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Research Article

Multiplication of green lacewing, *Mallada astur* (Banks) on frozen grubs of *Tribolium castaneum* Herbst

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ABSTRACT: The green lacewing, *Mallada astur* (Banks) was reared on frozen grubs of red flour beetle, *Tribolium castaneum* Herbst. The incubation period, larval period and pupal period were 3.0-3.3 days, 8.70–9.30 days and 9.10–10.40 days, respectively and total life cycle was completed in 20.8–22.7 days and continuous rearing for 5 generations did not alter any biological parameter significantly. The total immature mortality was 21 per cent and larval survival 76.66 per cent, when fed on a-week-old frozen prey. On prey stored at –4 to –6°C for a period of four weeks, survival was 46.5 per cent and it declined to 38.8 per cent after 42 days as against 85.5 per cent in control. A slight increase in developmental period was noticed with increase in cold storage of the prey beyond four weeks. These studies suggest that frozen grubs of *T. castaneum* are suitable for the multiplication of *M. astur.* The production of red flour beetle is cheaper than producing equivalent quantity of rice meal moth eggs, which are presently used for large scale production of the green lacewings.

KEY WORDS: *Mallada astur*, multiplication, *Tribolium castaneum*

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INTRODUCTION

The chrysopid, *Mallada astur* (Banks) (Neuroptera: Chrysopidae), was recorded in Karnataka region on guava in India (Singh and Narasimham, 1992). Subsequently, it has been reported as an important predator on many horticultural crops (Sujatha and Singh, 2003; Mani and Krishnamoorthy, 1999). Generally, green lacewing predators are reared on traditional factitious host, *viz.*, frozen or sterilized eggs of *Corcyra cephalonica* (Stainton) (Gautam, 1994) or on semi-synthetic diet (Venkatesan *et al.*, 2000), which is expensive. Besides, the moth scales of *C. cephalonica* are known to cause respiratory hazards to sensitive workers on prolonged inhalation. To avoid such problems, earlier studies revealed that frozen grubs of *Tribolium castaneum* Herbst were suitable, and rather better in terms of cost reduction and safety aspects in *Chrysoperla zastrowi sillemi* (Viji and Gautam, 2005a) and *M. desjardinsi* (Okamoto) (Elsiddig *et al.*, 2006). Cost of production of *C. z. sillemi* and *M. desjardinsi* on *T. castaneum* as against the eggs of *C. cephalonica* was reported to be less by three-fold besides safety to human health (Viji and Gautam, 2005b, Elsiddig, 2006). Hence, an attempt was made to rear *M. astur* on frozen grubs of *T. castaneum* to find out its suitability.

MATERIALS AND METHODS

Tribolium castaneum culture was maintained in plastic jars (15 x 20cm) containing wheat flour as suggested by Viji and Gautam (2005a, b) and Elsiddig *et al.* (2006). The jars were covered with cloth secured by rubber bands and the culture was kept at 30±1°C and 60±5% RH in a BOD. Adult beetles were released in wheat flour and left to lay eggs for two days. Then the flour was sieved to remove adults and they were transferred to a new jar with fresh wheat flour to lay eggs and continue the same cycle so as to get different stages of development at any point of time. This process was done for easy separation of larvae of equal age and size at the time of harvest. Stock culture of *M. astur* was maintained by using standard procedure set by Gautam (2008) for green lacewing predators in the Biological Control Laboratory, Division of Entomology, Indian Agricultural Research Institute (IARI), New Delhi, India. Adults were transferred to jars (21x18cm) containing a cotton swab dipped in 20% honey solution and Power Packed Green lacewing Feed (Gautam *et al.*, 2010) as supplementary food.

Generation wise suitability of frozen prey to the predator

Suitability of frozen grubs of *T. castaneum* as prey for the grubs of *M. astur* with regard to continuous rearing was studied at 27±1°C and 60±5 per cent RH. Newly hatched neonate larva of *M. astur* (Fig. 1) was transferred to small vials individually and each vial was covered using cotton wool. Each larva was provided with full grown frozen larvae of *T. castaneum* (one week old, 3 grubs) till it stopped feeding (Fig. 1). The prey larval density @ 3 per predator larva was maintained till cocoon formation. After pupation, the cocoon in the vial was left undisturbed till adult emergence. Five generations of *M. astur* were reared on frozen larvae of *T. castaneum.* The experiment had five replications, each containing a set of 50 predator larvae. Observations on incubation period, larval period, pupal period and total developmental period were recorded.

Mortality of immature stages

One hundred freshly laid eggs of *M. astur* reared on *T. castaneum* grubs were kept individually in small vials and observed daily for subsequent development and survival. After hatching, the larvae were fed on *T. castaneum* grubs. Daily observations on survival and development were recorded till emergence of adults.

Influence of cold storage of prey on green lacewing

For studying the influence of cold storage of fully grown grubs of *T. castaneum* as prey for the larvae of *M. astur*, final instar grubs were removed from wheat flour at different intervals using a 40–mesh sieve. These grubs were placed in airtight containers and kept in a refrigerator (–4°C to –6°C). The frozen grubs were removed at 7 days, 15 days, 30 days and 45 days interval and offered to the predator neonates for studying the shelf life of cold stored grubs and their influence on survival of *M. astur* from larval to adult emergence (per cent) and total developmental period (days). It was compared with control (unfrozen grubs) in three replications. Each replication had a set of 20 predator larvae.

RESULTS AND DISCUSSION

The egg incubation period in all the generations ranged between 3.0 and 3.3 days (Table 1). The longest incubation period of 3.3 days was observed in generation 4 (G4) as against the lowest of 3.0 days in generation 3 (G3) and 5 (G5), which remained statistically on par

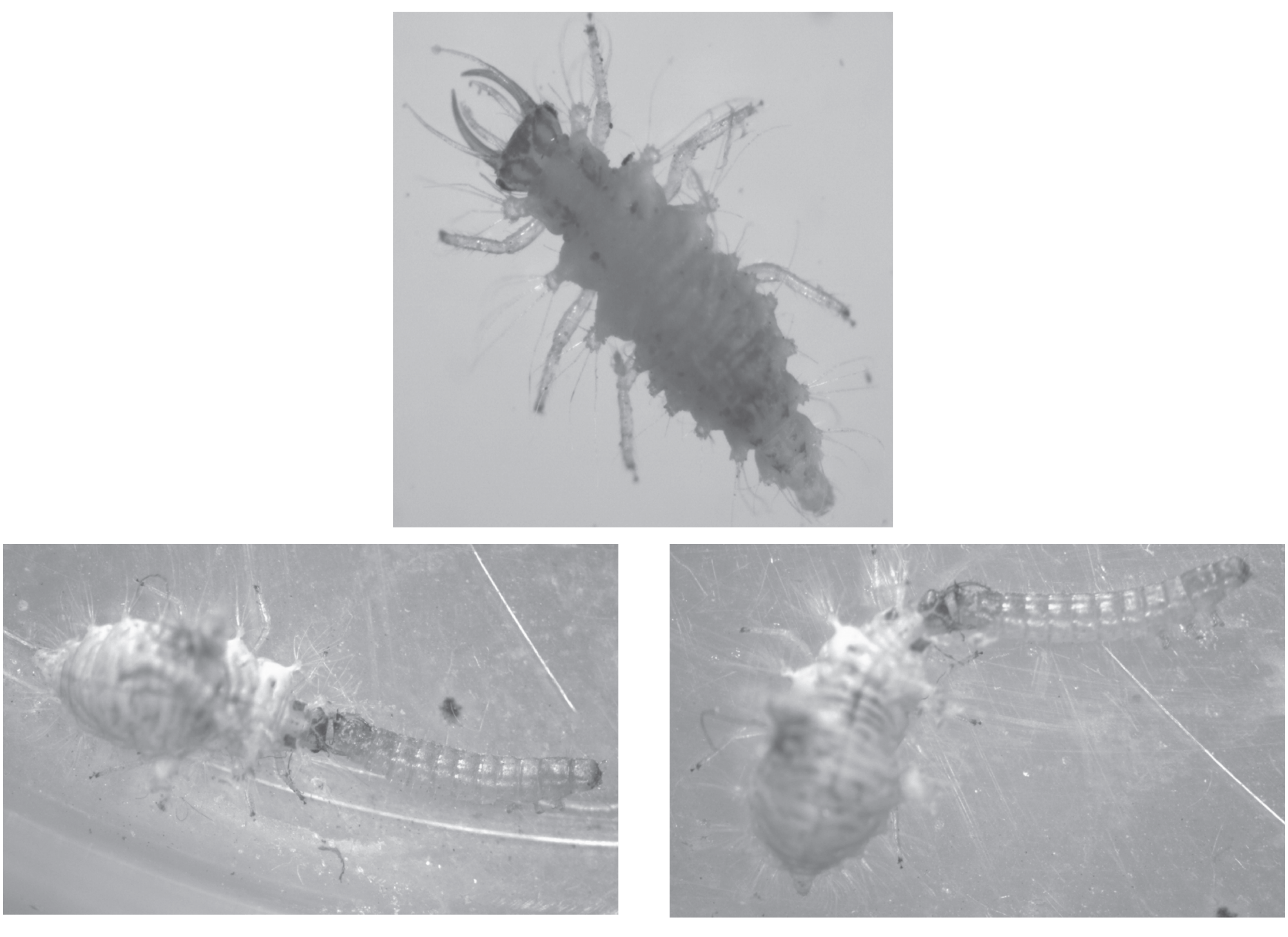

Fig. 1. Larval stages of *Mallada astur* (upper row: neonate larva; lower row: larvae feeding on frozen grub of *T. castaneum*)

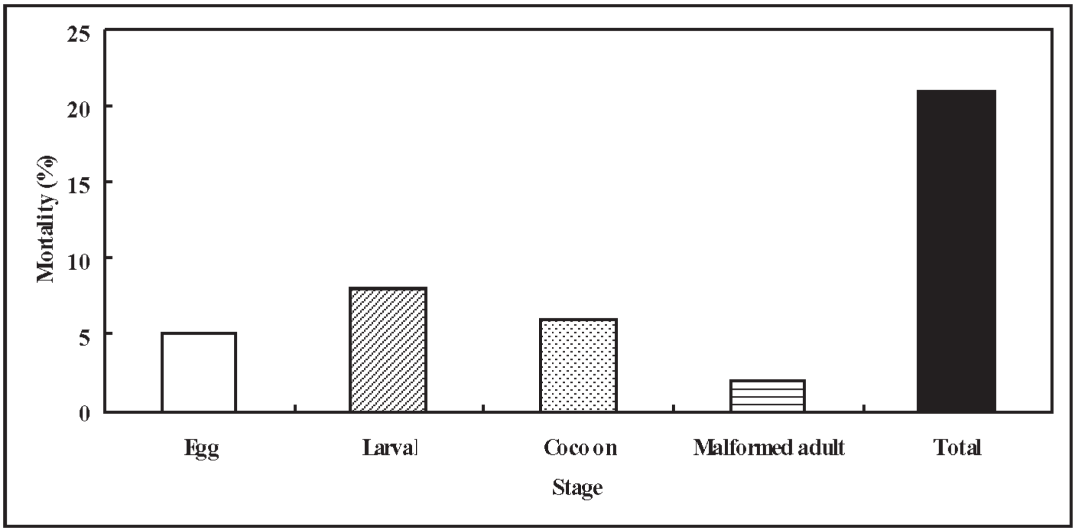

Fig. 2. Mortality of immature stages of *M. astur* reared on *T. castaneum* grubs

Table 1. Generation wise developmental period of *M. astur* fed on *T. castaneum* grubs

Generation (G)	Egg incubation period (Days) ± SE	Larval period (Days) ± SE	Pupal period (Days) ± SE	Total Period (Days) ± SE
G1	3.1 ± 0.49	9.3 ± 0.40	9.6 ± 0.58	22.0 ± 1.14
G2	3.1 ± 0.37	9.2 ± 0.60	10.4 ± 1.06	22.7 ± 1.28
G3	3.0 ± 0.31	9.0 ± 0.83	10.0 ± 1.30	22.0 ± 1.09
G4	3.3 ± 0.60	9.1 ± 0.66	9.6 ± 0.58	22.0 ± 0.54
G5	3.0 ± 0.00	8.7 ± 0.40	9.1 ± 0.37	20.8 ± 0.40
SEM ±	0.215	0.331	0.420	0.460
C.D. at 5%	N.S.	N.S.	N.S.	N.S.

Values presented are means of 5 replications; SEM – standard error of mean; mean ±SE; NS – non-significant

Table 2. Survival and developmental period of *M. astur* fed on *T. castaneum* grubs

Cold Storage Period (Days)	Survival from larval to adult emergence (%)	Developmental Period (Days) ± SE
T1 (0 day–Control)	85.5 (67.660)	18.83 ± 1.54
T2 (1 day)	90.33 (71.943)	19.16 ± 0.47
T3 (7 days)	76.66 (61.150)	20.16 ± 0.47
T4 (14 days)	66.66 (54.767)	21.33 ± 1.43
T5 (28 days)	46.5 (43.013)	23.83 ± 1.43
T 6 (42 days)	38.83 (38.570)	25.33 ± 0.62
SEM ±	(0.470)	0.800
C.D. at 5%	(1.365)	2.323

Values presented are means of 3 replications; mean ±S. E; values in parentheses are arcsine transformed; SE – standard error of mean with each other. The total larval developmental period ranged between 8.7–9.3 days. The lowest larval period of 8.7 days was observed in G5. On the other hand, longest larval period of 9.3 days was observed in G1. Similarly, pupal period ranged between 9.1–10.4 days. The longest pupal period of 10.4 days was observed in G2 as compared to the lowest 9.1 days in G5. Generation wise, the pupal developmental periods were close to each other statistically. The total developmental period (egg–adult) of *M. astur* on frozen grubs of *T. castaneum* was 20.8–22.0 days. Overall, total developmental period of *M. astur* on frozen larva of *T. castaneum* on all the generations was close to each other statistically. Similar observations in case of *C. z. sillemi* and *M. desjardinsi* were reported earlier by Viji and Gautam (2005a) and Elsiddig *et al*. (2006), respectively.

Fecundity was 60.7 eggs / female, pre-oviposition period 5.5 days, oviposition period 14.8 days, post oviposition period 26.9 days and per cent hatchability of 92.0% were observed when the adults of *M. astur* were offered with 20% honey solution.

Results on stage specific mortality of immature stages (numbers out of 100 eggs) of *M. astur* reared on *T. castaneum* larvae are presented in Fig. 2. The total immature mortality was 21 per cent, including egg, larval, and cocoon mortality in addition to malformed adults. Similar observations in case of *M. desjardinsi* were reported by Elsiddig (2006).

The data on the effect of cold storage of *T. castaneum* larva on survival and developmental period of larval-cocoon stage are presented in Table 2. Larval-cocoon survival was highest (90.3) in T_2 and statistically on par with T_1 but significantly differed from T_4 and T_5. On the other hand, lowest survival percentage of 38.8% was observed in T_6 and found non-significant when compared with T_5. Developmental period was shortest (18.8) in T_1 and statistically on par with T_2 and T_3 but significantly differed from other treatments. The largest development period was recorded for T_6 (25.3 days), which was also statistically on par with T_5 and T_4. The present study is in conformity with Elsiddig *et al*. (2006) who observed that cold storage of *T. castaneum* larvae beyond two weeks significantly reduced the cocoon weight and prolonged developmental period, while storage beyond four weeks significantly reduced per cent survival during larval-cocoon period besides affecting cocoon weight and developmental period.

It may be inferred from the above studies that frozen grubs of *T. castaneum* are a better and economical prey to mass produce green lacewings, including *M. astur*. The study is of paramount importance in quality mass production of the green lacewing predators with cheaper inputs and safety to workers as *T. castaneum* does not have injurious body scales unlike traditionally used prey, *C. cephalonica* in Indian laboratories.

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