INFLUENCE OF TEMPERATURE ON *PLASTANOXUS WESTWOODI* (KIEFFER) (HYMENOPTERA: BETHYLIDAE), AN ECTOPARASITOID OF RED FLAT GRAIN BEETLE *CRYPTOLESTES PUSILLUS* (SCHON.) (COLEOPTERA: CUCUJIDAE)

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ABSTRACT

Plastanoxus westwoodi is one of the dominant ectoparasitoid of *Cryptolestes pusillus*. The influence of temperature on parasitoid development, survival and some selected life history parameters was determined. At 15°C, developmental time was highest but at 35°C it was lowest. Maximum numbers of progeny/female/day (5.25±1.08) were produced at 25°C and minimum were 0.45±0.02 at 35°C. The sex ratios (% female) of *P. westwoodi* were 41.38, 45.53, 58.52, 61.01 and 41.40 for 15, 20, 25, 30 and 35°C respectively. Survivorship of ovipositing females was highest at 25°C but lowest at 35°C respectively.

INTRODUCTION

The development of parasitoids is usually delayed at low temperatures (Scopes *et al.*, 1973) and as a result, the rate of population growth becomes lower (or under extreme condition, zero or negative). As temperature increases, the rate of developmental activity of individuals increases and mortality falls, as a result, the rate of population growth becomes higher. All the species have an optimum temperature at which population growth is at its maximum level. Insects are poikilothermic and its rate of development varies with temperature (Andrewartha and Birch, 1954; Kitching, 1977).

Plsatanoxus westwoodi (kieffer) is a hymenopteran parasitoid that is frequently found with the red flat grain beetle, *Cryptolestes pusillus* (Schon.) in stored grain (Ahmed and Khatun, 1996a). This external parasitoid prefers to parasitizes fourth instar; however, it paralyze and feed on first through third instars (Ahmed and Khatun, 1996b). *P. westwoodi* may often prevent flat grain populations from reaching damaging levels and may be potentially useful as a biological control agent.

The effects of constant temperatures on the life history parameters of different hymenopteran parasitoids have been studied (Cave and Gaylor, 1988; Lysyk and Nealis, 1988; Flinn, 1991; James and Warren, 1991; Smith, 1992 and Lysyk, 1998). But no information on the impact of constant temperature of the parasitoid, *P. westwoodi* on *C. pusillus* are available. This led to the present study.

MATERIALS AND METHODS

The test insect, *C. pusillus* and parasitoid, *P. westwoodi* were collected from the established stock cultures maintained in Control Temperature (CT) room, Integrated Pest Management Laboratory, Institute of Biological Sciences, Rajshahi University since ten years. Newly emerged healthy and mated female parasitoids were introduced into small glass vial (size 4.5×1.1cm) containing 0.50 gm wheat flour and 25 larvae of *C. pusillus* (16-20-days-old). The mouth of each vial was covered with cotton. It is important to control host size because it affected parasitoid's life history traits (Okamoto, 1972; Bellows, 1985). Five different glass vials with constant host numbers and constant host ages were maintained separately for a single mated female parasitoid for oviposition up to 24 hour at 15°C in an incubator. The ovipositing female was reintroduced after every 24 hour and the parasitized larvae were kept at the same incubator for further development. This procedure was continued till the death of the female parasitoid.

All the experiments were replicated 5 times. The same procedures were conducted at 20, 25, 30 and 35°C. The data on the effects of developmental time, progeny production, immature mortality, percentage of sex progeny and adult longevity in different experiments were also noted. The data were analyzed by analyses of variance (ANOVA).

RESULTS

The relationship between temperature and developmental time of *P.westwoodi* varied inversely. Mean development times from oviposition to adult emergence at different constant temperatures have been shown in Figs. 1 A and B.

Developmental time and its variance increased with the decreasing temperatures. *P. westwoodi* completed development at all the temperatures conducted (15, 20, 25, 30 and 35°C) and their durations were 30.71±0.47, 24.53±0.43, 15.92±0.57, 12.35±0.47 and 10.54±0.34 days for males and 32.55±0.75, 26.13±0.38, 17.52±0.50, 13.24±0.42 and 11.21±0.33 days for females respectively. The males always emerged earlier than the females in all the cases. The effect of temperature on the developmental time was highly significant (P<0.01).

The age specific distributions of the developmental time varied on different degress of temperature for *P. westwoodi* (Figs. 3 A B C D E). Both male and female parasitoids developed at all the temperatures observed. At 15°C, developmental time was highest but it was lowest at 35°C.

The mean numbers of progeny production per female of *P. westwoodi* at 15, 20, 25, 30 and 35°C temperatures are shown in Figs. 2 A and B. The mean progeny production per female for males were 4.25±0.08, 15.55±2.45, 17.15±1.08, 13.56±3.78 and 3.00±0.06 and for females were 3.15±0.07, 13.23±3.78, 24.43±2.45, 21.29±2.45 and 2.12±0.06 at 15, 20, 25, 30 and 35°C respectively.

Figs. 1-A. Mean developmental times (in days) of *P. westwoodi* at different temperatures (°C)
1-B. Relationship between developmental time (in days) and temperature (°C) of *P. westwoodi*

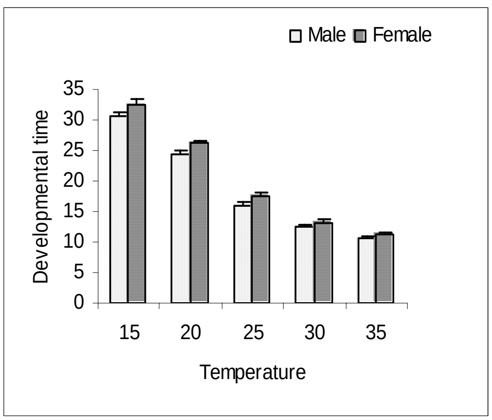

Fig.1-A

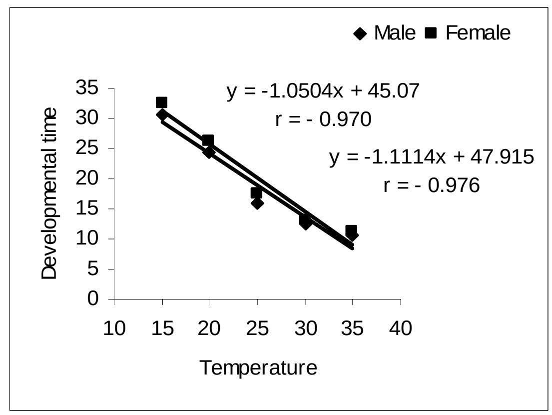

Fig.1-B

Figs.-2. A, B, C, D, E Age specific distribution of the developmental time of *P. westwoodi* in relation to temperature

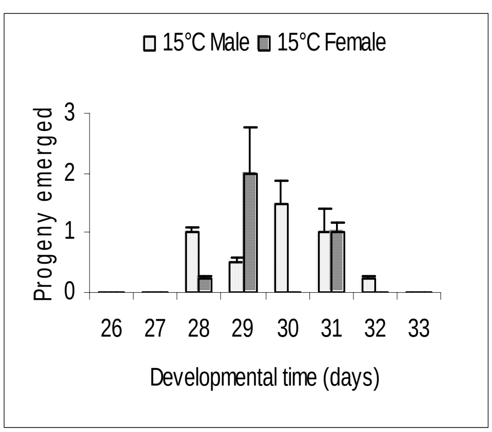

Fig.2-A

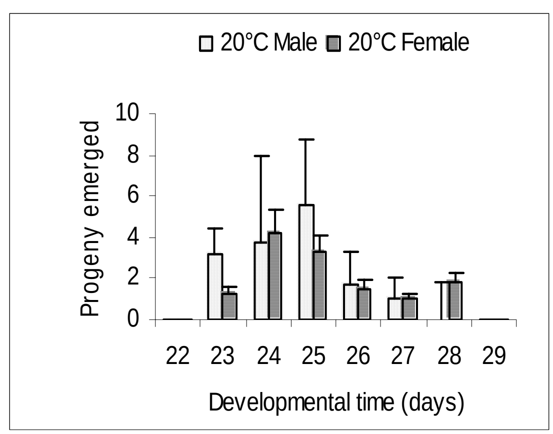

Fig.2-B

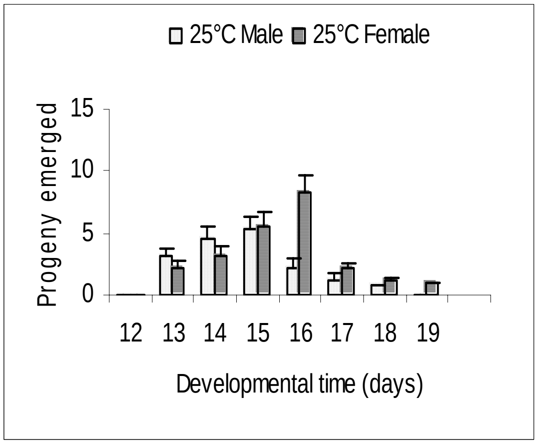

Fig.2-C

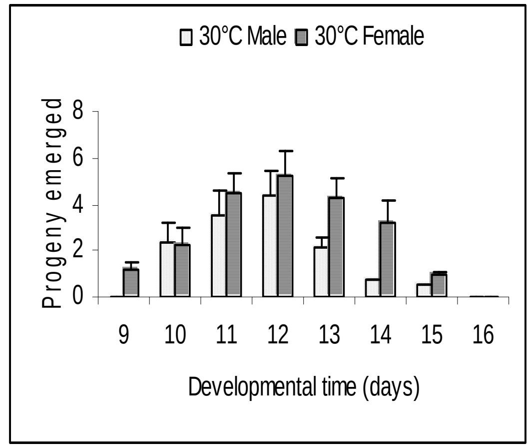

Fig.2-D

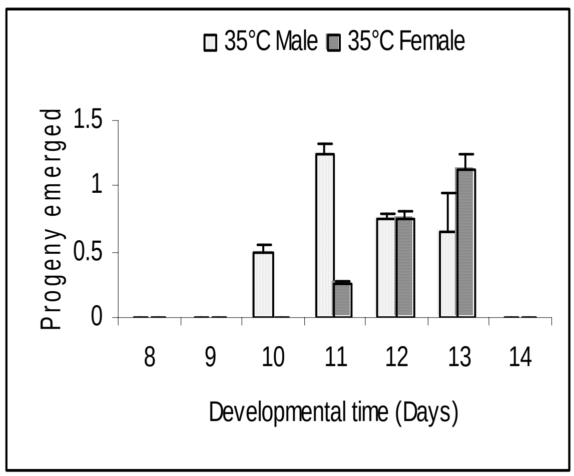

Fig.2-E

Figs. 3-A Mean number of progeny production/female of *P. westwoodi* at different temperatures
3-B Relationship between progeny production/female and temperature (°C)

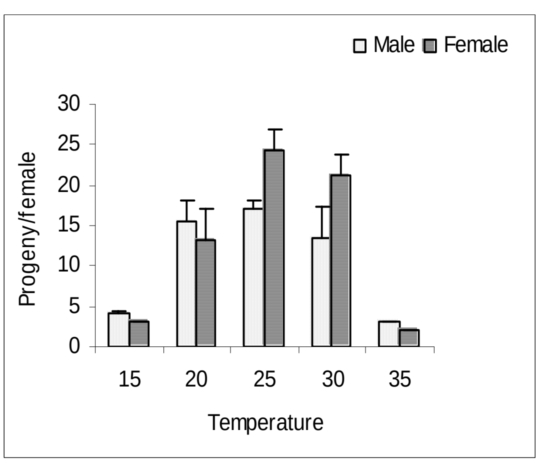

Fig.3-A

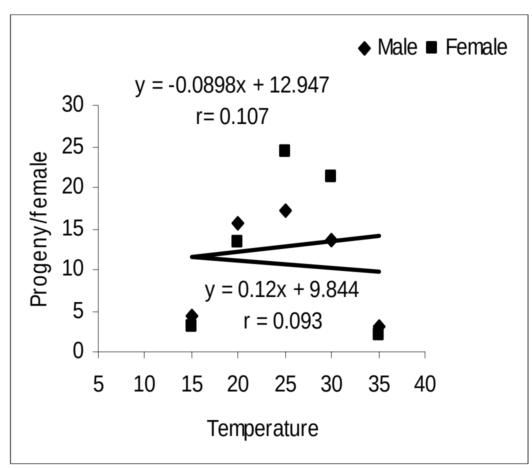

Fig.3-B

Fig.4. Mean number of progeny/female/day of *P. westwoodi* at different temperatures (°C)

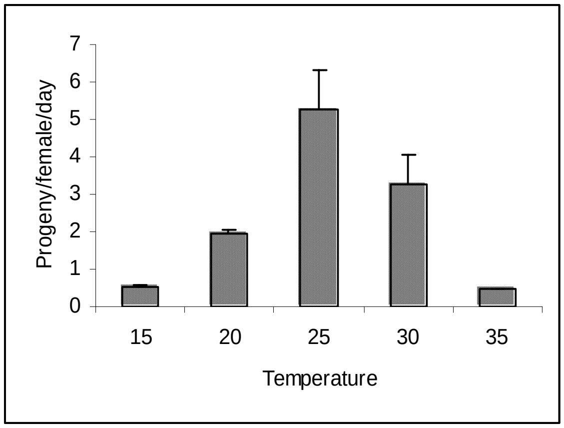

Fig.4

Fig.5. Mean adult female longevity (in days) of *P. westwoodi* at different temperatures (°C)

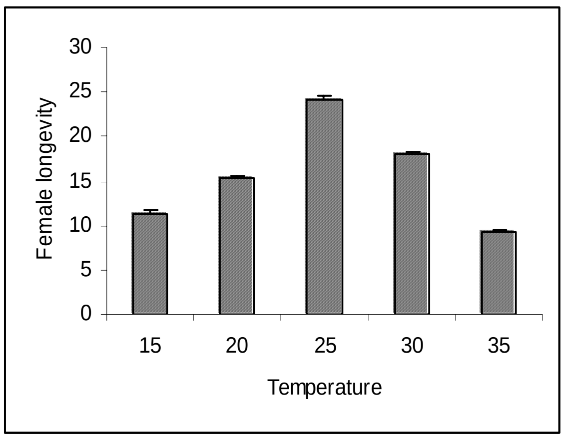

Fig.5

Figs.6-A Sex ratio (% female) of *P. westwoodi* at different constant temperatures (°C)
6-B Relationship between sex ratio (% female) and temperature (°C) of *P. westwoodi*

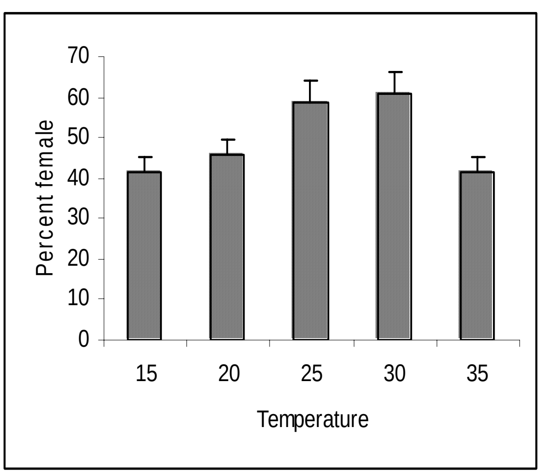

Fig.6-A

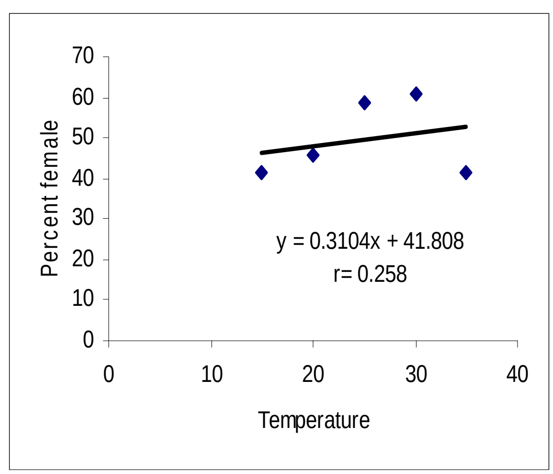

Fig.6-B

Maximum number of progeny (41.35±4.26) were produced at 25°C. The percentage of progeny were more or less female biased at all the temperature gradients, and these experiments revealed that the females were more successful in emerging from the parasitized larvae (*C. pusillus*) than the males. Analysis of variance shows that there is a significant ($P<0.01$) difference in progeny production at various temperatures. Mean production of males and females varied with different temperatures. The interaction between sex and temperature was also highly significant ($P<0.01$).

The rate of daily progeny production were 0.55±0.02, 1.95±0.08, 5.25±1.08, 3.25±0.08 and 0.45±0.02 at 15, 20, 25, 30 and 35°C respectively (Fig. 4). Maximum number of progeny/female/day (5.25±1.08) were produced at 25°C. Significant difference ($P<0.01$) was found in progeny/female/day at different degrees of temperatures.

The sex ratios (% female) of *P. westwoodi* were 41.38, 45.53, 58.52, 61.01 and 41.40 (Figs. 5 A B) for 15, 20, 25, 30 and 35°C. There was significant difference ($P<0.01$) between sex ratios (% female) of *P. westwoodi*.

Mean longevity (=survivorship) of ovipositing female parasitoids has been shown in (Fig. 6). At 15, 20, 25, 30 and 35°C temperature the survivorship were 11.32±0.47, 15.23±0.42, 24.21±0.36, 17.95±0.43 and 9.15±0.35 days respectively. Survivorship of ovipositing females was highest at 25°C but lowest at 35°C respectively. Significant differences ($P<0.01$) were found in the longevity of ovipositing female parasitoids at different temperature gradients.

DISCUSSION

Temperature and humidity are usually two of most important abiotic factors affecting the population dynamics of insects in storage system (Flinn and Hagstrum, 1990). It is evident from the present investigation that increasing temperature (from 15°C to 35°C) decreased the developmental time of the parasitoid, *P. westwoodi* in both the sexes, and 35°C caused fastest development. The male parasitoids emerged one day earlier than female. *Anisopteromalus calandrae* had the maximum developmental period at the lowest temperature (18°C) among the range of 18°C to 34°C which is in agreement with the present findings. Urbaneja *et al.* (2002) observed the developmental time of *Cirrospilus vittatus* (Hymenoptera: Eulophidae) at 5 constant temperatures on the host, *Phyllocnistis citrella* (Lepidoptera: Gracillariidae) in laboratory conditions and resulted that the development was inhibited at 15°C, and at 15 to 35°C the total developmental period decreased from 35.68±0.47 to 14.71±0.70 days in male and 36.58±0.82 to 14.60±1.69 days in females. Matadha *et al*. (2004) observed the developmental time of *Encarsia citrine* Craw (Hymenoptera: Aphelinidae) at five constant temperatures of 15, 17.5, 20, 25, 27.5 and 30°C and opined that the developmental time varied from 22.7 d at 27.5°C to 47.4 d at 17.5°C and the larval developments did not occur at 15 and 30°C. These reports depict that the developmental period decreased with the increase of temperature which is related to the present study.

Age specific distribution of developmental time was observed in the present experiment

Temperature significantly influenced the progeny production. The mean number of F_1 progeny of *P. westwoodi* were 7.25, 28.55, 41.35, 34.78, and 5.12 at 15, 20, 25, 30 and 35°C respectively. At low temperature (15°C), the production of progeny was minimum and it was maximum at 25°C. Elevated temperature of 35°C decreased the total progeny production. Okamoto (1972) noted that the emergence of *A. calandrae* was highest at 30°C. Smith (1992) reported that the mean number of progeny produced per female of *A. calandrae* during its life time and it increased to 10.4 at 20°C and 42.6 at 35°C. Pratissoli *et al.* (2004) observed the fertility life table of *Trichogramma pretiosum* and *Trichogramma acacioi* (Hymenoptera: Trichogrammatidae) on *Sitotroga cerealella* (Lepidoptera: Gelechiidae) and resulted that the highest fecundity for both species was observed at 25°C and at extreme temperatures such as 15°C and 35°C, these negatively influenced the developmental rate of both the species. The progeny sex ratio was much lower at 20°C (33% female) than those of 25, 30 and 35°C (55-68% female) that complies with the present findings.

In the present investigation, temperature played a dominant role for minimum and maximum longevity of the parasitoids. The maximum longevity of the females was 24.21 days at 25°C and minimum was 9.15 days at 35°C. Matadha *et al*. (2004) reported that the average longevity of adult parasitoids of *Encarsia citrine* ranged from 34.3 d at 15°C to 8.0 d at 30°C that differ from present findings. Smith (1992) reported that the longevity of *A. calandrae* female was greatest at 20°C and shortest at 30 and 35°C which are in accordance with the present results. *P. westwoodi* is an efficient parasitoid of *C. pusillus* in stores that could be used for biological control programmes in the suppression of major insect pests.

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