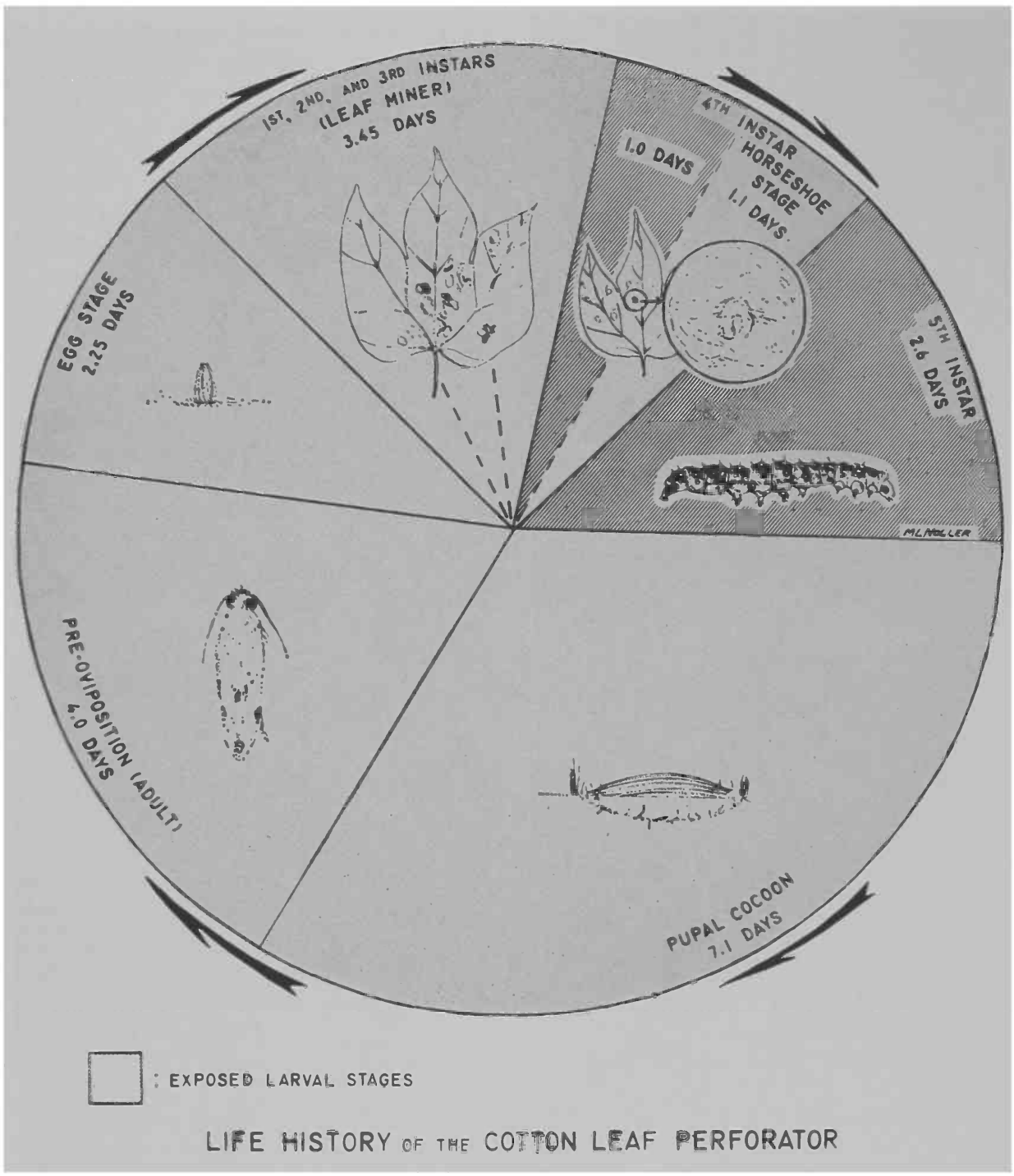

LIFE HISTORY OF THE COTTON LEAF PERFORATOR

Life Cycle of the Cotton Leaf Perforator

*By T. F. Watson and P. H. Johnson**

Until recent years the cotton-leaf perforator, *Bucculatrix thurberiella* Busck, was only an occasional pest of Arizona cotton. However, during the past 4 or 5 years it has become an annual problem, particularly in Yuma County. The problem has developed concurrently with the practice of controlling the pink bollworm, *Pectinophora gossypiella* (Saunders), with scheduled applications of insecticide. The most apparent explanation for this occurrence is that biological control of the cotton-leaf perforator has been disrupted with the increased use and rigid application schedules of insecticides to control the pink bollworm. Substantial evidence exists to corroborate this explanation, e.g., three species of parasites have been recovered from the perforator at Tucson where no insecticide was used.

Control of this pest has been difficult to achieve with most insecticides registered for use on cotton. Resistance to certain insecticides is probably one of the factors involved but additionally, the unique life history of this insect contributes to the problem of control, especially with the shorter residual insecticides. A detailed account of the biology of the cotton-leaf perforator should help to explain problems with control.

Eggs of the perforator are laid on both the upper and lower leaf surfaces, with an occasional one being placed on a petiole. The extremely small, whitish, elliptical egg is attached to the leaf by one end; the longitudinal axis then is perpendicular to the leaf surface. The incubation period averages about 2.25 days under greenhouse conditions of 70-90°F. Subsequent developmental times given for the immature stages are from the greenhouse study. The 1st instar larva emerges directly through the attached end of the egg and into the leaf, thus becoming a leaf miner. The first 3 instars are spent mining through the leaf, feeding primarily on the palisade tissue. A larva seldom crosses a main leaf vein, and avoids gossypol glands. The feeding channels are most readily visible on the upper surface of the leaf, becoming progressively wider with each of the two subsequent mining instars. The duration of the 1st three instars (mining stages) averages 3.45 days.

After completing the third instar, the larva emerges from within the leaf

**Professor and Assistant in Entomology, Department of Entomology, Agricultral Experiment Station, U of A.*

and begins the fourth stage, feeding on the leaf surface. During the feeding of the 4th and 5th instars, the larva eats only to the opposite epidermis. Feeding occurs on both upper and lower surfaces but during daylight hours the larvae generally feed on the lower surface of the leaf. When disturbed both fourth and fifth instar larvae wriggle vigorously, usually dropping from the leaf on a silken thread and returning when the disturbance is over.

At completion of the feeding stage of the 4th instar the larva spins a web-like cell on the leaf surface and assumes a "horseshoe" shape during this resting stage. The duration of the 4th instar is 2.10 days, 1.0 day in the feeding stage and 1.10 days in the resting stage. After molting, the 5th instar larva emerges from the cell and feeds on the leaf surface, as in the 4th instar, until mature. This requires about 2.6 days.

The fully-grown 5th instar larva then spins an elongate silken cocoon. This may be on the leaf but is usually elsewhere such as on a main branch, dead leaves on the ground or even in the soil. The pupal period requires an average of 7.1 days.

The moth which emerges from the cocoon is about 1/5 in. long, covered with whitish scales with a few black or brownish spots, and the head is concealed by a tuft of white hairs on the upper surface. After a pre-oviposition period of 4 days the females begin laying eggs. Thus, the entire life cycle, under green house conditions, requires about 21.5 days. A diagrammatic presentation of this life cycle is shown in the figure at left.

In addition to the life history described above, which was obtained under greenhouse conditions, studies were conducted in controlled- temperature cabinets to more precisely determine the effects of temperature on developmental time, fecundity, and adult longevity. These data are presented in Tables 1 and 2, respectively. Developmental time is inversely related to temperature. The shortest developmental time occurred at 90°F. and the longest at 68°F. Developmental times under fluctuating temperature conditions, with averages approximating the 3 higher constant temperatures of 75°, 83°, and 90°F., were slightly greater than under the corresponding constant temperatures.

Table 1. Influence of temperature on developmental time of the cotton leaf perforator.

	Developmental Time in Days (Means)						
		Duration of larval instar					
Temp. (°F.)	*Egg*	*1-3 (miners)*	*4*	*5*	*Pupa*	*Adult Pre-oviposition*	*Total (Egg to egg)*
Constant							
90	**3.19**	**3.08**	**1.74**	**1.65**	**4.56**	**1.83**	**16.05**
83	**4.03**	**3.86**	**1.89**	**2.16**	**5.63**	**1.91**	**19.48**
75	**5.67**	**6.29**	**1.96**	**2.66**	**8.00**	**2.37**	**26.95**
68	**8.02**	**8.32**	**3.06**	**3.47**	**13.79**	**3.30**	**39.96**
Fluctuating							
98-82 (90[1])	**3.43**	**3.32**	**1.97**	**1.97**	**5.22**	**2.18**	**18.09**
98-67 (82.5)	**4.48**	**4.82**	**1.92**	**1.96**	**6.35**	**2.08**	**21.61**
91-57 (74)	**5.50**	**5.86**	**2.08**	**2.80**	**8.24**	**2.55**	**27.03**
90-70 (G.H.[2])	**2.25**	**3.45**	**2.10**	**2.60**	**7.10**	**4.00**	**21.50**

[1] *Means are in parenthesis.*
[2] *G.H. = greenhouse*

The constant temperature of 75°F. and the fluctuating temperature of 91-57° (mean 74) were most favorable for total fecundity and adult longevity among treatments studied in the controlled temperature cabinets. However, greenhouse conditions were considerably more favorable for both fecundity and longevity than were those in the controlled cabinets (Table 2).

Earlier reports have indicated that the cotton-leaf perforator has 3 larval stages, one as a leaf miner and 2 external feeding stages. It was later thought that there were 2 mining stages and 2 external feeding stages. This study, however, clearly demonstrated the presence of 5 larval instars.

Additional observations:

Adult activity occurs at twilight or after dark. During the process of oviposition eggs are laid singly and usually near a leaf vein. The egg is white but darkens prior to hatching. The newly-hatched larva (leaf miner) usually feeds in a tight circle before initiating its meandering course through the leaf. The first external feeding stage (4th instar) spends less time feeding and does relatively little damage as compared to the 5th larval instar. The 5th instar does considerably more feeding in a single spot, thus creating larger "windows" in the leaf. As this stage completes development it usually becomes restless and leaves the leaf in search of a suitable place to spin its cocoon.

One of the difficulties in controlling this insect with contact insecticides appears to be related to the disproportionate amount of time which the insect spends in protected areas. For example, the life cycle (egg to egg) in the greenhouse required 21.5 days. Only 3.6 days were spent as an exposed, feeding larva.

Table 2. Effect of temperature on fecundity and adult longevity of the cotton leaf perforator.

	Means				
				Adult longevity	
Temp. (°F.)	*No. pairs of moths*	*No. days eggs laid*	*No. eggs per ♀*	*Males*	*Females*
Constant					
90°	**13**	**2.85**	**18.23**	**5.24**	**6.37**
83°	**11**	**3.00**	**29.82**	**6.51**	**7.14**
75°	**11**	**3.66**	**38.82**	**9.08**	**9.95**
68°	**10**	**4.60**	**21.00**	**8.48**	**10.94**
Fluctuating					
98-82° (90[1])	**11**	**2.45**	**36.45**	**4.93**	**6.41**
98-67° (82.5)	**12**	**2.08**	**25.75**	**5.54**	**6.32**
91-57° (74)	**11**	**3.00**	**37.73**	**7.78**	**7.80**
90-70 (G.H.[2])	**16**	**5.00**	**55.60**	**13.67**	**13.75**

[1] *Means are in parenthesis.*
[2] *G.H. = greenhouse*