

SOME DATA ON THE BIOLOGY OF THE SUGARCANE BORER

(*Eldana saccharina*, Wlk.)

By J. DICK.

INTRODUCTION.

During the last four years the author has been collecting information on the biology of the sugarcane borer, an outbreak of which was first noticed in September, 1939, on the Umfolozi Flats. No damage to cane in the rest of the Natal sugar area has as yet been recorded, although it is now known that the insect occurs, more or less as a rarity, in other parts of the sugar belt.

The data collected here are by no means complete, and this paper must be regarded as a progress report. A great deal of the information will appear to be merely of academic interest, but some of it has been found of importance in the study of the reactions of the moths, which is a possible approach to control, and much of the rest would be of value if outbreaks were to appear in other areas.

HISTORICAL.

The borer was first noticed as a pest of sugarcane in September, 1939, when an outbreak occurred in two-year-old P.O. J. 2725 on the Umfolozi Flats. The adults were identified by Professor Janse as *Eldana saccharina*, Wlk., belonging to the lepidopterous family Pyralidae. This species had previously been recorded as a pest of maize in Mozambique, Sierra Leone² and French West Africa⁴. A specimen had been collected at the Nyalazi River, not far from Mtubatuba, in 1928 and the Imperial Institute of Entomology reported, in a letter, that they had a specimen in their collection, taken in Beira in 1903.

The situation was investigated by Dr. Naudé and Dr. Ripley, of the Union Division of Entomology, who visited practically the whole sugar belt as well as areas further north, but could only find *Eldana* at Umfolozi.

It was at first thought that the insect was a recent introduction, probably from the north, and that there was danger of a rapid spread from the Umfolozi Flats to other parts of the sugar belt. However, a single specimen was collected at Umhlatuzi, and more recently adults were taken on several occasions when they were attracted to light at Mount Edgecombe, and it is now thought that the insect is a native of the country or a much older immigrant than at first appeared to be the case. It is probably distributed, although in small numbers, over a large part of the sugar belt, and its occurrence in dangerously large numbers at Umfolozi is probably due to such factors as the more uniformly high temperature and the presence of large stands of P.O.J. cane, which appears to be particularly susceptible. In most other parts of the sugar belt temperatures in winter are often low enough to inhibit mating by the adults and to retard the development of the larvæ.

NATURE OF DAMAGE.

The larvæ bore into the stalks of the cane which, in cases of severe attack, may be almost entirely hollowed out. As many as twelve larvæ have occasionally been found in a single joint, although such heavy infestation is rare. In most fields in the outbreak area the infestation has been somewhat patchy, heavily infested areas of variable size, but seldom greater than half an acre, being separated by cane free from borers or only slightly infested. Often, though not invariably, the infestation has been more severe around the outside of the fields.

Dr. Dodds¹ gives the following table to show the serious effect of borer attack during the first severe outbreak. The figures for damaged cane, however, were derived from sticks known to be attacked, and do not represent the average for the infested area which would contain a considerable amount of undamaged cane.

	Damaged Cane.	Average for Month.
Purity	77.95	85.7*
Glucose Ratio	10.93	2.3
Sucrose per cent. Cane	7.26	13.0

(* Estimated crusher juice purity)

Damage is more severe in cane which has been left standing for more than one season, since the borer population has had longer in which to build up, and the damage is, of course, accumulative. During the last two or three seasons considerably less stand-over cane has been left in the fields and damage by the borer, although it still occurs, is noticeably less severe.

FIELD OBSERVATIONS.

There is evidence of a complete overlapping of generations of *Eldana* on the Umfolozi Flats. Inspection has been carried out at all seasons and on each occasion all stages of the insect appeared to be present.

A systematic search in reeds, maize, sorghum and various grasses on or near the flats as well as at Nyalazi River, failed to yield any specimens of *Eldana*, although the Noctuid borer, *Sesamia calamistis*, Hmps., which also occurs in cane, was found.

Burning of the cane before cutting, and of the trash left in the fields, although it must kill large numbers of the insects, does not always prove fatal, living borers being found especially in stumps of cane in the ground.

The most severe damage has occurred in cane of the variety P.O. J. 2725, although the borer has also been found in P.O. J. 2714 and 2878, Co. 301 and in stools of Uba growing among P.O. J. 2725. Co. 281 appears to be resistant, as the only cases of attack found in this variety, even when it was growing next to the most heavily infested area, occurred in a few sticks which the borers had entered through cracks.

With the possible exception of a single fly which emerged from a pupal case, no parasites have been found attacking any stage of the insect. Egg parasites may occur and may not have been discovered on account of the difficulty in locating the eggs in the field. The few eggs actually found, however, were free from parasites and eggs laid by caged moths, placed in the fields and collected again after four days, did not become parasitised. An organism found growing on the body of a dead larva from Umfolozi was cultured and found to be a yeast and not a pathogenic fungus.

Ants may be important as predators, several species having been found in empty burrows. A common small brown ant destroyed all stages of the insect when they were kept in a room near the Umfolozi mill.

MATERIAL.

Most of the following observations were made on borers reared at the Experiment Station, Mount Edgecombe. Although temperature conditions there are often quite different from those that are the rule on the Umfolozi Flats, the summer temperatures at Mount Edgecombe are sufficiently high to enable normal breeding of the insects to take place.

It was found more satisfactory to rear the insects for experimental purposes in artificial medium than on sugarcane. Pieces of cane cut up for food rapidly decomposed and the products of decomposition were frequently poisonous to the insects. This was particularly so when the cane became infected with "pineapple disease." The borers did not thrive in pieces of cane sterilised by heating, and changing the food sufficiently often to avoid the effects of decomposition was too laborious to be practicable, besides causing considerable accidental mortality. The technique adopted was similar to that devised by Ripley *et al.*³ for rearing the citrus false codling moth. A mixture of maize-meal and water is cooked and sterilised in test tubes or jars plugged with cotton wool. The cultures are inoculated with a common grey mould, *Mucor hiemalis*, Wehmer, the presence of which gives better development of the larvæ. The eggs are washed in a 3 per cent. solution of formaldehyde before being introduced into the cultures.

In the remarks on development and reproduction which follow, only data from normal insects are given. Stunted individuals, taking longer to develop, were sometimes obtained when the

cultures were too crowded or when accidental infection of the medium by certain bacteria and fungi occurred. It was thought, however, that the introduction of data derived from this material would lead to confusion.

THE EGGS.

Repeated attempts at finding the eggs in the field having failed, moths were kept in cages with a layer of soil covered with dry trash on the floor, and containing stalks and leaves of fresh cane. It was found that eggs were laid either in the surface layer of the soil or attached to dry trash, more than half being in the soil. Later a few batches of eggs were found on dry trash in the field at Umfolozi, but it is still difficult to locate them on account of the large quantities of trash that accumulate. Caged moths will lay eggs in tightly folded pieces of paper, and this method is used to obtain eggs for starting cultures.

The eggs are about two-thirds of a millimetre long and slightly under half-a-millimetre wide. They are roughly oval in shape but are flattened when attached to trash and the edges are somewhat modified in shape by contact with other eggs. They are generally laid in batches which may contain from 10 to 200 eggs. The few batches found in the field contained between 150 and 200 eggs, but those laid by moths in cages were generally smaller. At the start of the oviposition period the batches were also larger than towards its close when the moths were producing fewer eggs per day.

When newly laid the eggs are white with a pearly lustre but, if fertile, they become pink on the second or third day, turning brown or blackish on the day before hatching. Infertile eggs shrivel and turn yellow on the second or third day after being laid. Of 600 eggs laid in the laboratory in February, 544 hatched on the fifth day, 41 on the sixth and 5 on the seventh, the remainder failing to hatch. The length of the egg stage is, however, influenced by temperature. Eggs kept at 52°F. for 14 days did not develop, but when they were again brought to a temperature of about 76°F., development continued although more than half of them failed to hatch.

LARVAL AND PUPAL STAGES.

Newly hatched larvæ are about 1.5 mm. in length while when fully grown they vary between 25 and 35 mm. The largest specimens give rise to female moths while the smallest produce males. The length of the larval period is influenced by temperatures, the shortest recorded at Mount Edgecombe being 20 days during January and February, the average at this season being 26 days. Larvæ which hatched in June took an average of 60 days to reach the pupal stage. The shortest larval period at Umfolozi is probably about 16 days. Larvæ which were kept at 52°F. for 14 days became inactive and did not feed, but revived and continued feeding when the temperature was raised again. This suggests the possibility of hibernation or very slow development in the larval stage occurring in the greater part of the sugar belt, where minimum temperatures of this nature, and mean temperatures of around 64°F., are the rule in winter. On the Umfolozi Flats such low temperatures are probably rare and development appears to be continuous throughout the year.

In the laboratory it was found that newly emerged larvæ could live as scavengers on decaying trash and other organic matter, and it is probable that this also occurs in the field, since larvæ less than one centimeter in length have never been found boring in the cane. This suggests the possibility of control in the early larval stage by means of insecticides. The larvæ also show cannibalistic tendencies particularly towards eggs and pupæ.

At Mount Edgecombe the pupal stage, in February, required between seven and fourteen days, with a mean of about ten days. The length of this period is also increased by lower temperatures.

ADULT STAGE.

Adults of both sexes occur in equal numbers but, from eggs laid on the same day, the first males reach the adult stage about four or five days before the first females. Peak emergence for males occurs two or three days before that for females, and females continue to emerge for five or six days after the last males. Distribution curves for the emergence of the two sexes are shown in Fig. 1. The difference is brought about in the larval stage and may be due to the females having one more larval instar than the males, as occurs in some other moths, but this requires confirmation.

The adults start emerging from the pupal cases at sunset, and emergence continues until about 9 p.m. During the day the moths are inactive, becoming active at sunset and continuing so throughout the night. All activity including mating, oviposition and spontaneous locomotion occurs between sunset and sunrise, being completely suspended during the day. Light intensity appears to be the main factor in this periodicity since turning on a 30-watt electric light bulb three feet away from the moths is sufficient to cause a suspension of activity. This, however, does not appear to apply to emergence from the pupal cases which, although it occurs in the period after sunset, is not suspended when the insects are artificially illuminated. A light approximately one eight-hundredth times as bright as that just mentioned is no longer sufficient to inhibit activity and becomes strongly attractive to the moths. Activity is normally greatest shortly after dark, becoming gradually less throughout the night, possibly on account of fatigue although falling temperature may also be a determining factor. There is less activity on colder nights, and older moths are less active than those which have recently emerged.

The chart in Fig. 3, demonstrating activity under different light conditions, was obtained by means of a balanced cage which records on a revolving drum both activity and directional response. A horizontal line indicates a period of inactivity while vertical lines indicate locomotion along the cage. More numerous vertical lines indicate greater activity, while the extent of these oscillations above or below the middle line indicates the position of the moths in the cage. Directional response to a stimulus can be estimated from the extent of the record which occurs on one side of the horizontal middle line.

In the record shown, the first portion was obtained when the moths were in complete darkness in a specially darkened cupboard. At the point marked A, a dim light was turned on at one end of the cage, the movement of the moths to this end being shown by the oscillations occurring mainly below the middle line. At the point marked B, a 30-watt bulb was turned on three feet away, the resulting inactivity being shown by the horizontal line. At the point marked C, the bright light was extinguished and the dim light again turned on. At D, the light was extinguished and the moths were left in total darkness. From this point the oscillations will be seen to be evenly distributed above and below the line, becoming fewer as the night progressed, showing the gradual falling off in activity of the moths. In this test the cage contained three females and four males; the temperature at the start was 74°F.

Mating generally takes place on the night of emergence, although it may be delayed until the next night in cooler weather or in the case of moths emerging later at night. In a test carried out at the end of December, fourteen out of sixteen females laid fertile eggs after being with the males on the night of emergence only. When the temperature at sunset falls below about 65°F., mating does not take place.

Although virgin females lay eggs, development and hatching of these infertile eggs does not occur. A single mating is generally sufficient to fertilise all the eggs produced by each female. Of 24 females left with males for the first night only, 14 laid fertile eggs until the end of the oviposition period, 7 laid a mixture of approximately half fertile and half infertile eggs throughout the laying period, while 3 laid fertile eggs for the first six days and then began to produce infertile eggs. However, similar results were obtained from females left with males throughout life, new males being introduced where mortality had occurred, and it would appear that mating does not take place once oviposition has commenced. Females which had been kept apart for the first three nights and were then caged with males, continued to lay infertile eggs.

Experiments to test whether the males mate more than once were rendered somewhat difficult by the fact that very few of the moths would mate at all when disturbed on the night of emergence. In one experiment, only one male out of twenty, each of which was given a new female each night, succeeded in fertilising two females, one on the night of emergence, and a second, newly emerged female two nights later. In another experiment, twenty males were each caged with four females but in no case did more than one of these females produce fertile eggs. It would therefore appear that, although a second mating is possible, it does not normally occur.

Oviposition by mated females commences on the second

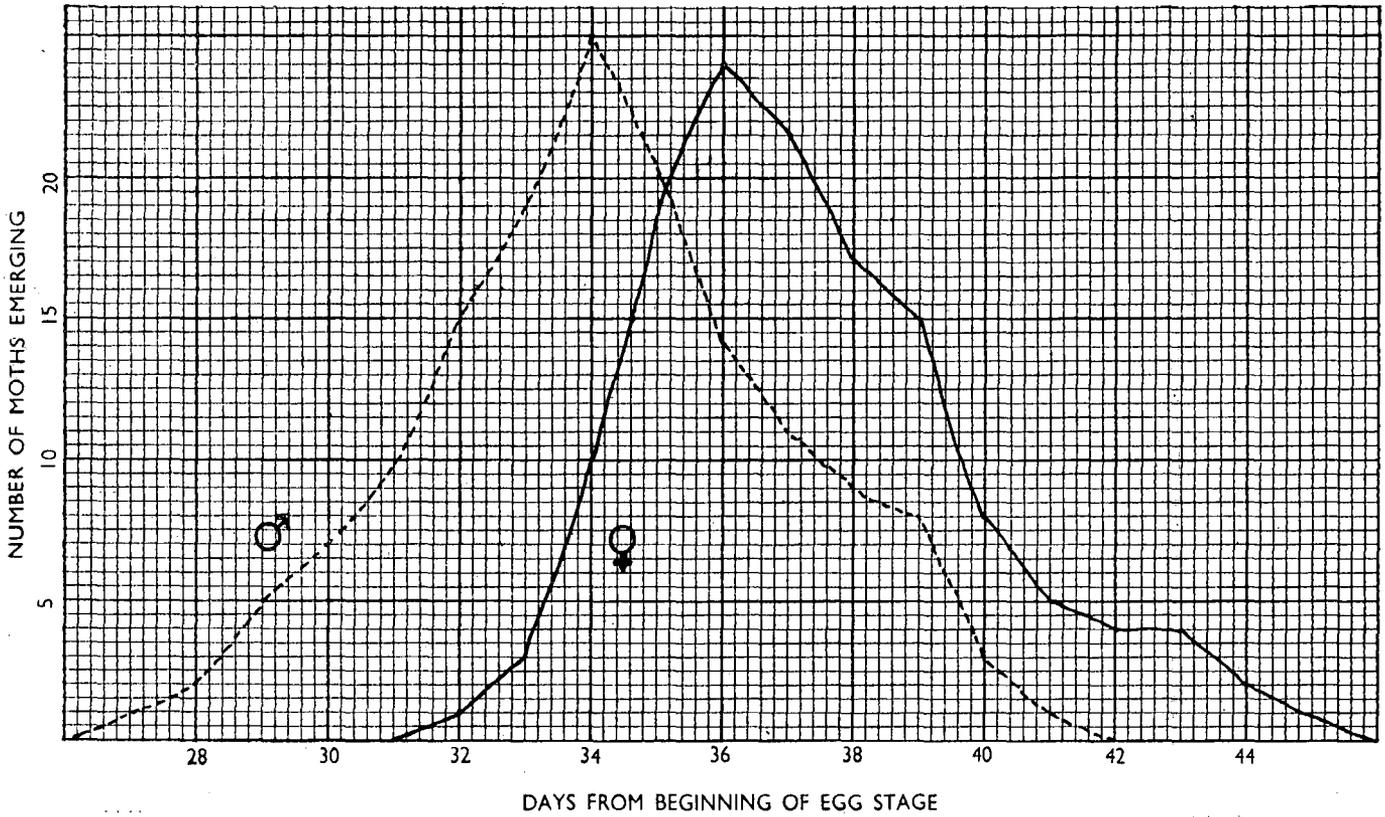


Fig. 1. SHOWING RATE OF EMERGENCE OF MALE AND FEMALE ADULTS OF ELDANA

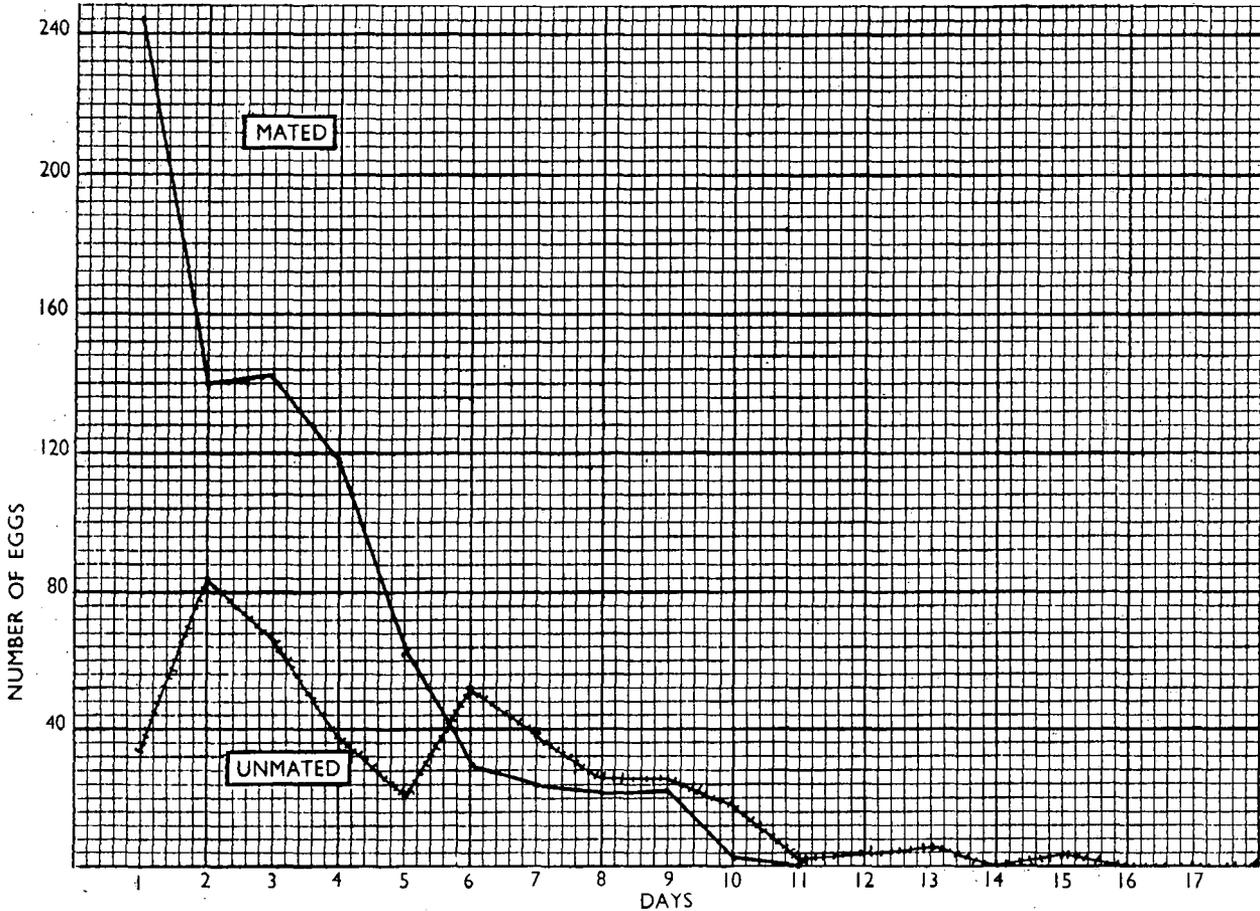


Fig. 2. TYPICAL OVIPOSITION RECORDS FOR MATED AND UNMATED FEMALES OF ELDANA

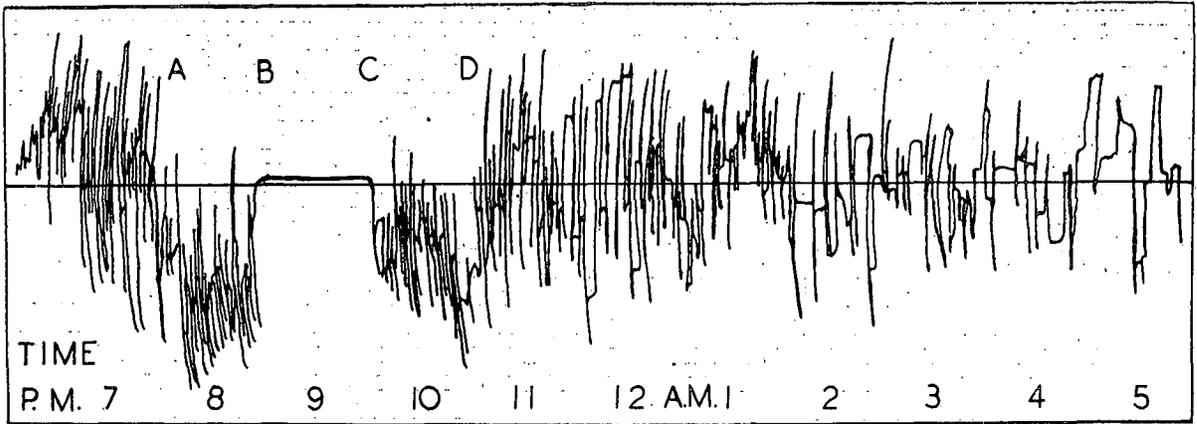


Fig. 3. ACTOGRAPH RECORD SHOWING ACTIVITY AND REACTION TO LIGHT OF ELDANA ADULTS

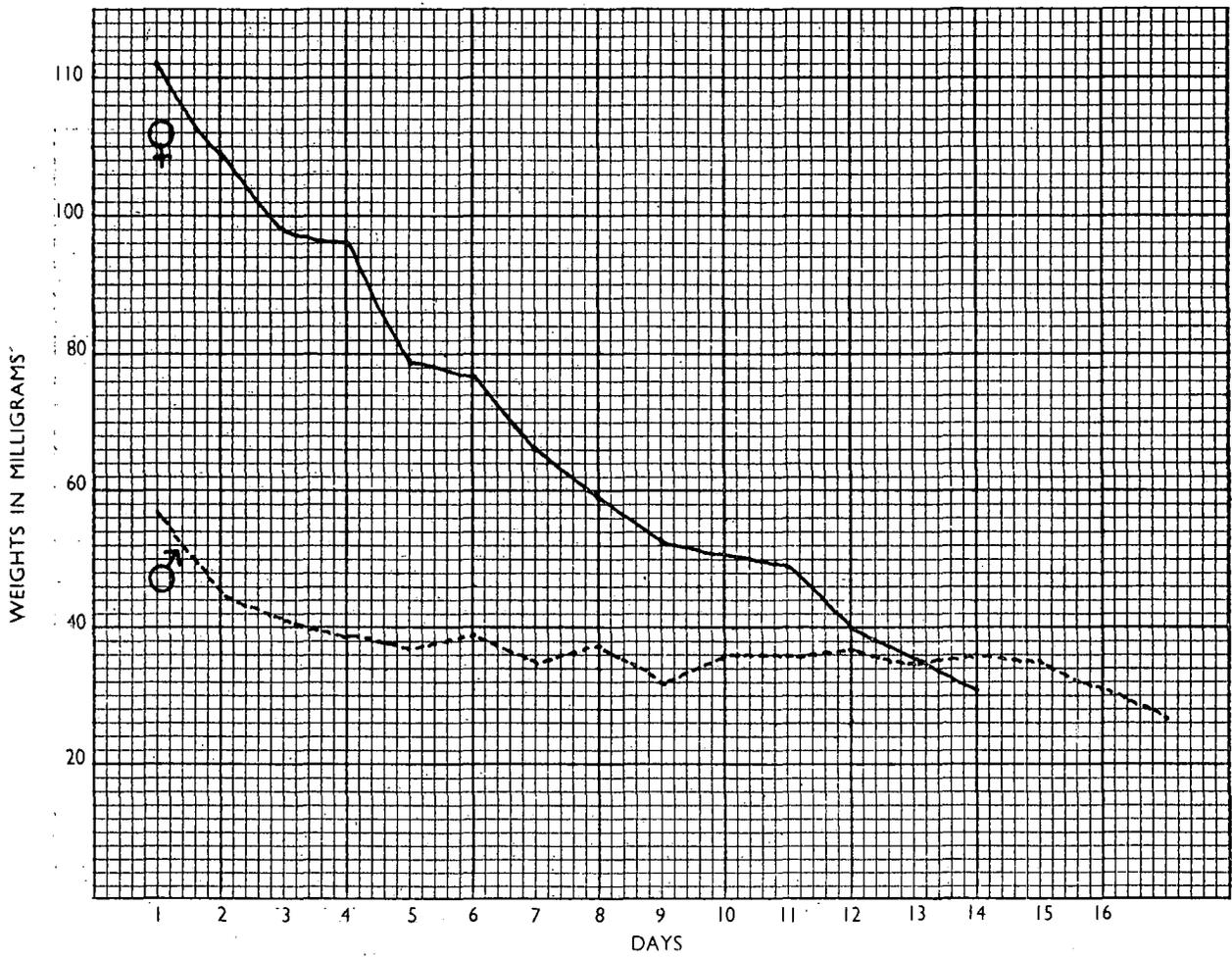


Fig. 4. TYPICAL WEIGHT CURVES FOR MALE AND FEMALE ADULTS OF ELDANA

night after emergence. Unmated females sometimes show a tendency to delay in laying. Thus during the period January to March, of 80 unmated females 59 started laying on the second night, 17 on the third, 2 on the fourth and one each on the fifth and sixth. When the temperature at sunset fell below about 65°F. this tendency to delayed laying was more marked, but mating did not take place, so that the effect of reduced temperature on oviposition by mated females could not be observed.

Mating significantly increases the number of eggs produced, but decreases the length of life of the moths. The average number of eggs per female laid by 16 mated females was 750, with a maximum of 1,004. The average for 16 virgin females was 373, with a maximum of 650. Statistical analysis showed that the significant difference between the means was 163 at 99 to 1 odds. The average length of life of the 16 mated females was 12.0 days, with a maximum of 18, while the average for the unmated females was 18.2, with a maximum of 26. In this case the significant difference between the means was 3.7 at 99 to 1. Graphs showing the oviposition records for mated and unmated females are shown in Fig. 2. Especially in mated females, the number of eggs laid during the first night of oviposition is generally large, the number laid each night rapidly decreasing as age progresses. The largest number laid by one female in one night was 394, these being produced on the first night of oviposition and representing 42 per cent. of the total for this moth. About 70 per cent. of females continued laying until death, but a few remained alive as long as 12 days after laying their last eggs.

The average lengths of life for mated and unmated males were 12 and 15 days respectively, but the difference was not found to be significant, nor was there a significant difference in longevity between males and females.

The adults do not appear to require food, although they drink water. In one series, females given water lived, on an average, 13 days and produced an average of 687 eggs, while the corresponding males lived for 11 days. Females given nothing to drink lived 6 days and produced 312 eggs, the males surviving for 6 days. Females given an 8 per cent. solution of No. 2 sugar instead of water lived 5 days and produced 340 eggs each, the males living for 7 days. Statistical analysis shows that, both in length of life and in oviposition, the moths which were given water were significantly more successful than those left dry or given sugar solution. There was no significant difference between the last two.

The average weight of ten newly emerged females was 113 mg., with a maximum of 135, and that of ten newly emerged males was 58, with a maximum of 69. During adult life the weights of

both males and females decrease, but those of females do so much more rapidly, with the result that at the time of death the weights are more nearly equal. This is due to the utilisation, during the production of eggs, of the large reserves of fat in the female. At the time of death the average weights in the two series were 35 mg. for females and 28 for males. Statistical analysis shows that, although the difference in weight between newly emerged males and females is highly significant, the difference at death is not significant. Fig. 4 shows the weights each day of a typical male and female. The moths in this series were given water, and it is probable that the loss of weight would be more rapid in moths left dry.

SUMMARY.

A short account is given of the history of the outbreak of borer on the Umfolozi Flats. After a summary of observations in the field, an account is given of data obtained in the laboratory at Mount Edgecombe, on the biology of the various stages of the insect, including activity, mating and reproduction in the adults. This information may, to some extent, explain why outbreaks have not occurred in other parts of the sugar belt.

References.

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- ³ Ripley, L. B. et al. (1939): Mass Breeding of False Codling-Moth, *Argyroplaca leucotreta*, Meyr., in Artificial Media. Union of S. Afr., Dept. Agric. & Forestry, Sci. Bull. No. 207.
- ⁴ Vayssière, P. and Mimeur, J. (1925): Dix insectes nuisibles aux cultures de l'Afrique occidentale française. Agron. colon. 94, 116. Paris.

Mr. Du TOIT said he was informed by the Chemist at Umfolozi that some consignments of cane received towards the end of last season were again badly infected with the borer and purities of juice again dropped to a very low figure.

He would like Dr. Dick to describe his method of separating the moths and pairing them without disturbing them and thereby upsetting their natural habits.

Dr. DICK said that at first he did not know that disturbing the moths would upset their habits, but after this fact had been ascertained, the moths were segregated in the pupal stage so as not to disturb them on the night of their emergence.

Experiment Station,
South African Sugar Association,
Mount Edgecombe.
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