THE EFFECT OF PHOTOPERIOD ON THE TERMINATION OF PUPAL DIAPAUSE IN THE WILD SILKWORM, *ACTIAS LUNA*[1]

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Williams and Adkisson (1964) have demonstrated that photoperiod controls the termination of pupal diapause in the silkworm, *Antheraea pernyi* Guérin-Méneville. For example, at 25° C, short-day conditions (4- to 12-hour photophases) strongly inhibit the termination of pupal diapause, while long-day conditions (15- to 18-hour photophases) promote the termination of diapause. The experiments which follow were carried out to determine if photoperiod also controls the termination of pupal diapause in the silkworm, *Actias luna* Linnaeus.

The first two experiments were carried out to determine the effect of photoperiod on previously chilled pupae. Sixty *A. luna* pupae were purchased from Butterfly Art Jewelry, Inc. on January 3, 1967 (I was told that these were raised and stored outdoors). They were kept in the garage where it was cool, until January 10 and then divided equally among four 2 pound coffee cans. Each can was covered with mosquito netting and immersed to a depth of about 2 inches in a fish tank of water. A constant temperature heater kept the water at 26–28° C. The containers were exposed to photophases of 0, 11, 16, and 24 hours. The 11-hour and 16-hour photophases were achieved by covering the containers with 3 pound coffee cans at 6 P.M. and 11 P.M. respectively and removing these at 7 A.M. The 0- and 24-hour photophase containers were left covered and uncovered respectively. Each of these latter cans was painted black on the inside and placed so that air but no light could get in. The whole set-up received illumination from two 40 watt GE F400W fluorescent cool white lamps hung about 4 feet above the containers.

Pupae exposed to the 11-hour and 16-hour photophases emerged as adult moths in an average of 17 days. The pupae exposed to continuous darkness emerged in an average of 19 days and those exposed to continous light emerged in an average of 20 days (Table 1). The fact that the first of these adults emerged in only 6 days as against 17 days in the following experiment suggests that many were no longer in diapause at the start of this experiment. If it can be assumed that those moths that emerged on or after the seventeenth day were all in diapause at the start of the experiment, the comparative times of emergence were such as to suggest that photoperiod was not an important factor.

[1] Part of a project which won the $8000 second prize in the Westinghouse Science Talent Search, Washington, D.C., 1969.

TABLE 1. TOTAL ADULTS EMERGING FROM COMMERCIAL PUPAE[a]

Days	0-hour Photophase	11-hour Photophase	16-hour Photophase	24-hour Photophase
6	0	1	0	0
7	0	1	1	0
8	0	2	1	0
9	0	2	2	2
11	2	2	2	3
12	5	3	2	3
13	5	3	2	5
14	6	4	5	7
15	7	5	7	8
16	8	7	8	8
17	8	8	9	9
18	8	9	9	10
19	9	9	9	10
20	10	9	10	10
21	10	10	10	10
23	10	10	11	10
24	11	10	11	10
26	11	10	12	10
29	11	11	12	10
30	11	11	12	11
31	12	11	12	12
34	13	11	13	12
35	14	12	13	12
39	14	12	13	13
40	14	12	13	14

[a] The remaining specimens were dead.

TABLE 2. TOTAL ADULTS EMERGING FROM PUPAE IN DIAPAUSE[a]

Days	11-hour Photophase	16-hour Photophase
17	0	2
18	2	2
19	3	2
20	5	3
21	6	5
22	7	5
23	8	5
24	8	6
26	9	6
34	10	6
37	10	8
40	10	9
43	10	12
44	12	13
46	12	14
47	13	14
49	14	15

[a] The remaining specimens were dead.

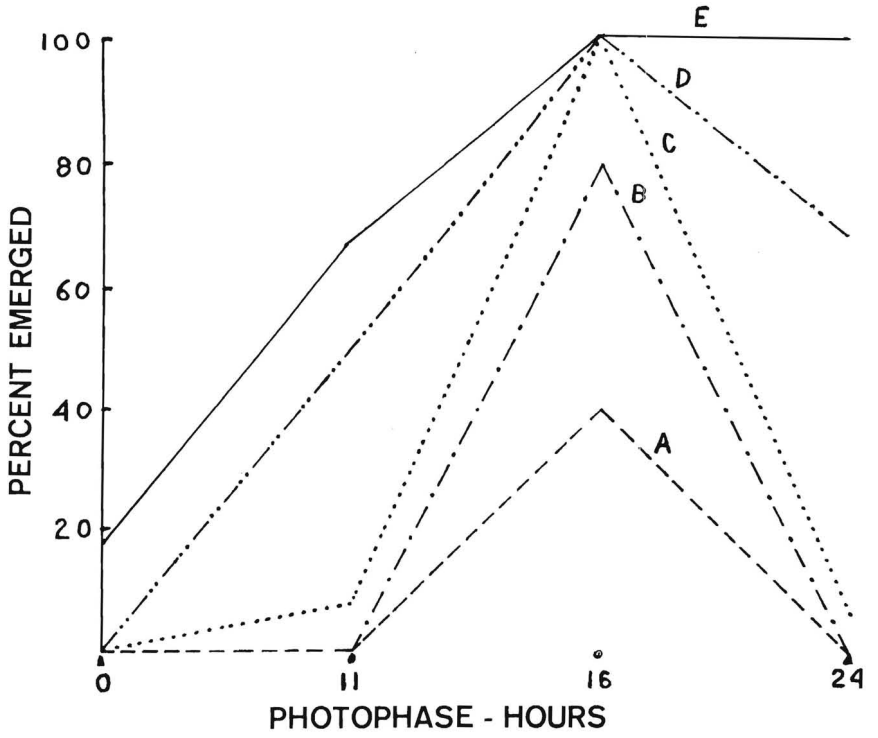

Fig. 1. The effect of photoperiod on the termination of diapause in the pupae of *Actias luna* not previously chilled. Percentage emergence after: A, 8 weeks; B, 13 weeks; C, 18 weeks; D, 23 weeks; E, 28 weeks.

In the second experiment *A. luna* larvae were raised under an 11-hour photophase as previously described by Wright (1967) to assure that all pupae were in diapause. The cocoons were stored in the garage, still under 11 hours of illumination, from June until February 28 so that they would be exposed to a period of low temperature before emergence. On February 28, 15 pupae were put into each of two 2-pound coffee cans. The procedure was essentially the same as that in the first experiment except that a bath temperature of 24–25° C and photophases of 11 and 16 hours were used.

The pupae exposed to the 16-hour photophase emerged as adult moths in an average of 33 days and those exposed to the 11-hour photophase emerged in an average of 29 days (Table 2).

A third experiment was carried out to test the effect of photoperiod on unchilled pupae. Sixty diapausing pupae were bought from Bill Shibe of

Moorestown, N. J. The cocoons were spun about September 2 and were shipped 2 weeks later. The experiment was begun on September 21. Fifteen *A. luna* each were exposed to 0-, 11-, 16-, and 24-hour photophases at 24–25° C using the same apparatus described above. The pupae exposed to the 16-hour photophase emerged in an average of 69 days and those exposed to the 24-hour photophase emerged in an average of 152 days. At the conclusion of the experiment (200 days), 67% of the pupae exposed to the 11-hour photophase and 17% of those kept in darkness had emerged (Fig. 1).

The difference in the number of days required for emergence of the adult moths from previously chilled pupae under the various photoperiods does not appear to be significant, and these experiments therefore suggest that day-length has little or no effect on the termination of diapause of overwintered *A. luna* pupae. On the other hand, the difference in the time of emergence of the unchilled pupae is significant, and we may conclude that photoperiod does play an important part in the termination of diapause of such pupae.

These results are interesting because they suggest that in *A. luna*, photoperiod is important in the termination of diapause of unchilled pupa but not of previously chilled pupae, whereas Williams and Adkisson demonstrate that in *A. pernyi* photoperiod affects the termination of pupal diapause of both chilled and unchilled pupae.

Literature Cited

WILLIAMS, C. M., AND P. L. ADKISSON, 1964. Physiology of insect diapause. XIV. An endocrine mechanism for the photoperiodic control of pupal diapause in the oak silkworm, *Antheraea peryni*. Biol. Bull. 127:511–525.

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FIELD NOTES ON THREE SKIPPERS IN TEXAS (HESPERIIDAE)

While collecting in the Rio Grande Valley-Brownsville area in southern Texas, the author took three skippers rarely taken in the United States. All were collected in the Santa Ana National Wildlife Refuge, Hidalgo County, Texas. The first, *Synapte salenus* Mabille (♀) was taken on the trail between the Old Spanish Cemetery and the Inland Lake in a shaded, grassy, low spot on 27 August, 1968. *Pyrgus albescens* Ploetz (♂) was captured in a clearing at the river end of West Gate Road, 29 August, 1968. A female *Pyrgus communis* was also taken at the same time and place. On the foot-trail between West Lake and West Gate Road, on 19 October, 1968, *Celaenorrhinus stallingsi* Freeman was taken when it settled on a low plant growing in a patch of sunshine coming through the trees overgrowing the trail. This is the second United States record for this species. Determinations were made by H. A. Freeman, Garland, Texas.

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