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BIOLOGY AND BIOLOGICAL PARAMETERS OF *MALLADA BONINENSIS* (OKAMATO) (NEUROPTERA: CHRYSOPIDAE) ON DIFFERENT HOSTS

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ABSTRACT
Laboratory experiments were conducted during 2013-14 to know the biology of *Mallada boninensis* on *Aphis craccivora*, *Aphis gossypii*, *Aleurodicus dispersus* and *Corcyra cephalonica*. Total developmental period was 23.04 days and female longevity and male longevity with 52.48, 28.04 days respectively. Fecundity per female was with 317.2 eggs per female. All the parameters were more on *C. cephalonica* compared to all the other hosts tested. Larval survival, pupation and adult emergence percentages were 92.8, 85.3 and 85.3 which were more on *C. cephalonica* compared to the other hosts. Eggs of *C. cephalonica* was found to be superior for all the parameters tested followed by spiralling whitefly- *Aleurodicus dispersus* (nymphs/adults), cotton aphid- *Aphis gossypii* (nymphs/adults) and cowpea aphid- *Aphis craccivora* Koch (nymphs/adults). The present study revealed that other hosts can be used as substitute for rearing of *M. boninensis* in the laboratory.

INTRODUCTION

Due to the ill effects of pesticides the concept of pest management changed from chemical control to the Integrated Pest Management (IPM). These include the use of natural enemies as one of the important components for pest management because they are ecologically safer, ecologically viable, self-perpetuating and long term effective against crop pest. Now a days, Integrated Pest Management (IPM) is well known to all of us where all the suitable pest control techniques are being used to find ecologically sound and environmentally safe ways of pest control (Abhishek shukla and Darshana S. Jadhav 2014). During the last two decades or so, the role of chrysopids as a predator of pest of different crops has been appreciated all over the world in IPM programme. They are encountered in most of the agricultural and horticultural ecosystems including plantation crops and mulberry (Narendra Kumar *et al*, 2001, 2010). Their ability to adapt to a wide range of ecological factors (Ulhaq *et al*, 2006) and tolerance to insecticides (Bigler, 1984; Vogt *et al*, 2001) has made them important candidates in the biological control programs. Conservation of predators particularly green lacewings being potential predators is very necessary (Nikitha S. Awasthi *et al*, 2013). Amongst the *Mallada* spp., *M. boninensis*, *M. basalis*, *M. aster* and *M. desjardinsi* are important as these are found to be potential predators of aphids, leaf miners, psylla, blackfly and whitefly. They can be successfully reared on eggs of *C. cephalonica* Stainton in the laboratory (Krishnamoorthy and Mani, 1982; Bakthavatsalam *et al.*, 1994; Jalali *et al*, 2003; Elsiddig *et al.*, 2006; Syed *et al.*, 2008; Riddick, 2009). As the natural population is inadequate, biological control would be best achieved by mass rearing and seasonal colonization of the aphid lion, *M. boninensis*. These predators can be reared in large numbers and can be released with less cost. Keeping the scenario in view an attempt has been made to know the biology and biological parameters of *M. boninensis* on *A. craccivora*, *A. gossypii*, *A. dispersus* and *C. cephalonica* for mass production purpose.

MATERIALS AND METHODS

Biology of *M. boninensis* on three natural hosts along with laboratory host was studied. The natural insect hosts were: cotton aphid (nymphs/adults), cowpea aphid (nymphs/adults) and spiralling whitefly (nymphs/adults) and laboratory host was *C. cephalonica*. The nymphs/adults of natural hosts were collected from fields, while eggs of *C. cephalonica* was collected from the Biological control laboratory in the Department of Entomology, TNAU, Coimbatore. The experiments were conducted in a completely randomized design (CRD) with five replications to analyse the biology and biological parameters of different hosts on *M. boninensis*.

Mass culturing of *Corcyra cephalonica*

C. cephalonica commonly called as rice meal moth or rice moth is a pest of stored foods, viz., cereals, cereal products,

oilseeds, pulses, dried fruits, nuts and spices. The basins (37.5 cm dia and 11 cm ht.) used for *Corcyra* multiplication are thoroughly cleaned with 0.5% detergent wash and rinsed in tap water followed by wiping with dry, clean used towel and shade drying. Sterilized bajra, groundnut, yeast and wettable sulphur (2.5kg: 100g: 5g: 5g) were placed in plastic basins. Nucleus eggs of *C. cephalonica* were sprinkled in plastic basins @ 0.5 cc per 2.5 kg of grains fortified with 5 g of yeast 5 g of wettable sulphur and 100g of groundnut kernel powder and the basins were covered with gada cloth. Care was taken to maintain the culture free from storage mite and diseases by mixing 5g of wettable sulphur (80%) and spraying streptomycin sulphate 0.05 per cent respectively. Emerged moths were collected from 40th day onwards and continued upto 90 days either manually or by using the vaccum aspirator. Adults were then transferred to round G.I. oviposition cage of 21 × 25 cm size fixed with wire mesh screen at the bottom and two windows (5 × 5 cm) on the sides for ventilation. Adults were fed with 50 per cent honey mixed with vitamin E drops. Eggs were collected on the receiving cage at the bottom of the mating drum. The scales of moths, insect fragments and other dust materials from the eggs were cleaned by using the gadget moth scale egg separator and finally by filter sieves. The Ultra-Violet rays (UV) treated eggs of *C. cephalonica* were used as fresh or after storage in refrigerator at 8-10^{o} C as and when required for culturing the predator.

Mass culturing of *Mallada boninensis* on *C. cephalonica* eggs

Grubs of *M. boninensis* were reared on *C. cephalonica* eggs kept inside separate small plastic bottles (3 cm diameter) closed with lid. Fresh eggs were given till the pupation of the grubs. Pupa were collected and transferred to G.I. round troughs for adult emergence. The rearing of the host insect and predator has been done under controlled room temperature and relative humidity conditions ranging between 24 ± 2p c and 60 ± 5% respectively. The adults were collected daily and transferred to pneumatic glass troughs or G.I. round troughs (30 cm x 12 cm). Before allowing the adults, the rearing troughs were wrapped inside with brown sheets, which act as egg receiving card. About 250 adults (60% females) were allowed into each trough and covered with georgette cloth secured by rubber band. On the cloth outside three bits of foam sponge (2 sq.inch) dripped in water is kept. Besides an artificial protein rich diet was provided in semisolid paste form in three spots on the cloth outside. This diet consisted of equal parts of yeast, fructose, honey, Proteinex R and water. The adults lay eggs on the brown sheet. The adults were collected daily and allowed into fresh rearing troughs with fresh food. From the old troughs, the brown paper sheets along with *Mallada* eggs were removed. Emerged grubs were collected and rearing was continued for getting a steady supply of grubs for different experiments. Two to three days old grubs were used for various experiments.

Collection of natural hosts

The natural hosts used in the present experiment were: cotton aphid- *A. gossypii* (nymphs/adults), cowpea aphid- *A. craccivora* Koch (nymphs/adults) and spiralling whitefly- *A. dispersus* (nymphs/adults). Cotton aphids were collected from cotton plants, cowpea aphids were collected from cowpea plants and spiralling whiteflies were collected from tapioca plants reared in insectary, Department of Entomology, TNAU, Coimbatore as per the methodology suggested by (Hassan *et al.*, 1985).

RESULTS

Egg period varied from 3 days on *A. dispersus* to 3.1 days on *A. craccivora*. Duration of first instar was maximum on *A. gossypii* with 3.54 days and minimum on *C. cephalonica* with 2.48 days. Duration of second and third instars was maximum on *A. dispersus* and minimum on *C. cephalonica* with 3.46 and 3.58 days respectively. Total grub period was maximum on *A. dispersus* with 11.7 days followed by *A. craccivora* with 11.6 days, *A. gossypii* with 11.1 days and *C. cephalonica* with 9.52 days respectively. Lowest prepupal period was recorded on *C. cephalonica* with 1.26 days and maximum was recorded on *A. dispersus* with 1.5 days. Pupal period was more on *A. craccivora* with 10.12 days and lowest on *A. dispersus* with 8.82 days. Total developmental period was more on *A. craccivora* with 26.14 days and lowest was recorded on *C. cephalonica* with 23.04 days. Both female and male longevity was more on *C. cephalonica* with 52.4, 28.04 days and lowest on *A. craccivora* and *A. gossypii* with 45.9, 19.3 days and 45.8, 19.9 days respectively. Fecundity per female was more on *C. cephalonica* with 317 eggs and least on *A. craccivora* with 134 eggs (Table 1).

Larvae survived comparatively more on grubs fed with *C. cephalonica* with 92.8 per cent followed by *A. gossypii* with 83 per cent, *A. dispersus* with 79.3 per cent and *A. craccivora* with 76 per cent survivals respectively. Pupation per cent was more on *C. cephalonica* with 85 per cent followed by *A. dispersus* with 78 per cent, *A. gossypii* with 76 per cent and *A. craccivora* with 73 per cent. Adult emergence also followed the same pattern as pupation with 85, 74.3, 74.2 and 70 per

Table 1: Biology of *Mallada boninensis* (days) on different hosts

Hosts	Developmental period (Mean) Egg period	I instar	II instar	III instar	Total grub period	Pre- pupal period	Pupal period	Total developmental period	Female longevity	Male longevity	Fecundity per female
A. dispersus	3c	2.68c	4.28a	4.74a	11.7a	1.5b	8.82d	25.02b	47.4b	22.2b	216.6b
A. gossypii	3.02ab	3.54a	3.82b	3.74c	11.1b	1.42a	9.82b	25.36b	45.8c	19.9c	140.8c
A. craccivora	3.12a	3.22b	3.82b	4.56b	11.6a	1.3c	10.12a	26.14a	45.96c	19.36cd	134.8d
C. cephalonica	3.04a	2.48d	3.46c	3.58d	9.52c	1.26d	9.22c	23.04c	52.48a	28.04a	317.2a
SEd	0.05	0.03	0.04	0.05	0.07	0.04	0.09	0.16	0.48	0.38	1.52
CD(0.05)	0.11	0.07	0.09	0.10	0.15	0.09	0.20	0.34	1.01	0.80	3.24

Table 2: Effect of different hosts on biological parameters of *Mallada boninensis* under laboratory conditions

Hosts	Larval survival (%)	Pupation (%)	Adult emergence (%)	Sex ratio (Female:Male)	Fecundity/female
A. gossypii(Nymphs/Adults)	83.6 ± 0.28b	76.82 ± 0.38c	74.3 ± 0.20c	1.3:0.9	140.24± 0.19c
A. craccivora(Nymphs/Adults)	76.64 ± 0.35d	73.20 ± 0.26d	70.98 ± 0.24d	1.1:0.8	134.9 ± 0.24d
A. dispersus(Nymphs)	79.34 ± 0.13c	78.04± 0.17b	74.20± 0.21b	1.2:0.9	213.38 ± 0.22b
C. cephalonica(eggs)	92.80 ± 0.19a	85.34 ± 0.26a	85.52± 0.17a	1.4:1	323.5 ± 0.33a
SEd	0.36	0.39	0.29	-	0.36
CD(0.05)	0.77	0.85	0.63	-	0.77

cent on *C. cephalonica, A. dispersus, A. gossypii* and *A. craccivora* respectively. Sex ratio of 1.4: 1 was noticed, when grubs were fed with *C. cephalonica,* 1.3:0.9 when fed with *A. gossypii,* 1.2:0.9 when fed with *A. dispersus* and 1.1:0.8 when fed with *A. craccivora*. Maximum fecundity per female with 325 eggs was recorded on *C. cephalonica* followed by *A. dispersus* with 213 eggs, *A. gossypii* with 140 eggs and *A. craccivora* with 134 eggs (Table 2).

DISCUSSION

Egg incubation period, the developmental period of first, second and third instar grubs, pre-pupal period, pupal period, female longevity, male longevity and total developmental period of *M. boninensis* on different hosts vary from one prey to the other prey. Chen and Liu (2001) studied effects of *A. gossypii* and *Myzus persicase* on *C. rufilabris*: survival (100,100 %). Legaspi *et al*. (1996) reported that *C. rufilabris* larvae feeding on *B. tabaci* reared on poinsettia and lima bean lived only to the third instar and died before reaching the pupal stage; however, larvae provided whitefly from cucumbers and cantaloupes reached the adult stage. They speculated that *B. tabaci* reared on poinsettia or lima bean were nutritionally inadequate for the lacewing, or the whitefly reared on these plant hosts may have an accumulative toxic effect on *C. rufilabris* (Legaspi *et al*., 1994). The difference in this even could be due to superabundant honeydew that was ejected by whitefly colony as food assistance role in development predators and prey species, environmental conditions, or geographical population of *C. carnea*. Maximum fecundity per female with 325 eggs was recorded on *C. cephalonica* followed by *A. dispersus* with 213 eggs, *A. gossypii* with 140 eggs and *A. craccivora* with 134 eggs. Zhang *et al,* (2004) recorded female fecundity of *C. pallens* as 326 eggs when fed on *A. craccivora* whereas El-Serafi (2000) reported female fecundity of *C. carnea* on *A. gossypii*, *S. avenae*, *R. maidia* and *A. nerii* as 480.2±14.2, 320.26±10.9, 336.44±12.5, and 215.7±9.6 eggs respectively on different hosts.

Larvae survived comparatively more on grubs fed with *C. cephalonica* followed by *A. gossypii*, *A. dispersus* and *A. craccivora*. Pupation and adult emergence per cent was more on *C. cephalonica* followed by *A. dispersus*, *A. gossypii* and *A. craccivora*. Maximum fecundity per female with 325 eggs was recorded on *C. cephalonica* followed by *A. dispersus* with 213 eggs, *A. gossypii* with 140 eggs and *A. craccivora* with 134 eggs. It is widely reported that unsuitable food can extend the pre-imaginal development of chrysopids and decrease the survival, fecundity and longevity of the adults (Principi and Canard, 1984; Obrycki *et al*., 1989; Zheng *et al*., 1993). Narendra Kumar *et al*. (2011) reported that on the *B. mori* larvae (1st instar), the total larval duration of *M. desjardinsi* (Okamoto) lasted for 14.6 ± 0.13 days, whereas on that of *S. cynthia ricini*, it was 14.75 ± 0.19 days at a constant temperature of 25 ± 2°C and 65 ± 5% R.H. A single *M. desjardinsi* larva on an average consumed 103.35 ± 2.31 and 100.40 ± 2.05 chawki larvae (1st instar) of *B. mori* and *S. c. ricini*, respectively. The sex ratio of male: female was 1:1.4 and 1:1.2 with 78.9 and 69.3 per cent adult emergence, respectively on *B. mori* and *S. c. ricini*. The results were on par with the results of Nagamallikadevi *et al*. (2013). They observed that eggs of *C. cephalonica* were superior over all treatments followed by sucking pests for all biological parameters. The total larval (16.95, 15.60, 16.39), pupal (12.32, 13.57, 14.91), pre oviposition (16.33, 14.85, 15.60) and incubation period (5.90, 5.20, 5.97) days, when larvae reared on neonates of *H. armigera*, *S. litura* and *E. vitella*, respectively. Male and female longevity of predator was found superior for neonates of *S. litura* (21.16, 35.58) followed by *H. armigera* (18.11, 34.41) and *E. vitella* (19.61, 33.35) days. Reproductive potential was recorded as 84.66, 94.50, 91.16 eggs/female of *M. boninensis* when its larvae fed with neonates of *H. armigera, S. litura* and *E. vitella*, respectively. The study revealed that other sucking pests can be used as substitute for rearing of *M. boninensis* in the laboratory for experimental purposes.

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