A PRELIMINARY ASSESSMENT OF THE EFFECTS OF DIFFERENT CONSTANT TEMPERATURES ON THE REPRODUCTION OF ELDANA SACCHARINA (LEPIDOPTERA: PYRALIDAE)

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Abstract

Studies on newly emerged adults held at constant temperatures of 15°C, 20°C, 25°C and 35°C provided information on the reproductive biology of Eldana saccharina Walker. The following aspects were investigated:

- adult female longevity
- mating success
- oviposition
- egg development.

Female longevity was highest at the lower temperatures and mating was recorded at all temperatures. Fecundity was greatest at 20°C and 25°C, and eggs hatched at both temperatures. At 15°C eggs were fertile but failed to hatch after one month incubation. Eggs laid at 35°C were infertile. Some implications for the distribution of eldana are discussed.

Introduction

Until 1980, the distribution of the borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae) in sugarcane in South Africa was restricted to a relatively narrow coastal zone in Natal, probably limited by cold winter temperatures (Atkinson, 1980). Subsequently, however, field surveys and light trapping showed that eldana had spread into the Midlands. This became particularly apparent in recent drought years. The spread of eldana into a region which, in the past, was regarded as too cold to allow normal larval development (Atkinson, 1980), has raised questions about the biology and adaptability of the insect.

Before these questions can be answered, basic life history studies have to be completed (Price, 1984). These studies should be aimed at determining the biology of eldana at low temperatures. Particular attention should be paid to the effect of temperature on the longevity, mating success and fecundity at the range of temperatures to which it may be exposed. This paper presents data on the effects of constant temperatures of 15°C, 20°C, 25°C and 35°C on the longevity, mating success and fecundity of a laboratory colony of eldana.

Materials and Methods

Pupae were obtained from a laboratory colony held at 26°C and 70% RH maintained on an artificial diet (Graham and Conlong, 1988) at the South African Sugar Association Experiment Station. Adults emerging from pupae from the laboratory colony were placed in temperature cabinets in the dark at constant temperatures of 15°C, 20°C, 25°C and 35°C. The following aspects of the life cycle of eldana were then determined at each of these temperatures:

- mating success
- female longevity
- fecundity
- egg development.

Mating

Mating was ascertained by dissecting females from the 15°C, 20°C, 25°C and 35°C temperature cabinets once they had died (n = 15, 22, 36 and 31 respectively). Mated females were separated from unmated females according to the presence or absence of hardened spermatophores (Atkinson, 1980).

Longevity and fecundity

To measure longevity and fecundity, paired moths were put into paper cups (125 ml) immediately after emergence and monitored for the duration of the female's life. Each cup contained an 8 cm length of fluted wax paper as an oviposition substrate, and water was provided in 7 ml vials with a cotton wick. The cups were then returned to the same temperature cabinet from which the moths had emerged. A total of 45, 38, 104 and 89 pairs were monitored at 15°C, 20°C, 25°C and 35°C respectively.

Any eggs were collected and counted daily and transferred to plastic vials (25 ml) for development and hatching at the relevant test temperature. The vials were maintained for at least one month for egg development.

Results

Longevity

Longevity was inversely correlated with temperature ($y = 21{,}3 - 0{,}49x$, $R = 0{,}95$) (Figure 1). Mean longevity decreased from 15 days at 15°C to 5 days at 35°C.

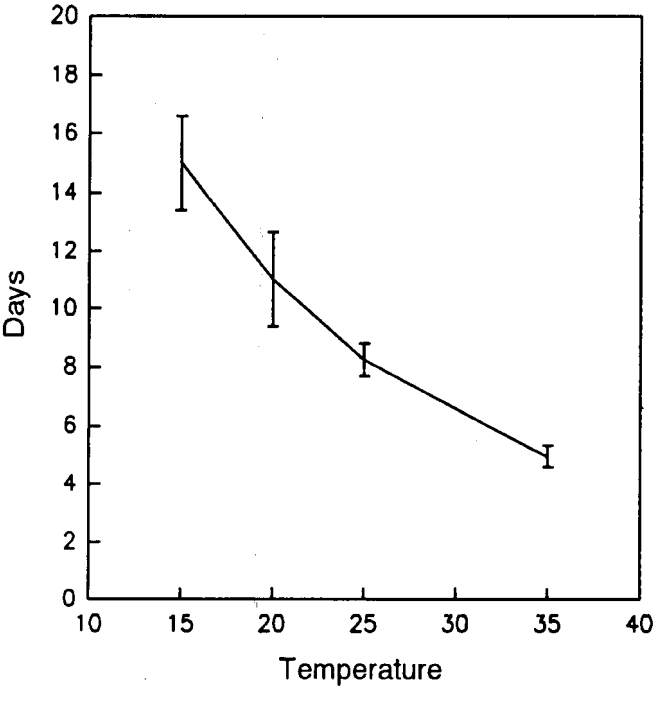

FIGURE 1 Female longevity at four constant temperatures. Values are means with 99% confidence levels.

Table 1

Average fecundity at four temperatures

Temperature °C	Number females	Eggs/ female	SD
15	45	205,78	65,4
20	38	417,74	106,5
25	104	432,84	66,4
35	89	183,19	42,1

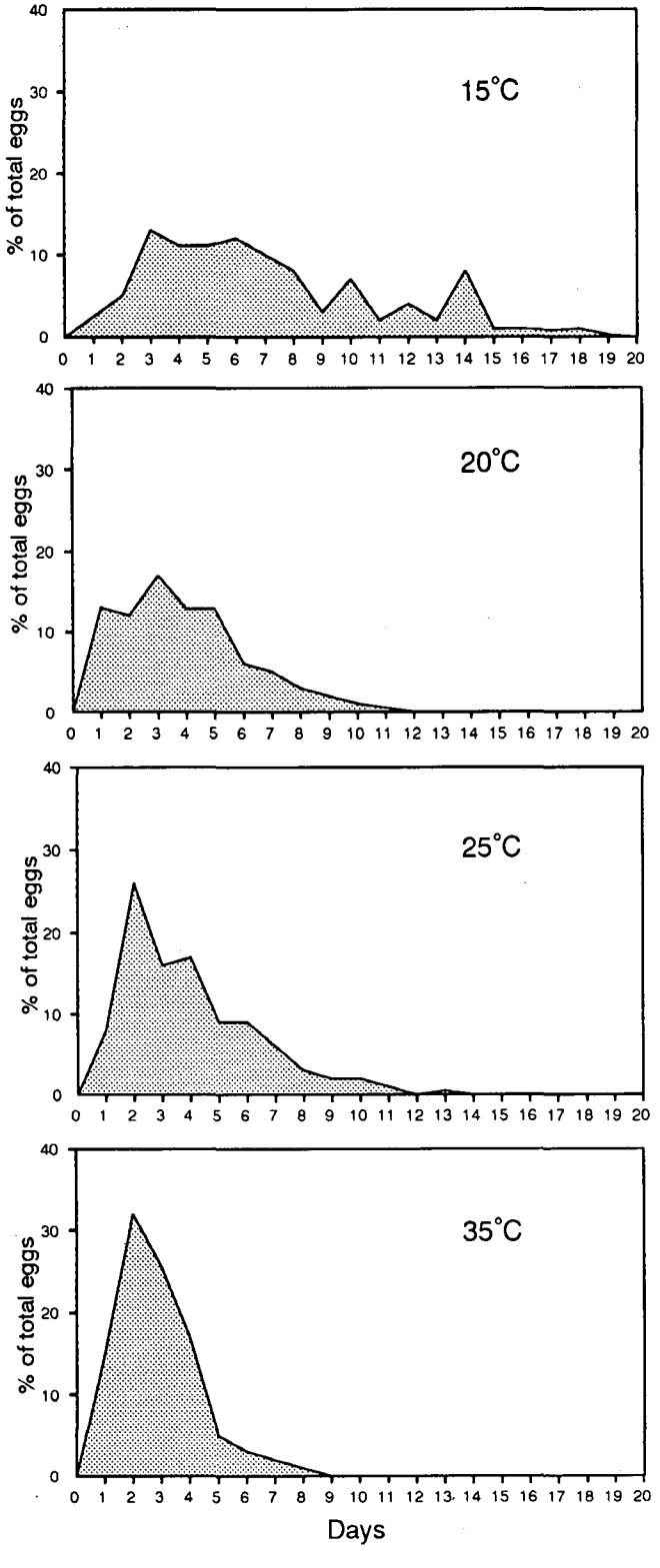

FIGURE 2 Oviposition pattern at four constant temperatures.

Mating success

Females mated at all four temperatures. A total of 47% (n = 15), 64% (n = 22), 75% (N = 36) and 23% (N = 31) had mated at 15°C, 20°C, 25°C and 35°C respectively.

Oviposition

Oviposition occurred at all four temperatures (Table 1). However, the females maintained at 20°C and 25°C laid significantly more eggs (almost double) than those at the extremes of 15°C and 35°C.

More than 90% of eggs were laid within seven days of emergence, except at 15°C (Figure 2). Females reared at 15°C oviposited over a 19 day period, whereas those reared at 35°C laid over nine days only. Those reared at 20°C and 25°C laid over 13 days.

Hatching success

At 20°C and 25°C the percentage egg hatch was 54,9% and 49,3% respectively, whereas no eggs hatched at 15°C and 35°C (Table 2). The percentage eggs hatching decreased as oviposition progressed. At 20°C females laid fertile eggs for seven days after mating, whereas at 25°C fertile eggs were laid for 11 days.

Eggs failed to hatch at 15°C, although females mated at this temperature. To determine whether these eggs were fertile, several egg batches were transferred immediately after they were laid to the 25°C temperature cabinet. A few of these eggs hatched after ten days' incubation at 25°C.

Eggs laid at 35°C failed to develop at this temperature (Table 2), and also failed to hatch after one month's incubation at 25°C. They remained yellow and collapsed, which indicated that they were infertile.

Table 2

Number of eggs hatching at four temperatures

Temperature °C	Number females	Total eggs	Number hatched	% Hatch	SD
15	45	9 260	0	0	
20	38	15 874	8 715	54,9	6,8
25	104	45 015	22 178	49,3	9,3
35	89	16 304	0	0	

Discussion

Generally, insects respond to increased temperature by speeding up development and activity, which results in decreased longevity, and *vice versa* (Chapman, 1969). These results show that the basic response of eldana to temperatures of 20°C and 25°C is no exception. Longevity and fecundity estimated in this study are within the ranges reported elsewhere. For example, Shanower *et al.* (1993) in West Africa studied eldana reared on artificial diet and reported longevity values of 14,6 and 8,8 days, and fecundity values of 474 and 619 eggs/female at 20°C and 25°C, respectively.

There is little published information on the effects of low and high temperatures on the biology of eldana. Dick (1945) found that eggs failed to hatch at 11,1°C but did hatch when transferred to 24,4°C, similar to the results obtained in this study.

One of the theories proposed to explain the presence of eldana in the Midlands is that temperatures have recently increased, making it possible for the insect to be active and to mate at night in a region previously believed to be too cold. This is supported by an upward trend in the winter

temperatures in the Midlands, particularly over the last four years when the mean winter temperatures were 98%, 99%, 102% and 106% of the long term mean. In the summer in the Midlands, eldana is capable of mating because the mean summer temperatures have remained at around 20°C over the last four seasons. The tentative conclusion is that the increasing occurrence of eldana in the Midlands may be linked to warming in this region in winter, coupled with the insect's ability to reproduce at these temperatures.

Another possible theory is that eldana has adapted to the lower temperatures by developing lower development thresholds. This remains to be investigated.

This paper also presents eldana's response to a temperature of 35°C. The results were similar to those obtained at 15°C in that mating and egg laying were recorded; however, the eggs failed to hatch because they were infertile. This result also indicates that the upper threshold temperature for successful mating is between 25°C and 35°C.

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