J.Biol.Control, 6 (2), 72-76, 1992

Temperature - Induced Effects on Predation and Growth of *Eocanthecona furcellata* (Wolff) (Pentatomidae : Heteroptera)

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The effect of different temperatures (15, 20, 25, 30 and 35°C) on growth and food consumption of a pentatomid predator, *Eocanthecona furcellata* were studied in the laboratory. Higher temperatures (25°C) accelerated the growth period thereby reducing the time to the adult maturity, coupled with an increase in the food comsumption. Lower temperatures (20°C), had opposite effects and arrested egg development. Prey capture efficiency increased with increasing temperature. Males killed greater number of prey than did the females, but the latter consumed a larger amount of prey than did the males.

KEY WORDS : *Eocanthecona furcellata*, effect of temperature, prey capture efficiency, *Spodoptera litura*, food consumption, growth, reproduction, prey

Eocanthecona furcellata (Wolff) (= *Cantheconidea furcellata* Wolff) has been documented as a predator of several pests of agricultural crops in southeastern Asia and India (Pant, 1960; David and Basheer, 1961; Ghorpade, 1972; Chu, 1975; Rai, 1978; Gope, 1981; Chien *et al.*, 1984). For successful establishment of an insect predator as a biocontrol agent, it is necessary to understand the food consumption and growth rate of the predator and the impact of temperature which usually influences the predatory efficiency. Reproduction is another factor which is also adversely affected by the extreme temperatures more readily than most other physiological functions and the range of favourable temperatures is correspondingly limited. In the present invetigation, the effect of temperature on the growth rate of the predatory stink bug, *E. furcellata* was studied. A quantitative estimation of the food uptake and prey capture efficiency at various temperatures was also carried out.

MATERIALS AND METHODS

Nymphs of *E. furcellata* were obtained from Mr. M.Takai of Kochi Prefectural Institute of Agriculture and Forestry, Japan, who collected this insect in Ishigaki island, Okinawa Prefecture, Japan in 1989. The bugs were reared in the laboratory at 25°C and 16L:8D photoperiod regime. First instar nymphs were reared in plastic Petri dishes (9 cm dia 2 cm ht.) and provided with distilled water. Second to 5th instar nymphs and adults were kept in groups of 5 to 10 individuals in polystyrene containers (7 cm dia 4 cm ht.) capped with polyethyelene lids having a mesh at the centre allowing air exchange. Larvae of *Spodoptera litura* F. reared on an artificial diet (Wakamura, 1988) were provided as food for the stink bugs. Each experiment had six replicates for each sex and temperature.

To determine the favourable temperature ranges and the effects of temperature on growth and reproduction of the stink bug, second instar nymphs were transferred into polystyrene containers and were kept at 15, 20, 25, 30 and 35°C. Each test group consisted of 5 sub groups of 5 individuals each. Insects were provided with *S. litura* larvae as food and observed daily. All experiments were carried out at 16L:8D photoperiod regime.

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Duration of development was determined by counting the total length of the larval period and the developmental time when 50 per cent or more of individuals reached the adult stage. After the eclosion, all adults were weighed and dissected for the observation of the reproductive organs.

The temperature effect on mating and oviposition was studied by transferring ten mating pairs and ten newly mated females separately at various temperatures. Duration of copulation, number and time of egg laying were recorded. The role of temperature on egg hatching was investigated by placing Petri dishes containing groups of 100 eggs at various temperatures as described above. A wad of moist cotton attached to the lid of the Petri dishes generated humidity.

For the quantitative measurement of the rate of ingestion at various temperatures, 25 adults were divided into 5 groups of 5 bugs each and kept at 15, 20, 25, 30 and 35°C and were allowed to acclimatize for two days prior to the experiment. On day 3, each predator was weighed and replaced with one pre-weighed late third instar larva of *S.litura* (330-350 mg). The predators and the remains of the prey were re-weighed after the feeding stopped. The difference in body weights provided the quantity ingested by each bug. Bugs seldom excreted, but such bugs were discarded for the analysis. The data were subjected to statistical analysis.

To determine the effects of temperature on predator's efficiency of capture, 10 to 12 day - old adults of *E. furcellata* of similar weights were starved for 24 h before tests. Twelve late 3rd instar *S. litura* larvae weighing 310-330 mg were released into glass Petri dishes (12.5 cm dia), along with a small amount of artificial diet (5 g). One predator was released into the Petri dish followed by transfer of the setup into environmental chambers maintaining constant temperatures (15, 20, 25, 30 and 35°C). Number of larvae killed, consumed and alive were counted after 24 h. All predators were weighed prior to the experiments and were re-weighed after 24h to confirm the feeding. A set of controls was run for each temperature to determine prey mortality in the absence of predators.

RESULTS AND DISCUSSION

Temperature affected the growth and reproduction of *E. furcellata*. The eggs hatched normally at 25 and 30°C, but were desiccated at 35°C. Fig.1 shows the mean days of maturity of bugs at each temperature. High temperature (35°C) accelerated the growth thereby shortening the developmental duration. According to Chapman (1971), the normal increase in metabolic rate with increasing temperature is reflected in an increased rate of development. At 30 and 35°C, the bugs grew rapidly, consumed more food and consequently became heavier than those reared at other temperatures. The resulting heavier adults laid more number of eggs than did the others, a phenomenon which has been reported for a number of other insect species (Markkula and Roivainen, 1961; Doane, 1963). At these temperatures, the predators were much more active and moved faster than at low temperatures. The high temperatures also caused an increase in cannibalism. This is one of the reasons for the decrease in the percentage nymphs molted to adults.

Growth of *E. furcellata* was very slow and the final size was smaller at 15 and 20°C as compared to growth at 25°C. Adults weighed less and had a prolonged developmental duration. However, these nymphs when transferred to 25°C and above developed promptly. At 15 and 20°C, after the prolonged duration, 80 per cent of the nymphs succeeded in molting into adults, but the sexual maturation was not achieved and there was no reproduction in the adults. This reproductive arrest in both sexes was characterized by cessation of feeding and mating, coupled with under development of reproductive organs in females. It is well known that high temperatures tend to avert diapause in arthropods,

Table 1. Effect of temperature on amount of food ingested by the predatory stink bug, *Eocanthecona furcellata*

Temp. °C	Mean quantity of *S.litura* ingested (a) (mg, mean ± S.D)		% bugs observed feeding	
	Female	Male	Female	Male
15	7.3 ± 5.6 (26)	5.2 6.1 (30)	65	53
20	12.0 ± 1.1 (28)	10.7 9.8 (29)	69	75
25	56.2 ± 1.6 (30)	22.4 7.0 (30)	100	99
30	58.0 ± 1.3 (30)	26.8 9.1 (30)	100	100
35	64.7 ± 1.4 (30)	28.7 6.5 (30)	100	100

(a) Figures in parenthesis indicate the number of insects tested

while low temperatures favour the arrest of growth (Lees, 1955). With *E. furcellata*, this study has shown that at somewhat lower temperature than the optimum, nymphal development was slowed down, but diapause did not set in. Nymphs whose development was delayed at 15 or 20°C, developed promptly when transferred to 25°C or above, indicating that low temperature did not induce diapause. Low temperatures (15 and 20°C) arrested development of eggs too, with no eggs hatching even after 30 days.

When the bugs which initiated mating at 25°C were transferred to 15 and 20°C, duration of mating period was prolonged up to 48 ± 1 h (n = 12) and 30 ± 2 h (n = 12) respectively from the normal mating period of 5-6 h at 25°C. However, the mating period was shortened to 2.5 ±0.5 h (n = 10) at 30 and 35°C.

Females reared at 25°C and transferred to various temperatures immediately after mating, failed to lay eggs at 15 and 20°C. Normal oviposition took place at other temperatures.

The quantitative measurements of food ingestion by *E. furcellata* at different temperatures are given in Table 1. Tempera-

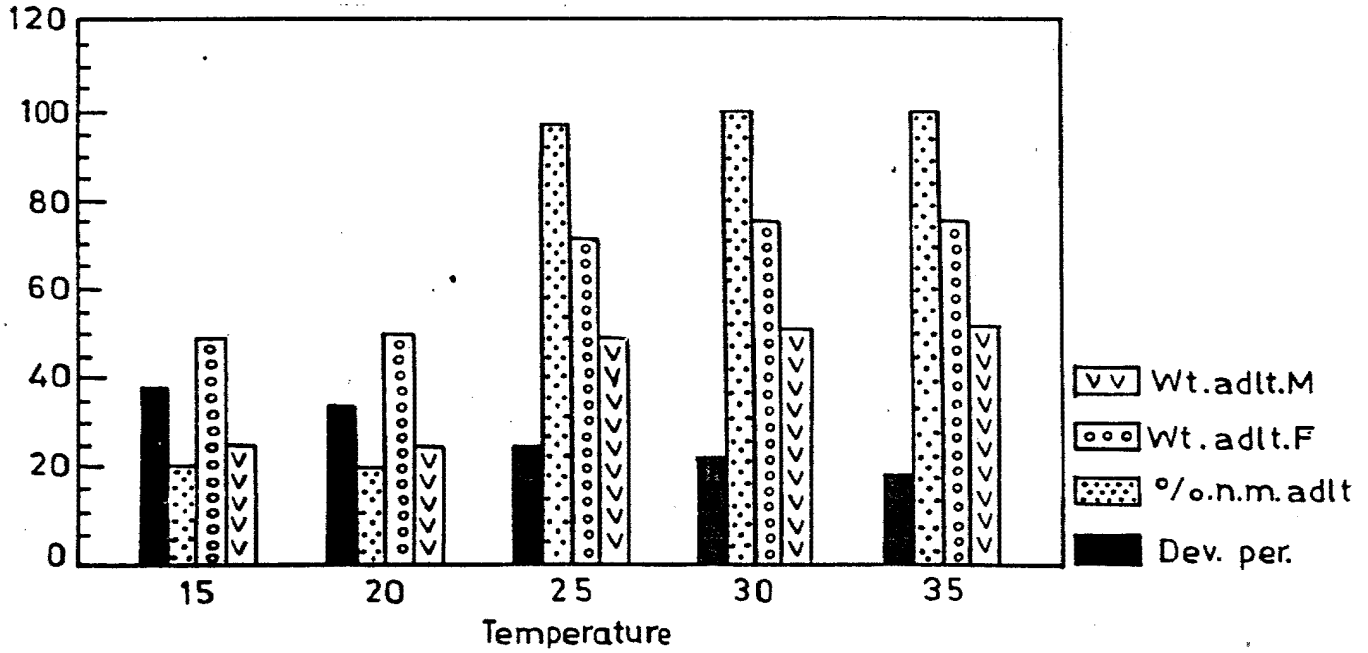

Fig.1. Effect of temperature on development of *Eocanthecona furcellata*. Values are mean ± S.D. (n=30) at each temperature

ture influenced feeding behaviour of predators in two ways. The first is the percentage of animals that fed and the second is the rates of feeding in those individuals in which this occurred. Lower temperatures (15 and 20°C) reduced the percentage of predators feeding and lowered the food intake. The percentage of animals feeding and the rate of ingestion increased almost linearly with the temperature. In almost all cases, females fed more than the males.

The higher food intake at 30 and 35°C could presumably be due to the temperature effect on gut clearance of *E. furcellata* because the environmental temperature influences the rate of digestion and assimilation of food, hence the rate of change of gut state with time after a meal (Giller, 1984). The rate of change seemed to be much slower at the lower temperature, increasing the time over which prey can be detected. Again this may be due to food remaining for longer periods within the foregut.

Efficiency of prey capture of *E. furcellata* increased with increase in temperature (Fig. 2), along with the number of prey consumed. At 30 and 35°C, the movement of predators as well as prey were faster. The overall number of prey consumed and also the quantity ingested were more at 30 and 35°C than those at 25°C. At temperatures below this, the predatory efficiency was lowered and the general movement of the predator and prey was slow. However, the number of prey killed (but not consumed) increased with the raise in temperature up to 25°C. These results conform with those of Awan (1988) who observed a lower predation rate at lower temperature that increased as the temperature increased in the case of the Pentatomid predator, *Ochalia schellenbergii* Guerm- Meneville.

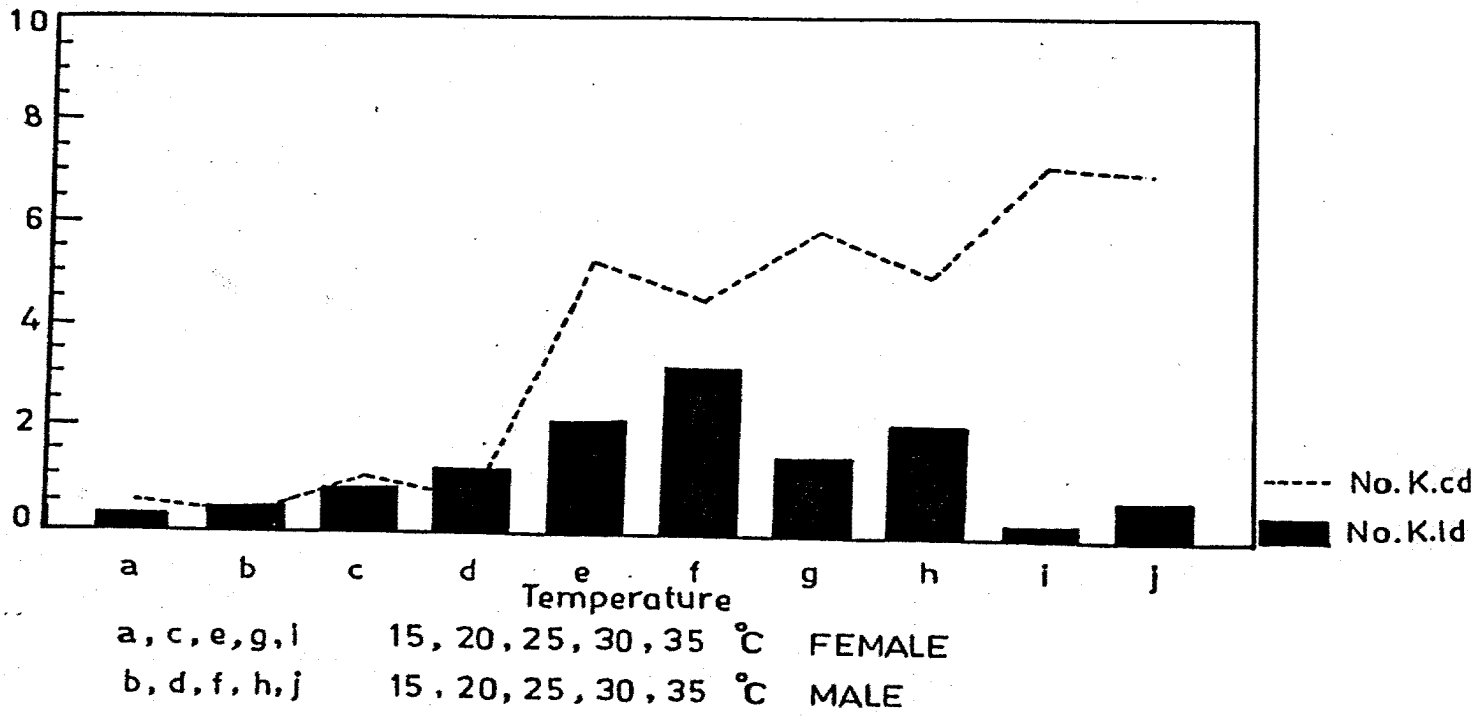

Fig.2. **Prey capture efficiency of the predacious stink bug *Eocanthecona furcellata* at various temperatures.** Values are mean ± S.D. of 13 predators. Each predator offered with 12 3rd instar ***Spodoptera litura*** larva for 24 h

A marked difference in the prey capture efficiency and amount of prey consumption between the sexes of the predator was observed. At almost all the temperatures tested, males killed greater number of prey than did females with the latter consuming more prey body contents. Awan (1988) noted that females of *O.schellenbergii* always consumed more number of caterpillars irrespective of searching conditions and temperature regimes. Although the predatory efficiency in the field conditions are yet to be known, this laboratory study indicates that *E. furcellata* can be used as a potential biocontrol agent to reduce the natural cutworm populations at warm and temperate climates.

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