TIME-LAPSE PHOTOGRAPHY FOR THE OBSERVATION OF PORINA CATERPILLAR BEHAVIOUR

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Summary

Time-lapse photography was used to study the emergence and feeding of porina caterpillar (*Wiseana* spp. larvae). This behaviour was found to be extremely irregular. Earlier suggestions that cold or frosty conditions inhibit feeding have to some extent been confirmed, but the apparently natural fluctuation of caterpillar emergence tends to mask this effect. Results show that drought, periods of rainfall, temperature, and the cyclic nature of the feeding behaviour are all contributory factors to this erratic picture.

INTRODUCTION

THE USE of short residual life organophosphate insecticides for the control of porina caterpillar (*Wiseana* larvae) has highlighted the need for a better understanding of emergence and feeding behaviour. A plea to this effect was made by Perrott (1966). It cannot be assumed that all larvae will feed on any particular night or even that all the population will emerge during the life-span of the insecticide. Nothing has been published on these aspects of porina caterpillar behaviour, but it has been suggested (Taylor, 1964; Kelsey pers. comm. to Lowe, 1966; Waller, 1968) that cold or frosty conditions might inhibit emergence. This study was therefore initiated to record the emergence and feeding activity and relate these to the physical and meteorological conditions of the environment.

EXPERIMENTAL

EQUIPMENT

The time-lapse unit used for the study was developed and manufactured in 1968 by the Physics and Engineering Laboratory, DSIR. It was based on a 35 mm Nikon F camera with a motor-driven back capable of holding in the magazine film sufficient for 250 to 300 exposures. The camera was mounted some four feet over the study plot on a tubular steel frame. The Micro Nikkor 55 mm lens used gave a field of view of approximately 3.4 sq. ft.

The camera was programmed by an electronic timing device to fire at 2½ minute intervals and at the same time generate pulses of electronic flash illumination. Starting and stopping times for each night's recording sequence were controlled by a built-in time switch, and heating circuits were provided to prevent fogging of the camera lens and clock face, which was placed on the ground within the field of view to give

FIG. 1: *The camera (top centre) suspended over the study plot. The flash unit is on the right of the camera housing and the associated electronic equipment to the left. In the foreground is the removable wire grid and clock.*

the time of each photograph. All instruments and components were protected from rain and dust. Power was provided by a 12 V car accumulator giving independence of mains supply.

Meteorological data were gathered using a grass minimum thermometer, a thermograph housed in a standard Stevenson screen, and a continuous recording rain gauge. Weekly readings were taken of soil temperatures at 6 and 9 in. depths and soil moisture at 6 in. using gypsum resistance blocks.

TECHNIQUES

Initial experimental work done by Waller in 1967 using a 16 mm cine camera and various types of illumination led to the manufacture of the equipment described above. After some further trials carried out by the writer in winter 1968, the study began on March 11, 1969, in a 10 acre paddock on a flat, but low-lying area of Richmond clay loam at the rear of Motor Assemblies Ltd., Nelson. The vegetative cover of this sheep-grazed pasture was composed of ryegrass, clover and some weeds.

Exposed film was taken daily from the camera, developed, and then contact printed to a positive film base producing a film strip. This strip was projected by a modified slide projector, the pictures being enlarged to approximately 6 ft by 4 ft. Each exposure was examined and the caterpillar activity noted against the time shown on the clock. This information was then compared with the recorded meteorological data in an attempt to determine any relationship with the observed behaviour.

The experimental site was free of porina caterpillars. Twenty larvae averaging one inch in length collected the previous day at Opouri were seeded into the plot on March 7, 1969, on a grid pattern 5 in. by 4 in. apart. They were allowed to remain undisturbed for two days and then exposed to flash illumination only for a further three days before filming began. Six larvae known or suspected to be dead were replaced on April 4. A removable wire grid placed over the plot enabled the initial seeding points to be rapidly located during scanning of the films. The pasture cover was clipped by hand when it became too thick to see the caterpillars easily. Initially recording began each night at 8.30 p.m. and finished at 6.30 a.m. From May 19 this time was extended from 7 p.m. to 7 a.m.

It was intended to start the study when the larvae were sufficiently large to be clearly seen and continue until the population had pupated. However, difficulties with the camera caused a week in April and the period from May 23 to June 17 to be lost and the experiment to be abandoned in mid-July. Despite these losses, 22,000 photographs were taken.

RESULTS

It has proved to be extremely difficult to present any tabulated data on the observed behaviour owing to its irregular nature. The number of caterpillars emerging, the time spent on the surface, and the time of night of their emergence all fluctuated wildly under what appeared from the climatic records to be almost identical conditions. However, from this mass of data these features emerged:

- (1) Failure to emerge under dry conditions.
- (2) The cessation of feeding during rain.
- (3) The effect of frosty conditions.
- (4) The clearly defined cyclic nature of emergence.

DROUGHT

Early in the trial, conditions were extremely dry, the soil pH was approximately 4.5, and during this period caterpillar emergences were almost nil. Only one caterpillar was seen to emerge and actively search for food. Two others seen to come up were found dead the following morning and it was feared that the caterpillars had failed to establish. The plot was watered on March 27 and that night 10 caterpillars were seen. The grass minimum temperature was 39° F and first emergence was not until 11.30 p.m. building to a peak with the largest number of caterpillars out between 3 and 5 a.m. The last caterpillar was seen at 6.16 a.m.

RAINFALL

During recording, only a few rain showers fell during the hours of darkness. On one occasion, the night of April 7-8, seven caterpillars fed up until 1.30 a.m. when rain started to fall. The shower lasted 1½ hr and during this time only one caterpillar was seen on only one picture. However, five larvae emerged after the rain stopped.

FROST

As stated earlier, it was frost which claimed the most attention of previous workers as a possible explanation for failure of caterpillars to emerge. This study has to a large extent confirmed these suspicions but some results seem anomalous. The first frost was recorded on the night of March 25 and it completely inhibited emergence, but the second of 6° F on the night of April 9-10 appeared to have no effect at all, as 11 larvae were seen to emerge during the night. However, activity ceased a little earlier than usual, no activity being seen after 4.50 a.m. In June and July, frosts of up to 12° F were experienced and these had a marked effect on the behaviour. On a number of nights, no activity was recorded and a maximum of only 4 caterpillars on any one night were seen on these occasions. These larvae were usually seen in the period 8 p.m. until midnight.

CYCLIC FEEDING

Figure 2 clearly illustrates this mode of activity. Only two larvae were chosen as at no time was there any confusion over their identity. This is a problem with some other larvae because the feeding and burrowing ranges tended to overlap. Only a short period is illustrated, as intermittent camera failures might have caused a particular larva to be missed on any particular night, especially if the period of emergence was only a short one.

Differences in the times of first emergence, ranging from 8.31 p.m. to 1.56 a.m.; time spent on the surface (present in one frame only, up to a total of more than three hours); and the total number of larvae appearing are largely unexplained. On no occasion did more than 70% of the population appear. The caterpillars were never seen fully out of their feeding burrow, at least the last segments being kept inside.

FIG. 2: The emergence pattern of the two larvae shown is typical of that found during the study. No correlation with grass minimum temperature, apart from frost, was found to exist.

DISCUSSION

This project suffered from many problems, some of which are outlined. The unreliability of the camera was perhaps the main worry, and on many occasions it failed to run at all or missed lengthy periods, so losing important information. Fogging of the lens and clock was overcome with the provision of heating elements, but again valuable information was lost early in the study. Another problem was the time needed to view the enormous quantity of film, about five hours being needed to scan each night's record. Meteorological data were insufficient for a detailed analysis and any future work will need much better information. Both the thermograph and continuous recording rain gauge were unreliable. The gypsum blocks for soil moisture determination were 4 ft from the study plot, which meant that the information obtained from them was of use only in general terms. Lastly, the larvae were too close to enable certain identification of individuals.

In spite of the difficulties and failures discussed, it is clear that weather plays a very important role in the aspects of behaviour studied. It remains for these factors to be adequately quantified either by a modification of the time-lapse technique or some other method. Work being done by R. A. French, Research Division, Department of Agriculture, Lincoln, using more sophisticated recording equipment may help to elucidate some of these problems.

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