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Development and Survival of *Cydnocoris gilvus* (Heteroptera: Reduviidae) at two fluctuating temperature regimes.

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ABSTRACT

The knowledge of bioecology of any predator is essential to explore its biocontrol potential. This study presents the effect of different temperature regimes i.e., 22-27°C and 27-32°C on the development and survival of the predator *Cydnocoris gilvus*. Low temperatures regims showed deleterious effects on nymph development and nymph survival. The stadial period decreased with increasing temperature. The maximum rate of nymphal and egg development occurred at 27-32°C temperature range. When compared both temperature regimes in the laboratory, the incubation period averaged 8.7±0.3d and 4.0±0.1d respectively. The five nymphal stadia averaged 8.7, 8.0, 11.25, 11.25, 16.5, 84.5 and 4.0, 5.0, 8.6, 6.57, 8.43, 12.5 for 22-27°C and 27-32°C regimes, respectively. Survival of all instars was high in 25-30°C range. The survival rate was increased with increased temperature

Introduction

Biological control can reduce pest population and maintain environmental balance without utilization or with lower insecticide use which can improve life quality in different ecosystem (Symondson et al., 2002). Members of Harpactorinae are commonly associated with plants and some have been studied as biological control agents of crop pests (Forero et al., 2008). These gregarious species might extent survival, development and morphological characters by sensitizing the overwinter temperature and photoperiod (Ito and Nakata, 1998; Nakashima and Hirose, 1997; Ruberson et al., 1998; 2001).

The effect of temperature on rate of development and survivorship is of fundamental importance to understanding insect phenology and abundance. Insects are able to function at faster and more efficiently at higher temperature. They can feed, develop, reproduce and disperse when the climate is warm, though they may live for a shorter time (Drake, 1994). Existing studies suggest that direct effects of temperature are likely to be larger and more important than any other factor (Braman et al 1993; Bale et al., 2008). Such data are also necessary to gain an understanding of interaction between prey and natural enemies in biocontrol system.

Reduviids can be successfully used as effective biocontrol agents of important agricultural pests (Ambrose, and Claver, 2000; Ambrose 2003). Biological parameters were reported for *Cydnocoris gilvus* Brum (Srikumar et al. 2014), In India 3 species of *Cydnocoris* Stål 1866 was reported namely *C. crocatus* Stål 1866, *C. fasciatus* Reuter 1881 and *C. gilvus* Burmeister 1838. Details of these three species were largely nil except one *C.gilvus* (Maldonado 1990).

The knowledge on biology, behaviour and pest suppression efficacy of any organism is a prerequisite for its utilization as a biological control agent. An attempt was made to study the utility of the biocontrol agent *Cydnocoris gilvus* from South India (Venkatesan., 1997). But no reports are available about *Cydnocoris gilvus* collected from North India which has some ecotypic morphological variations. Moreover, this gregarious species might extent survival, development and morpho – functional characters by sensitizing the overwinter temperature and photoperiod (Claver et al. 2010, 2011). Hence an effort was undertaken to describes the effects of fluctuating temperature on the development of *Cydnocoris* sp. (Hemiptera: Reduviidae), an effective insect predator under laboratory conditions.

Materials and Methods

Sampling was conducted along major roads with side trips to promising habitats in the Indian state of Uttar Pradesh. The annual rainfall in the state varies from 1000mm-1200mm of which about 90% occur during June and September by south west monsoon and temperature ranges between 5°C during winter to 45°C in summer. Insects were collected by sweeping, beating foliage and hand picking along roadsides, grassy field and agroecosystem, preserved in 70% alcohol and taken to the laboratory. Field data (eg. collection sites, times of observation and habitat types) were supplemented with data associated with specimens housed in Entomology collection.

A pair of *Cydnocoris gilvus* collected on Oct 20, 2013 on grasses near the agro-ecosystem at Deoria (between 26°00'N-26°70'N latitude and 83°70'E-84°70'E) and brought to the laboratory. Pair of adult was kept in 5× 10 diameter container with soil (moisten with water daily) and fed 7-8 khapra beetle larvae every other day. A strip of bark (approximately 4cm wide and 6 cm long) was propped against the inner surface of container to provide additional walking surface and to serve as a possible ovipositional site.

The female oviposited a batch of 7 eggs on October 24, 2013, during 10 am to 12 pm.

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The nymph were distributed into plastic containers with two individuals of *C. gilvus*, and kept alive. Five khapra beetle larvae per nymph were provided daily as food. The containers were examining daily, moults recorded and exuviae removed. Initially nymphs were grouped by hatch date. The egg batches laid by female bug in the laboratory were incubated in moist cotton swabs in small containers to provide humidity.

Effect of fluctuating temperatures on the biology of *C. gilvus* was made during the winter period from October to March and summer period from March to May under lab condition. Data on different developmental parameters on two fluctuating temperature regimes i.e., 15-25°C and 25-35°C were recorded and subjected to relevant statistical analysis.

Results

This species was collected in Mahuapatan, Deoria district. Eggs were orange to dark red and attached by their posterior ends on the substratum. The first instars emerged through a circular opening in the cephal end of the egg, pushing aside a cap. They were orangish at this time but darkened to the more typical coloration (ie, head, thorax and abdomen red and appendages black) within 3-4 h. They fed on khapra beetle larvae within 1day.

Egg incubation and developmental periods of *C. gilvus* are shown in table1. The egg incubation period was decreased as the function of temperature. The percentage egg hatch was higher than 93% at both temperatures tested (table 2).

The first, second, third, fourth and fifth stadia of *C. gilvus* took about 8.0, 11.25, 11.25, 16.5 and 84.5 days respectively at 15-25°C. The total developmental period of *C. gilvus* was extended up to 131.5d in 15-25 °c temperature regimes as against at 25-30°C (62.1day only) (table 1). Mortality during the nymphal stadia resulted from incomplete ecdysis and unnatural causes (no strong surface for moulting). Developmental times for successive stages generally increased as nymphs developed from 2nd to 5th instars; the 5th instar was the longest stage at both temperatures.

C. gilvus completed its nymphal development when it was reared at 15-25 °C and 25-30°C temperature regimes. However the total nymphal development period of this reduviid decreased with increasing temperature. Among the two different temperatures tested, the total life cycle of *C. gilvus* was took at the maximum 139.5 days at 15-25 °C regime, whereas it was reduced to 62.1day at 25-30°c (table 1). At 15-25°C regime, 5th stadium nymphs did not moult for over 85day. It seemed that a low temperature winter season, even at 15-25°C regime might be unsuitable for the development of *C. gilvus* and the activity might be very low.

The developmental duration of 1st 2nd 3rd 4th and 5th instars were could not be recorded the temperature regimes below 15°C as well as above 35°C during winter and summer seasons respectively due to the dormancy condition (table 1). In nature, during this unfavourable timing insects might go for deep tunnel for saving its life as well as limit its food intake to reduce its metabolic rate. Survival percentage of first instar was comparatively lower than other instars. The developmental period of female was faster (40.1±3.35d) than males (42±3.85d) at 25-30°c and (132.5±45.25d) and (133±45.85d) at 15-20°C respectively.

C. gilvus took (45.1±0.92d) at 25-30°C an (131±45.01d) at 25-30°C to complete a generation. Survival of *C. gilvus* was 100% in fifth instar at both the temperature regimes while it was 85.71% and 66.67% in first and third instar at 15-25°C range respectively and 87.5% and 88.89% in fourth and second instar respectively at 25-30°C range. Survival during the second, fourth and fifth instar is higher (100%) at 15-25°C.

Discussion

Reduviids are well known as generalist predators feeding on a variety of prey (Miller, 1971). Their value as regulators of insect pest populations has rarely been investigated (Murdoch et al., 1985; Westich and Hough-Goldstein 2001).

Little has been published on the effect of temperature on development and survivorship in reduviids (Sahayaraj and Sujatha, 2012; Sahayaraj et al. 2003). Srikumar et al. (2014) described the life history of *C. gilvus* and provided data on aspects of its reproductive biology. They (2014) reported about 45.1 day as the developmental duration at 26-28°C C, which prevails in south India through the year for complete nymphal period, which accords well with the 45.1 days recorded in this study for 25-30°C.

Developmental times for successive stages generally increased as nymphs developed from 2nd to 5th instar irrespec temperatures. Early instar of reduviids required less time to develop than later instars. Similar results were reported in other reduviids like *Zelus renardii*, *Rhynocoris marginatus* and *Coranus spinscutis* by Ali, A.-S. A. and T.F. Watson. (1978) and Claver et al (2010, 2011).

The duration of second and third instar was similar with both temperatures but the first, fourth and fifth instars of *Cydnocoris* sp. were affected by the temperature (table 1). The duration of the nymph stage of *C. gilvus* was longer with 15-25°c than with 25-30°c (table 1). High temperature accelerated the growth thereby shortening the developmental period (Nishi and Takahashi, 2002; Isenhour and Yeargan, 1981 James, 1992; Usharani 1992).

Table 1. Mean (±SE) developmental time (days) for egg and nymphal stages of *Cydnocoris gilvus* at fluctuating temperature ranges. Values followed by different alphabets are statistically significant (AOVA-DMRT; P=0.01)

Temp. regimes	Egg stage	1st	2nd	3rd	4th	5th	Total stadial period	Egg to adult period	Adult longevity
15-25°C	8.7±0.3b	8.0 ±0.3b	11.25±0.4b	11.25±0.4b	16.5 ±0.4b	84.5±3.8b	131.5 ±9.1b	139.5 ±9.1b	76.71±15.1b
25-35°C	4.0±0.1a	5.0 ±0.1a	8.6 ±0.5a	6.57±0.2a	8.43 ±0.5a	12.5 ±0.3a	41.1 ±0.7a	45.1 ±6.9a	41.6±931a

Table 2. Survivorship of *Cydnocoris gilvus* from egg hatch to adult emergence under fluctuating temperature regimes.

Temperature regimes(°C)	% Survival to each life stage						
	Egg	1st	2nd	3rd	4th	5th	Adult
15-25°C	90.42	85.71	100	66.67	100	100	25.0
25-35°C	94.04	100	88.89	100	87.5	100	57.14

C. gilvus completed its nymphal development at both the temperature regimes 15-20°c and 25-30°c. The temperature regime 25-30°c was highly suitable for the development of the species (table 1). Lower temperature has a negative effect on the incubation period of the eggs and nymphal survival of the predator. The incubation period of the egg was extended as the temperature decreased from 25-30°c. Similar result was observed earlier in another reduviid predator *A. biannulipes* (Tawfik and Awadallah, 1982; Torres et al., 1998).

Survival of first, third and fifth instar was higher in 25-30°c range. The result revealed that the survival rate was increased with increased temperature. This result is contrary to that observed from the coleopteran beetle predator (Obrycki and Tauber, 1982; Evans, 1987 and Naven, 2000).

The average number of eggs laid per ovipositing female tended to increase with increasing temperature. Low temperature arrested the development of egg too (Obrycki and Tauber 1882; Roy et al. 2007).

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