SENSITIVITY OF TUFTED APPLE BUDMOTH (LEPIDOPTERA: TORTRICIDAE) LARVAL INSTARS TO PHOTOPERIODIC INDUCTION OF DIAPAUSE AT 21C

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ABSTRACT

An examination of the sensitivity of the tufted apple budmoth, *Platynota idaeusalis* (Walker), larval instars to a diapause-inducing photoperiod at a constant 21C revealed that maximum expression of diapause occurred only when all five instars were exposed to a short daylength. No intermediate instar was found in which the developmental program could be switched from a diapause to a non-diapause one, or vice versa.

Key Words: Tufted apple budmoth, *Platynota idaeusalis*, diapause sensitivity, larval diapause, TABM.

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INTRODUCTION

The stage of an insect's life cycle sensitive to photoperiod for diapause induction may be, in different species, during any stage of development. Similarly the resulting diapause may be at any stage of development, although usually the stage is species-specific (Saunders 1981).

Recent evidence has been given for the importance of photoperiod and temperature in the larval diapause of the tufted apple budmoth (TABM), *Platynota idaeusalis* (Walker). Laboratory studies have revealed the critical photoperiod and effect of temperature on the induction of larval diapause (Rock et al. 1983). This paper presents additional experiments to determine the sensitivity of larval instars to a diapause inductive photoperiod.

MATERIALS AND METHODS

The source of the laboratory colony, composition of the semisynthetic diet for rearing, environmentally controlled rearing chambers, and criteria for diapause determination were previously described (Rock et al. 1983). Neonate larvae were placed singly into capped 30-ml plastic cups containing diet. Experiments to determine the sensitivity of the larval stages to diapause inductive conditions were fashioned after one employed by Adkisson et al. (1963). The response of the various larval instars was determined by systematically transferring larvae from a diapause to a non-diapause inducing regime and vice versa. Neonates were set up in LD 10:14 (diapause) and LD 16: 8 (non-diapause) at 21C and transferred at a designated larval-larval ecdysis to the alternatre regime. Controls were maintained in both regimes from the first instar. Larvae were examined daily, and when ecdysis occurred the exuvium was removed from the rearing cup. Observations were continued until larval-pupal ecdysis. Diapause in individual larvae was determined by the failure to reach larval-pupal ecdysis by a certain age. This age, which varied with temperature, was the maximum time required for development from hatch to larval-pupal ecdysis under a non-diapausing photoperiodic regime. At 21C this larval age was 50 days, and therefore larvae which had not reached larval-pupal ecdysis by day 50 were considered in diapause (Rock et al. 1983).

RESULTS AND DISCUSSION

The results in Table 1 show that at 21C the insect did not respond to a diapause-inducing photoperiod in any one particular instar in larval development. Rather, appreciable (26 and 39%) diapause occurred only when four of the five stadia were exposed to a short daylength. Maximum expression (100%) of diapause occurred when all five stadia were exposed to a short daylength. The probability of induction of diapause increased with the lengthening of the larval exposure period to a short daylength (Table 1). This is in agreement with Beck (1980), in that whether an insect's sensitivity to photoperiod is manifested in one or several growth stages, a time factor is involved. For TABM, some number of photoperiod diapause-inducing cycles need to occur during the time the insect is sensitive to diapause determination. Since photoperiodic input is cumulative (Beck 1980), each daily photoperiod must contribute some increment toward diapause or non-diapause determination for TABM. In a previous study, diapausing TABM larvae were shown to develop at the same rate as non-diapausing larvae up to the fourth

Table 1. Incidence of diapause in tufted apple budmoth larvae exposed to long (L = 16 h light/day) or short (S = 10 h light/day) days during development at 21C.

Total larvae	Exposure regime during instar					% diapause	Mean short-day exposure (days)*
	1	2	3	4	5		
34	L	L	L	L	L	0	0
32	S	L	L	L	L	0	8.5
38	L	S	L	L	L	0	5.0
39	L	L	S	L	L	0	5.1
40	L	L	L	S	L	0	6.0
39	L	L	L	L	S	0	11.1
38	S	S	L	L	L	0	12.8
41	L	S	S	L	L	0	10.2
38	L	L	S	S	L	0	10.1
32	L	L	L	S	S	0	13.9
36	S	S	S	L	L	0	18.4
45	L	S	S	S	L	5	16.2
39	L	L	S	S	S	0	18.7
38	S	S	S	S	L	26	26.1
36	L	S	S	S	S	39	28.5
46	S	S	S	S	S	100	40.6

* Short-day exposure for instars 1 - 5.

instar, after which diapausing larvae showed a significant increase in duration of instars four and five (Rock and Shaffer 1983). These results support those of the present study showing that photoperiodic input is cumulated and that at least four instars must be exposed to short day cycles before diapause is expressed.

Insects that have a facultative diapause are sensitive to certain environmental variables and thus respond to seasonal cycles. Diapause is determined by the exposure of sensitive instars to critical environmental conditions preceding the unfavorable season. By reciprocal transfers of larvae between diapause-inducing and diapause-suppressing photoperiods, instars sensitive to photoperiod and duration of sensitivity can be identified (Beck 1980). As previously noted by other investigators, the results obtained from this type of experiment depend upon the experimental design (Beck 1980). The data obtained are strongly influenced by whether the experiment is designed to determine the instar in which diapause programming can no longer be reversed (transfer from short to a long daylength) or in which diapause can still be induced (transfer from long to a short daylength). Also, experiments of this type must be interpreted with caution, because a series of short days which follow a treatment with long days cannot be easily compared with the effect of short days preceding such a treatment (Saunders 1980). Nevertheless, in this study TABM did not respond to a diapause-inducing photoperiod at any particular stage in larval development. Rather, maximum expression of diapause occurred only when all five larval instars were exposed to a short daylength. The data obtained about the sensitivity of the larval instars to diapause inductive conditions indicate that no critical intermediate instar exists in which the developmental programming can be completely switched from diapause to non-diapause, or vice versa. These findings are of significance in understanding the role diapause induction plays in the phenology of TABM under natural field conditions.

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LITERATURE CITED

Adkisson, P. L., R. A. Bell, and S. G. Wellsco. 1963. Environmental factors controlling the induction of diapause in the pink bollworm, *Pectinophora gossypiella* (Saunders). J. Insect Phsiol. 9: 299-310.

Beck, S. D. 1980. Insect Photoperiodism. 2nd ed. Academic Press, Inc. New York. 387 pp.

Rock, G. C., and P. L. Shaffer. 1983. Tufted apple budmoth (Lepidoptera: Tortricidae): Effects of constant daylengths and temperatures on larval diapause development. Environ. Entomol. 12: 71-5.

Rock, G. C., P. L. Shaffer, and A. D. Shaltout. 1983. Tufted apple budmoth (Lepidoptera: Tortricidae): Photoperiodic induction of larval diapause and stages sensitive to induction. Environ. Entomol. 12: 66-70.

Saunders, D. S. 1980. Some effects of constant temperature and photoperiod on the diapause response of the flesh fly. *Sarcophaga argyostoma.* Physiol. Entomol. 5: 191-8.

Saunders, D. S. 1981. Insect photoperiodism — the clock and the counter: a review. Physiol. Entomol. 6: 991-116.