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Hatching of Sod Webworm[1] Eggs in Relation to Low Temperatures[2]

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Abstract

Eggs of *Chrysoteuchia topiaria* (Zeller), *Crambus pascuellus floridus* (Zeller), and *Pediasia trisecta* (Walker) were exposed to temperatures of 25, 15, 10, 4, and –10°C. Only those of *P. trisecta* hatched after exposure to 4°C for 30 days, while none hatched after exposure to –10°C. Eggs of none of the species hatched after exposure to 4 and 10°C for 60 days. Pre-exposure and post-exposure conditioning had no significant effect on percent hatch of *P. trisecta* eggs, while length of exposure period had a significant effect.

To obtain basic information on the biology of sod webworms, a study of the effect of temperature on egg hatch was undertaken. This study was to determine (1) if these species are able to withstand low temperatures and (2) if an investigator can successfully delay hatching, a useful technique in a rearing program.

In Tennessee, a few species of webworm moths are in flight even after the 1st frost. The eggs of these moths are subjected to near-freezing and subfreezing temperatures for various durations. We wanted to determine if sod webworm eggs could survive these low temperatures and thus survive throughout the winter. In addition, moths from the high elevations of the Appalachian Mountains are often subjected to low temperatures in midsummer and we wanted to determine the effect of low temperatures on the eggs of these species.

In a rearing program, it is often desirable to control hatching date so that it will occur at a time when labor is available for placing the newly hatched larvae on food. Since temperature is an important factor in regulating developmental rate (Wigglesworth 1965), it was employed in this study.

Materials and Methods

Eggs of 3 species, *Chrysoteuchia topiaria* (Zeller), *Crambus pascuellus floridus* (Zeller), and *Pediasia trisecta* (Walker), were used. Moths were hand collected with plastic jelly cups.[4] Cups containing moths were returned to the laboratory, and the moths were allowed to oviposit.

C. topiaria and *C. p. floridus* were collected in the Appalachian Mountains. The *C. topiaria* were collected from a grassy bald on Stone Mountain (elevation 4,000 ft) near Mountain City, Tennessee, while the *C. p. floridus* were collected from a grassy bald on Roan Mountain (elevation 6,300 ft) near the village of Roan Mountain, Tennessee. The *P. trisecta* were collected in Knoxville (elevation 1,000 ft).

According to Dr. A. B. Klots (personal communication) all 3 of the species reported upon are essentially Boreal and closely related to Palaearctic species. In North America all occur very widely, chiefly in the northern United States and Canada. For both C. *p. floridus* and *C. topiaria* the records in Tennessee are nearly at the southern extremities of their ranges in the East. Undoubtedly they have survived farther southward in the Appalachian Mountains, where the cooler environment is relatively northern, than in the hotter Atlantic Coastal Plain or Mississippi Valley. *P. trisecta* extends farther southward and in warmer climates than the other two, but it is still definitely Boreal in distribution.

Incubators were used for the 25, 15, and 10°C exposure temperatures; a refrigerator was used for 4 and –10°C. All eggs were less than 1 day old when the test was begun. The RH varied around 50–60% under the various temperatures, but a preliminary test indicated that this difference would not significantly affect percent hatch. All treatments were replicated 3 times with 10 eggs/replicate. Eggs were examined daily to determine the number that had hatched.

Test 1

The 1st test consisted of determining the effect of exposure temperature on percent hatch and length of the incubation period. Eggs exposed to temperatures which were too low to allow hatching (10, 4, and –10°C) were placed in the 25°C incubator after 30 and 60 days and allowed to hatch. Eggs of all 3 species were tested.

Test 2

Only *P. trisecta* eggs were used. From information obtained in Test 1, it seemed desirable to obtain more information on the effect of exposure temperature (4 and 10°C) and exposure period (5 and 15 days) on hatching. Preliminary experimentation indicated that a conditioning period of gradually changing temperatures might favorably affect percent hatch. Thus, the effect of pre-exposure and post-exposure conditioning was also investigated.

Pre-exposure conditioning consisted of placing the eggs in successively lower temperatures (25, 20, 15, 10, and 4°C) until the proper exposure temperature (10 and 4°C) was reached. Postexposure conditioning consisted of the reverse. Conditioned eggs are referred to as C. Nonconditioned eggs (NC) are those placed directly in the exposure temperature (no pre-exposure conditioning) and those placed directly in 25°C (no postexposure conditioning).

Results and Discussion

The results of Test 1 (Table 1) indicated that percentages of hatch at the various temperatures were significantly different at the 0.01 level with 25 and 15°C resulting in greater percent hatch (for all species) than 10, 4, and –10°C. *P. trisecta* appeared to be the most coldhardy of the three, as it was the only species which hatched after being subjected to 4°C temperatures for 30 days. The hatch of *P. trisecta* was significantly higher ($P < 0.05$) than the hatch of the other 2 species only at 4°C. It would seem more likely that the *C. topiaria* and *C. p. floridius* eggs would hatch at 4°C, as these species occur at the higher elevations. On the other hand, these 2 species are ovipositing in June and July when the daily low temperatures are usually above freezing, whereas *P. trisecta* lays eggs from late April until after frost in the fall. No species hatched after 30 days exposure to –10°C. Thus it is very likely that freezing temperatures for 1 month would prevent these species from overwintering in the egg stage.

Table 1. Percent hatch[a] of 3 species of sod webworm eggs at various temperatures

	Species		
Temp (°C)	*C. topiaria*	*C. p. floridus*	*P. trisecta*
25	93 a	93 a	93 a
15	67 a	77 a	97 a
10[b]	3 b	10 b	23 b
4[b]	0 b	0 b	7 b
–10[b]	0 b	0 b	0 b

a. All means followed by the same letter are not significantly different at the 1% level of probability. Arc/sine transformation.
b. Eggs placed in 25°C incubator after 30 days.

Table 2 indicates the length of incubation period required at the various temperatures. *C. topiaria* eggs required 6–8 days of incubation at 25°C while *C. p. floridus* and *P. trisecta* required 7–8 days. At 15°C, *C. topiaria* eggs hatched in 17–20 days, *C. p. floridus* in 20–24 days, and *P. trisecta* in 21–28 days. Thus, hatching took about 3 to 4 times longer at 15 than at 25°C. Eggs exposed to 10 and 4°C did not hatch until they were placed in 25°C. The developmental-hatching threshold, the lowest temperature at which development with hatching occurs (Johnson 1940), is between 10 and 15°C. When the 10°C eggs were raised to 25°C, they required as few as 3 days of incubation. This indicates that some development occurred at 10°C, as these eggs completed half their development in 30 days (6–8 days required at 25°C). Since 8 days of 25°C incubation were required for eggs exposed to 4°C,

apparently no development occurred at 4°C. Thus, the developmental threshold, the lowest temperature at which development occurs (Johnson 1940), was between 4 and 10°C.

Table 2. Number of days required for nonconditioned eggs to hatch at various temperatures

		C. topiaria		*C. p. floridus*		*P. trisecta*	
Temp (°C)	Days	Daily % hatch[a]	Daily hatch[b]	Daily % hatch[a]	Daily hatch[b]	Daily % hatch[a]	Daily hatch[b]
25	6	61	17				
	7	36	10	61	17	96	27
	8	3	1	39	11	3	1
15	17	45	9				
	18	40	8				
	19	10	2				
	20	5	1	9	2		
	21			9	2	4	1
	22			39	9	7	2
	23			30	7	21	6
	24			13	3	28	8
	25					17	5
	26					10	3
	27					7	2
	28					7	2
10	3	100	1	33	1		
	4			0		29	2
	5			0		43	3
	6			33	1	0	
	7			33	1	29	2
4	8	0		0		100	2

a. Based on total of daily hatch.
b. From total of 30 eggs.

Table 3 indicates results of Test 2. There was a significant difference ($P < 0.05$) in percent hatch between 4 and 10°C. Pre-exposure conditioning and post-exposure conditioning had no significant effect on hatchability; perhaps differences would have occurred under longer exposure periods.

Table 3. The effect of temperature, exposure period, pre-exposure conditioning, and post-exposure conditioning on hatching percentage of *P. trisecta* eggs

Temp (°C)		Exposure period (days)		Pre-exposure conditioning		Post-exposure conditioning	
4	10	5	15	NC	C	NC	C
70	77	87	60	72	75	72	70
(6.2)[a]		(10.5)[a]		(1.4)[a]		(1.4)[a]	

a. F value: 4.2 required to be significant at the 5% level and 7.6 at the 1% level.

The percent hatch was much higher (87%) when exposed for 5 days than when exposed for 15 days (60%) ($P < 0.01$). Figure 1, for which data from Tests 1 and 2 were pooled, illustrates the effect of exposure time at 4 and 10°C on percent hatch of nonconditioned eggs. After 60 days' exposure, no eggs hatched when placed in 25°C. Lindsay (1954) in his studies on the influence of temperature on the development of the pale western cutworm, *Agrotis orthogonia* Morrison, found that exposure to 5°C for 2 days had no effect, whereas at 32 days' exposure, hatch was reduced to 0%. Similar studies by Watters (1966), Adler (1960), and Kishaba and Henneberry (1966) with various species demonstrated the same response. Apparently the egg must hatch within a certain time or die.

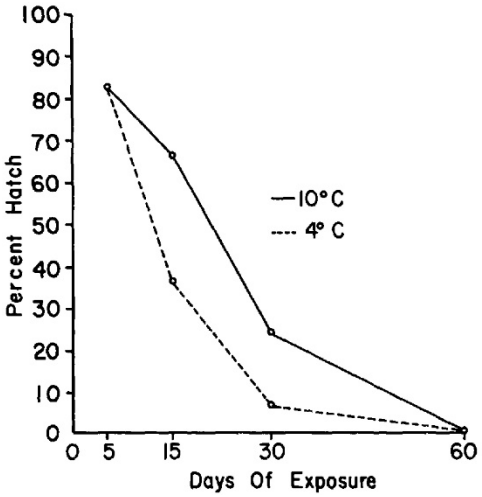

Figure 1. Percentages of nonconditioned *P. trisecta* eggs hatching after exposure to 4 and 10°C for various time periods.

As previously indicated, it is not possible to delay hatch for more than a few weeks without greatly affecting percent hatch. If an investigator using these species wishes to delay hatch for about 2 weeks, he can do so by subjecting the eggs to 15°C temperatures. This temperature will not affect the hatch of *P. trisecta* and will lower the hatch of *C. topiaria* and *C. p. floridus* only about 20%.

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Notes

1. Lepidoptera: Pyralidae
2. Received for publication February 20, 1969
3. Assistant Professor and Assistant
4. Premium Plastics Co, 2440 S. Indiana Ave., Chicago, Illinois, no. 6916

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