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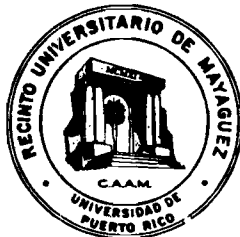
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CARIBBEAN FOOD CROPS SOCIETY



**THIRTEENTH ANNUAL MEETING
ST. AUGUSTINE TRINIDAD, W. I.
JULY 6-12, 1975**

**PUBLISHED WITH THE COOPERATION
OF THE
UNIVERSITY OF PUERTO RICO
MAYAGUEZ CAMPUS
1980**



VOLUME XIII

**BEHAVIOURAL STUDIES OF *ANCYLOSTOMIA STERCOREA*
(ZELLER) LEPIDOPTERA (PHYCITIDAE).**

A POD-BORER ON PIGEON PEA IN TRINIDAD

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SUMMARY

Ancylostomia stercorea (Zeller) is a major pest of pigeon pea, *Cajanus cajan* in Trinidad. The behaviour of the moth was studied under controlled conditions (12L: 12D) in the laboratory and greenhouse. 34% of *A. stercorea* emerged during the photophase. Females emerged first almost one day ahead of the males. In the greenhouse the peak locomotor activity was between 22.00 h and 01.00 h. When the female moths become sexually mature and receptive to the males they adopt a "calling" posture similar to that exhibited in other phycitid females. There is a marked periodicity of "calling" during the 12L: 12D diel cycle. The peak of calling activity in virgin females held under continuous darkness, was similar to that found during the 12L: 12D cycle. Mating caused a marked decrease in calling activity of the pod-borer moths. Throughout the laboratory investigation the pod-borer only oviposited in the presence of green pods and or flowers.

INTRODUCTION

The pod-borer, *Ancylostomia stercorea* (Zeller) is a major pest of pigeon pea, *Cajanus cajan* (L.) Millsp., in Trinidad and elsewhere in the Caribbean region (Bennett, 1960). Its biology has not been studied in detail and there are only scattered references to its incidence, host-plants, the damage caused and control. An investigation into the behaviour under laboratory and glasshouse conditions of the adult pod-borer was made as a contribution to a better understanding of this pest. The work was done at Macdonald Campus of McGill University, Montreal, Canada from 1969 to 1972.

Materials

- (a) Source of material for experiments -

Larvae were collected in the field at Central Experiment Station, Trinidad and shipped in the pupal stage.

- (b) Equipment used in experiments -

- (i) Breeding container-one gallon cylindrical cardboard carton fitted with a screened top.

(ii) A Cabinet:

A controlled environment cabinet (4 x 2 ft) was used for most experiments, set on a 12: 12D cycle, 27± 3°C and 60 - 80% r.h. Light was by overhead day-light fluorescent tubes and humidity was maintained by a vapourizer/humidifier and open pans of water. For observation in the dark a small flashlight shaded with several layers of red tissue paper was used.

(iii) A glasshouse.

METHODS, RESULTS AND DISCUSSION

Periodicity of emergence

Observations were made to determine when adults emerged. Figure (1) shows that of 80 pupae (40 males and 40 females) observed about 34 percent emerged during the photophase and 66 percent during the dark. Females emerged first and 45 percent of the females emerged during the light phase as opposed to 22.5 percent of the males. There seemed to be some difference between sexes. Most of the females emerged almost one day ahead of the males. Emergence began nine hours before dark and continued until after 24.00 hours as shown in Figure (1). Very few insects emerged after 01.00 h. All the imagos in this experiment emerged within three days of each other. Since females emerge almost one day ahead of males, this may help with synchronization of the sexual receptive stages in both sexes.

Locomotor Activity

As the adults are nocturnal their activity was studied under controlled conditions in a glasshouse by Callahan's (1958) method, using a cage (12 x 18 x 18 in.) with plastic screen and transparent plastic top. Indirect illumination of the cage at night (18.00 - 06.00 h.) was by means of a 10 W bulb set 10 feet away.

Movements of five pairs of one-day old moths placed in the cage were observed for two nights between 18.00 and 04.00 h. An hourly activity index was obtained, one unit being equivalent to ten movements of one moth or one moth moving ten times.

Moths of both sexes began fluttering and flying about the cage immediately with the onset of darkness. The activity remained at uniformly low level for the first three hours of darkness as shown in Figure (2) and peaked between 22.00 and 01.00 h. There was a sharp decrease in activity after 01.00 h and all activity subsided towards the light

period. No locomotor activity was observed during the light phase. Only moths five or more days old evidenced disordered locomotion during the photophase. This disordered locomotion was also described by Blest (1960) in *A. kuehniella* and *Endrosis sarcitrella* (Hubner).

Calling Behaviour

When *A. stercorea* females became sexually mature they adopted a calling posture. This posture of the female, with the tip of the abdomen turned upwards indicates readiness for mating as Norris (1932) found in *Plodia interpunctella* (Hubner) and *Anagasta (Ephestia) kuehniella*.

Effect of light and dark cycles on the calling of virgin females

- (i) Female pupae about to emerge were confined individually in clear plastic phials (45 x 75 mm) with plastic snap-on lids and incubated in the cabinet in a 12L : 06.00 to 18.00; 12D (18.00 to 06.00 h) light regime. Observations of the number of calling females were initiated when the test insects were about 24 hours old. Counts were made hourly between 19.00 and 01.00 h and every three to six hours for the rest of the day.

The age of the test insects and the time intervals chosen for observation were based on preliminary studies of the behaviour of adult *Ancylostomia*. The females were examined in this experiment which ran for 72 hours and was replicated five times.

- (ii) An experiment similar to (i) was conducted except that the test insects were placed in complete darkness throughout the experiment. Ten females were used in this test which was completed after 40 hours and replicated four times. The pupal stages of these insects were held in 12L : 12D light regime.

Effect of mating on calling

Mated two-day old females were placed individually in labelled clear plastic phials (45 x 75 mm) with plastic snap-on lids and exposed to conditions similar to those outlined in (i). The experiment was completed in 48 hours. On completion of the experiment the females were dissected to ascertain whether they had been mated. This was determined by the presence of spermatophores. Ten to fifteen mated females

were used in this experiment. Ten 2-day old virgin females were tested at the same time and used as the control. This experiment was replicated four times.

There was a marked periodicity of virgin females calling during the 12L: 12D diel cycle as shown in Figure (3). There was no evidence of calling during the photophase. However, some females assumed a calling posture soon after eclosion during the photophase. This was usually a partial calling posture, that is the tip of the abdomen was not fully extended upwards. Virgin females began calling three to four hours after the onset of the dark period and reached a peak of calling activity two to three hours after calling was first initiated. Calling subsided seven hours after dark. Individual females did not call continuously but occasionally stopped, especially if they were disturbed and crawled about for one or two minutes and then resumed calling. It was found that once calling behaviour began in some females it might persist for an extended period (more than 90 minutes in some instances) even when the calling females were exposed to bright light in the laboratory.

The number of females observed calling varied with age. There was a significant difference ($P = 0.05$) between the number of times one-day old and two and three-day old virgins that were seen to call during the peak period (23.00 h to 24.00 h). During the first dark phase a total of 32 observations were made of calling females whereas in the second and third dark phases there were 104 and 99 respectively.

Effect of complete darkness on calling of virgin females

When the test insects were maintained in complete darkness throughout the experiments, except for very brief periods of low light intensity required to service and check the experiments, the results obtained indicated that calling occurred only during the period when the dark regime would normally be in effect in a 12L: 12D diel cycle. During the first dark phase the number of females that were calling did not differ appreciably from the findings in the previous experiment. The number of females that called after 24 hours had elapsed was appreciably lower than those observed during the first 24 hours (see Figure 4).

This behaviour exhibited by virgin female *Ancylostomia* moths when exposed to total darkness was similar to the behaviour of *A. kuehniella* held under continuous darkness (Traynier, 1970) and would indicate an endogenous circadian rhythm in the insect.

Effect of mating on calling

The results indicate that mating caused a marked decrease in calling in *Ancylostomia* females. During the peak periods of calling

activity (from six to seven hours after the onset of darkness), 30 - 60 percent of the controls were calling as compared with 4.25 to 16.6 percent for the mated females. In the first replicate none of the five mated moths tested called. Of the total of 24 mated moths tested there were fourteen instances of calling exhibited as compared with a total of 135 for 40 virgin females used as control. The number of mated females that called during the two dark periods in the experiment did not differ appreciably.

The behaviour exhibited by mated female pod-borers might be explained by the reasoning advanced by Fatzinger and Asher (1971) for mated *D. abietella* females. They reported that once *D. abietella* mated and viable eggs were produced the females no longer called.

Mating

On encountering a calling female, a male *Ancylostomia* waves the antennae four to five times and flutters the wings vigorously. The male then crawls to the anal end of the female and brushes his antennae over her wings, abdomen (ventral) and partially extended ovipositor. The male then quickly darts the abdomen dorsolaterally until the extended claspers are attached to each other in a tail-to-tail mating position and all wing and antennal movements cease.

The entire display prior to copulation usually lasted less than one minute; the act of mating took 25 to 129 min. (mean 55 ± 8 min; $n = 12$). While in copula the moths exhibited very little locomotor activity but they readily crawled about if disturbed.

Mating occurred anywhere in the breeding cage. Some pairs failed to separate after mating as has been recorded for *Heliothis zea*, (Snow *et al.*, 1967).

Periodicity of mating

There was a definite periodicity to the mating behaviour of the pod-borer as determined for 25 pairs of imagos during 12L: 12D cycle in the laboratory as shown in Figure (6). No mating was observed during the light regime even when females were calling. Mating occurred three to eight hours after dark cycle commenced, with the maximum mating activity occurring six hours after onset of darkness. It was not possible from the design of the experiment to indicate the frequency of mating for each male but dissection of the females at the end of the experiment and counting the number of spermatophores in each gave an indication of their mating frequency.

Only 18 of the 25 females dissected had mated and eleven of those had mated only once, five twice and one three times. The periodicity of the mating behaviour exhibited in these tests coincide with the periodicity of calling activity in the female moths and with the maximum locomotor activity of the imago. It was observed also that feeding occurred during the period of copulatory activity of the moths.

Oviposition

Investigation of the preference of egg laying sites was made by the following methods five pairs of one-day old adults were confined in breeding cartons and placed in the cabinet. In each carton the moths were given a choice of ovipositing on two green pods, four flowers, two opened, two unopened, two leaves, two peduncles (5 to 10 cm long) (of *C. cajan*), strips of paper, or the muslin screen top. The pods, flowers, leaves and stems were replaced daily so that only fresh material was presented to the moths. This experiment was continued until the moths died and was repeated five times.

Field observations in Trinidad revealed that eggs were deposited on pigeon pea pods and flowers. The results obtained in the laboratory (Table 1) indicated that the moths preferred to lay eggs on green pods next in order of preference were flowers (opened and unopened) peduncles and leaves. Very few eggs were found on the moistened cotton of the feeding trough and on the edges of the paper strips. The lower surface of the leaf was preferred to the upper surface for oviposition. Ching-Feng *et al.* (1965) found that the soya bean pod-borer *Leguminovora glycinivorella* (Mats.) Obreztsov deposited their eggs in the field in the same pattern as *Ancylostomia*, where the overwhelming majority of eggs were deposited on the bean pod.

Throughout the laboratory investigation it was noted that the pigeon pea pod-borer oviposited only in the presence of flowers and or green pods of *C. cajan*. Only once during the entire study in the laboratory were a few eggs found in the absence of the host plant material and these eggs were not viable. All attempts to initiate oviposition in the absence of the host plant material and these eggs were not viable. All attempts to initiate oviposition in the absence of the host plant by feeding the moths honey, sugar solution, molasses in several combination and concentrations and varying the size of the rearing cages failed. The factor releasing normal oviposition in *Ancylostomia* is not known. The presence of sperms in the receptaculum was not the primary stimulant for normal oviposition as Norris (1933) also found with *A. kuehniella*. Green (1971) reported similar findings with the bean leaf roller, *Urbanus proteus* (Linn.) on snap beans. Green (1971) found that trials with

several combinations of temperature artificial light and greenhouse sizes did not result in oviposition on bean plants when fresh bean blossoms were absent.

The plant effect on oviposition probably resulted from either its physical presence or as Snow and Callahan (1967) reported for the corn earworm, *Heliothis zea*, the plant material had a triggering effect related to infra-red radiation and or scent molecules.

TABLE 1. Preference of oviposition sites

Oviposition site	No. of eggs deposited						Average*
	Rep 1.	Rep 2.	Rep 3.	Rep 4.	Rep 5.	Total	
Peduncle	12	15	15	14	12	68	13.6 bc
Leaf:							
Upper surface	2	4	1	4	2	13	8.8 c
Lower surface	11	8	4	3	5	31	
Flower:							
Opened	13	25	26	14	22	100	20.0 b
Unopened	24	20	19	15	28	106	21.2 b
Green pod	50	72	82	85	72	361	72.2 a
Paper strip	1	1	0	1	3	6	1.2 d
Muslin screen	0	0	0	0	0	0	0.0 f
Moistened cotton	22	3	5	2	2	14	2.8 d
	115	148	152	138	146		

* Average not having one alphabetical suffix in common differ significantly at 5% level.

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