercyniae* (Htg.) (7), *Malacosoma disstria* Hbn. (4)), indicate that a similar large proportion of the feeding occurs during the final stadium. The data of Morris for the European spruce sawfly, *D. hercyniae* (Htg.), are included in Table II for purposes of comparison.

A limited study was conducted to determine the relation of frass production to foliage consumption. A few fifth stage larvae were allowed to feed on a known number of measured needles (mean length = 17.3 mm.). The frass pellets produced were counted, oven-dried, and weighed. From this information it was calculated that each milligram of dried frass represented the consumption of 1.6 needles (average length 17.3 mm. and mean dry wt. 0.84 mg.).

Under the conditions in which they were reared these fifth stage larvae utilized ca. 25 per cent of the dry matter of the foliage consumed. Fifth stage larvae are somewhat wasteful feeders due to their incomplete mastication and digestion of the ingested needles. Therefore, the actual over-all utilization of all stages is probably somewhat higher than this. Food utilization (dry wt. basis) of other phytophagous insects, as reported in the literature, is in most cases in the neighbourhood of 35 per cent for the total development period of the larval stages (1, 2).

From these data it was further calculated that the total mean frass drop of 271 milligrams (dry wt.) per larva represented the consumption of 363 milligrams (dry wt.) of needles. This is not to be accepted as an absolute value but rather as a representative figure indicating the order of magnitude. It would be subject to considerable deviation under differing circumstances due to such varying biotic and physical factors as differences in the foliage and temperature fluctuations. This limitation must necessarily be borne in mind in the use of such data as a basis for population measurement, the logical application of such information.

SUMMARY

The feeding habits of larvae of the larch sawfly, *Pristiphora erichsonii* (Htg.), are described. The resulting defoliation pattern of the host is related to the ovipositional habits of the adult insect, the photic responses and relative behaviour of the larvae, and the growth characteristics of the host tree.

Quantitative data on frass yield for all larval stages are given. Approximately 80 per cent of the frass-drop occurs during the fifth (final) larval stadium. Data concerning the quantitative relationship between frass yield and foliage consumption are presented and discussed.

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