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EFFECT OF TEMPERATURE ON THE REPRODUCTIVE BIOLOGY OF *GONIOZUS NEPHANTIDIS* MUESEBECK (HYMENOPTERA: BETHYLIDAE), A LARVAL PARASITOID OF *OPISINA ARENOSELLA* (WALKER)

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ABSTRACT
The effect of four constant temperatures, ranging from 20 to 35^{0}C on the oviposition, longevity, development and emergence of *Goniozus nephantidis* (Muesebeck) were tested using coconut black headed caterpillar, *Opisina arenosella* as host insect. It was found that the optimum temperature for maximum progeny production was 30^{0}C (116.80 + 4.08 eggs) followed by 25^{0}C. Production of Goniozus severely hampered at 35^{0}C (46.16 + 7.40 eggs). Longevity of male and female parasitoids was inversely related to temperature. Sex ratio was in favour of female at all temperatures except 35^{0}C where a reversal of sex ratio was observed. Male and female *G. nephantidis* took significantly longer time (21 and 24.35 days, respectively) at 20^{0}C to complete their lifecycle, whereas shortest development period of 13.50 and 14.20 days for male and female respectively was recorded at 35^{0}C. It appears, therefore, that 25 to 30^{0}C temperature regime would be optimum for mass culturing of the parasitoid, *G. nephantidis*.

KEY WORDS: *Opisina arenosella*, *Goniozus nephantidis*, Temperature, Mass culturing

INTRODUCTION

Among various insect pests infesting coconut palm, *Opisina arenosella* Walker (Lepidoptera: Oecophoridae) stands out as predominant leaf feeder in peninsular India. This caterpillar attacks palms of any age from nursery to grown up plants causing severe yield loss ranging from 25 to 75 per cent (Lal, 1968). Severe damage to coconut leaflets results in reduction in the number of flower spikes produced, increased immature nut fall and retardation of growth (Dharmaraju, 1963). Among the different natural enemies recorded on this caterpillar, the larval parasitoid *Goniozus nephantidis* (Muesebeck) was considered to be very efficient in the field due to its specificity. Moreover it is also amenable for mass rearing in the laboratory (Rao *et al*., 1948). Temperature critically influences the bio-attributes of parasitoids. It is attributed to be a major determinant in survival and development of immature stages and reproductive performance of the parasitoids (Chandrika Mohan *et al*., 2004). Studies on the effect of temperature may contribute to effective mass rearing and regulating field releases in adverse environmental conditions for more effective utilization of the bio-agents. Keeping above facts in view, the present investigation was undertaken to find out the optimum temperature requirement for growth and development of the parasitoid.

MATERIAL AND METHODS

Cocoons of *G. nephantidis* were collected from *O. arenosella* infested coconut leaves in a garden. From this culture, a pair (male and female) of freshly emerged adult parasitoids was placed in glass test tubes (25 x 100 mm) covered with cotton plug and allowed to mate. Diluted honey (1:1) was provided as adult food. The honey was placed on a strip of plastic sheet in the form of tiny droplets and introduced into the glass tubes. These tubes were kept in the BOD incubator set at a fixed temperature. One healthy 7th instar larva of *O. arenosella* was introduced into the glass tube and observed daily for egg laying. The parasitized larvae were removed on observing egg laying and fresh larvae were provided to the parasitoid till the death of female parasitoid. The parasitized larvae were kept individually in glass tubes at same temperature regimes and observed for adult emergence. Male and female progeny that emerged were sorted and counted separately. Various parameters such as fecundity, progeny sex ratio, developmental mortality and developmental time were recorded in all temperature regimes. Forty replicates were maintained for each temperature assessed. After emergence of wasps from cocoons, their longevity was determined by keeping them in glass tubes, under same controlled conditions as they were handled at pupal stage. Diluted honey on daily basis was provided as food source of adult parasitoids. The data generated was subjected to an analysis of variance test. When statistical differences existed within a data set, Duncan's multiple range test was used to separate the means.

RESULTS AND DISCUSSION

Data synthesized revealed significant variation in pre-oviposition period, fecundity, sex ratio and longevity of male and female parasitoids emerged from *O. arenosella* under various temperature conditions ranging from 20^0 C to 35^{0}C (Table I).

Pre-oviposition period: Time take by the female parasitoid to begin egg laying on *O. arenosella* was least (4.20 ± 1.00 days) at 35^{0}C and it was on par with those under 30^{0}C (4.25 ± 0.63 days), followed by 4.90 ± 0.71 days at 25^{0}C. However, more time was taken by the parasitoid at the lower temperature level of 20^{0}C (7.50 ± 1.46 days). Akin to this, Dharmaraju and Pradhan (1976) observed 5 days

of pre oviposition period at 30^0C and 70% RH for the same species of parasitoid.

Fecundity and sex ratio: The parasitoid showed a great deal of variation in progeny production at various constant temperatures. Optimum temperature for maximum progeny production (116.80 ± 4.08 eggs) was found to be at 30^0C, which was followed by 25^0C (97.95 ± 11.30 eggs), while the average number of eggs per female declined to 57.35 ± 8.50 and 46.16 ± 7.40 eggs at 20^0C and 35^0C, respectively. Chandrika Mohan *et al*., (2004) found zero oviposition by *G. nephantidis* at temperature regimes of 10-15^0C; higher fecundity of 42 eggs per female at 30^0C and lowest of 17 eggs per female at 20^0C.The sex ratio of the progenies produced was not significantly different at the temperatures of 25^0C and 30^0C (0.11 and 0.10 males, respectively). At 20^0C, the sex ratio was found to be slightly male biased (0.14 males), whereas, a male dominated progeny was produced at 35^0C (0.28 males). The suggested reasons for this could be non viability of sperms or lack of fertilization (Force and Messenger, 1964) or differential mortality of sexes (Hekal, 1990). Both these reasons can be tenable in the case of *G. nephantidis*, since male biased sex ratio of progeny resulted from rearing at 35^0C. Although exact reasons for better survival rates of males at higher temperatures are not known, it does provide vital clues regarding the consideration of weather parameter during the field release program.

Longevity: The average longevity of both males and females emerged from *O. arenosella* was inversely related to temperature. It was also observed that female of *G. nephantidis* out lived male at all the temperatures regimes. Maximum longevity was observed at 30^0C where male lived for 9.40 ± 3.42 days and female for 29.60 ± 8.60 days. Shortest longevity was observed at 35^0C with male and female surviving for 3.30 ± 1.20 and 15.55 ± 4.11 days, respectively. In the remaining temperatures of 25^0C and 20^0C, the male and female lived for 8.00 ±2.97, 26.30 ± 8.75 and 5.10 ± 2.17, 19.20 ± 9.68 days, respectively. Similar results of decreasing adult longevity with increasing temperature were reported in another bethylid parasitoid, *Parasierola* sp., parasitizing *Pectinophora gossypiella* (Hekal, 1990).

Duration of development: Developmental duration of male parasitoid was found to be shortest when reared at 35^0C and longest at 20^0C. Total duration of development of male parasitoid at 20^0C, 25^0C, 30^0C and 35^0C was 21.00 ± 1.00, 17.65 ± 0.69, 15.10 ± 0.85 and 13.50 ± 1.20 days, respectively (Fig. 1). Developmental period of female *G. nephantidis* was also found to be significantly different when reared at various constant temperatures. Female *G. nephantidis* completed its life cycle in shortest period of 14.20 ± 2.00 days at 35^0C followed by 17.00 ± 1.50 days at 30^0C and 19.5 ± 1.72 days at 25^0C. Development was prolonged to 24.35 ± 3.40 days when parasitized host larvae were reared at 20^0C.

Survival of Progeny: Extent of successful completion of various stages of life cycle of parasitoid varied significantly across temperatures (Table II). Hatching of eggs of *G. nephantidis* was found to be highest (92.15%) when the parasitized host was reared at 30^0C, which was on par with those reared at 25^0C (91%) followed by 86.20% at 20^0C. However, the hatching was found to be the least at 35^0C (76.10%). Similarly, maximum pupation was recorded at a constant temperature of 30^0C and 25^0C (92.85% and 94.55%, respectively). Lowest successful pupation of 88 %, was noticed at 35^0C.

G. nephantidis adults developed and emerged successfully at all the temperatures tested. The per cent emergence at 30^0C was significantly higher (98.05%) and was at par with those reared at 25^0C (97%) followed by 20^0C (89.20%) and 35^0C (72%). Information generated during current investigation suggests that temperature ranging from 25 to 30^0C would be an optimum regime for rearing and mass culturing of *G. nephantidis* parasitoid.

TABLE I: Effect of different temperature regimes on biological parameters of *Goniozus nephantidis* on *Opisina arenosella*

Temperature (^{0}C)	Pre oviposition period (Days)	Fecundity	Sex ratio*	Adult longevity (Days)	
				Male	Female
20	7.50^c (± 1.46)	57.35^c (± 8.50)	0.14^b	5.10^b (± 2.17)	19.20^b (± 9.68)
25	4.90^b (± 0.71)	97.95^b (± 11.30)	0.11^a	8.00^a (± 2.97)	26.30^a (± 8.75)
30	4.25^a (± 0.63)	116.80^a (± 4.08)	0.10^a	9.40^a (± 3.42)	29.60^a (± 8.60)
35	4.20^a (± 1.00)	46.16^d (± 7.40)	0.28^c	3.30^c (± 1.20)	15.55^b (± 4.11)

* Proportion of males per female

Mean denoted by the same letters on each column are not statistically different by (p=0.05) DMRT

Figures in parenthesis are values for standard deviation from the mean

TABLE II. Effect of temperature on the developmental stages of *Goniozus nephantidis* reared on host, *Opisina arenosella*

Temperature (^{o}C)	% hatching	% pupation	% adult emergence
20	86.20 (68.19)^b	88.00 (69.73)^b	89.20 (70.81)^b
25	91.00 (72.54)^a	94.55 (76.44)^a	97.00 (80.02)^a
30	92.15 (73.68)^a	92.85 (74.44)^a	98.05 (81.87)^a
35	76.10 (60.73)^c	82.40 (65.20)^c	72.00 (58.05)^c

Mean denoted by the same letters on each column are not statistically different by (p= 0.05) DMRT

Figures in the parenthesis are arc sine transformed values

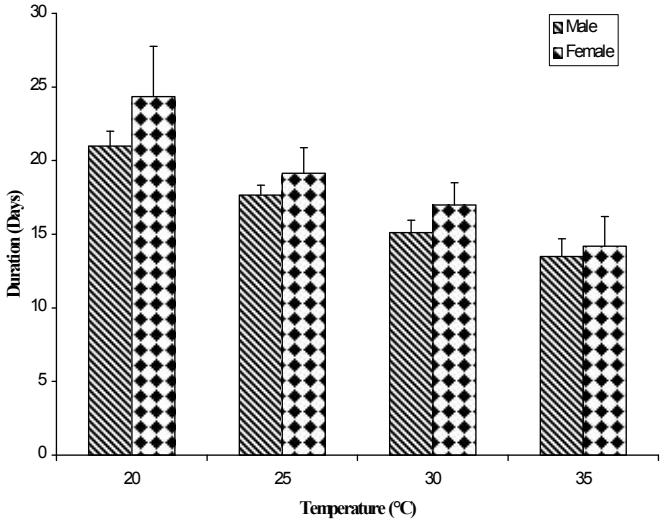

Fig 1. Total development period (egg to adult) of *G. nephantidis* at different temperature regimes

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