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Potential for lab rearing of *Apanteles taragamae*, the larval endoparasitoid of coconut pest *Opisina arenosella*, on the rice moth *Corcyra cephalonica*

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Abstract A lab rearing technique was standardised for *Apanteles taragamae* Viereck (Hymenoptera: Braconidae), the early larval parasitoid of the coconut leaf-eating caterpillar, *Opisina arenosella* Walker on the alternate host *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae). The parasitoid took 23.3 ± 3.2 days to complete the egg to adult period. Adult longevity for males and females was 15.3 ± 4.6 and 13.8 ± 4.6 days respectively. Fecundity was 14.8 ± 4.3 eggs per female. The percentage parasitism was 60.6 ± 5.7 on the alternative host *C. cephalonica* and 64.6 ± 5.5 on the natural host *O. arenosella.* Eight- to ten-day-old caterpillars were the ideal stage of *C. cephalonica* for rearing *A. taragamae*. The results indicated the amenability of rearing *A. taragamae* on *C. cephalonica* in the laboratory.

Keywords *Apanteles taragamae* · *Corcyra cephalonica* · *Opisina arenosella* · Lab rearing technique · Coconut

Introduction

Coconut palm *Cocos nucifera* Linnaeus is a perennial oilseed tree crop commercially cultivated in the tropics. The palm is subjected to the damages of several pests and diseases. Of the pests, *Opisina arenosella* Walker (Lepidoptera: Oecophoridae) is the most noxious leaf-eating caterpillar ever recorded on coconut palm. *O. arenosella* shows wide distribution in almost all coconut growing states of India. However, damage severity is high in Southern India, particularly the east and west coast and also in the interior areas of Karnataka and Tamil Nadu States. It is a highly fecund, voraciously feeding, defoliating pest and accounts more than 90% of leaf damage during the periods of severe infestation (Nirula 1956). Larvae of *O. arenosella* always

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remain concealed inside the gallery woven with silken thread along with its excreta and bitten or chewed leaf bits. Hiding in these galleries, the larvae feed on the parenchymatous tissues of coconut leaves. The damage results in defoliation of leaves, reduction in the rate of production of flower spikes, retardation of growth and photosynthetic efficiency and decline in the yield. Over 40 parasitoids and 20 predators have been reported to attack *O. arenosella* during its different stages of growth (Pillai and Nair 1993). The indigenous hymenopterous parasitoids like the late larval parasitoid *Goniozus nephantidis* Muesebeck (Bethylidae), the pre-pupal parasitoid, *Elasmus nephantidis* Rohwer (Elasmidae) and the pupal parasitoid, *Brachymeria nosatoi* Habu (Chalcididae) play a significant role in suppressing the population of *O. arenosella* on the coastal and backwater tracts of Kerala (Sathiamma et al. 1996). Although these parasitoids are effective in suppressing the advanced larval to pupal stages of *O. arenosella*, the optimal potential for the conservation, augmentation or inoculation of the other effective natural enemies of the pest is yet to be explored and evaluated in the coconut plantations. *Apanteles taragamae* Viereck (Hymenoptera: Braconidae), a solitary endoparasitoid, is the only early instar larval parasitoid reported on *O. arenosella.* Releases of such parasitoids would be more advantageous in controlling the pest populations at the initial stages of the pest build-up itself, before causing severe injury to the leaves. One of the problems expressed by the earlier workers in utilising *A. taragamae* in the biocontrol programme is the difficulty experienced to mass rear it in the laboratory conditions (Nirula 1956; Rao et al. 1948; Mohammed et al. 1982; Ghosh and Abdurahiman 1985). Some of the other known hosts of *A. taragamae* are *Laspeyresia tricentra* Meyrick (Shri Ram 1968; Rawat et al. 1974), *Grapholita critica* Meyrick (Latheef and Reddy 1984; Mishra et al. 1987), *Pericallia ricini* Fabricius (Raja et al. 2000) and *Maruca vitrata* Geyer (Sahoo and Senapati 2000; Chi-Chung et al. 2003). Ghosh and Abdurahiman (1996) suggested the importance of kairomones in host acceptance behaviour of *A. taragamae* for rearing on alternate hosts. Mohan et al. (2000) described a mass multiplication technique for *A. taragamae* on early instar *O. arenosella* maintained on potted coconut seedlings. However, a steady supply of early instar caterpillars of *O. arenosella* is the major constraint in this method. Hence, this investigation was undertaken to develop a technique for lab multiplication of the parasitoid on the alternate host, the larvae of the rice moth *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae).

Materials and methods

Observations for this investigation were made in the laboratory at the Central Plantation Crops Research Institute, Regional Station, Kayangulam, Kerala, India (9°48′ N and 76°19′ E) at a temperature of 30 ± 2°C and relative humidity 80 ± 5%.

Parasitoid stock culture

The stock culture of *A. taragamae* was obtained from field-collected parasitoid cocoons and parasitised host larvae. Ten to fifteen newly emerged adults at a ratio of 1:2 males to females were transferred to 250-ml glass beakers, which were the egg-laying units or cages. Adult parasitoids were fed on undiluted honey provided as droplets on wax-coated strips of paper. Required numbers of parasitoids were reared

on early instar caterpillars of *O. arenosella* as per the method described by Mohan et al. 2000. Several such units were maintained to get a steady supply of parasitoids.

Maintenance of *C. cephalonica* culture

C. cephalonica culture was maintained in the laboratory on semolina (sooji/rawa) as food material. For collecting *C. cephalonica* eggs, the moths were put in a cylindrical plastic container (15 × 12 cm), the bottom portion of which was removed and replaced with a nylon mesh. The top part was also covered with nylon mesh. The container was kept on a funnel, the tail portion of which was introduced to a conical flask. The eggs collected in the flask are passed over a slanting paper sheet to remove the scales and dust particles. These eggs were used for inoculating the food material. The food was supplemented with streptomycin sulphate and yeast tablets at 0.5 mg/kg of food material, which was inoculated with 0.2 cm^3 of *C. cephalonica* eggs. This was taken in petri dishes (10 cm in diameter) at the rate of 50 g each, labelled and kept in plastic trays for the development of larvae. After 10–12 days of egg inoculation, *C. cephalonica* larvae could be collected and provided to *A. taragamae* for parasitisation. Several such units were maintained for a steady supply of the required age *C. cephalonica* larvae.

Multiplication of *A. taragamae* on *C. cephalonica* larvae

The *O. arenosella* larval gallery was used for introducing the host to the parasitoid as per the method described by Mohan et al. 2000. Ten 10-day-old *C. cephalonica* larvae were introduced to the larval gallery of *O. arenosella* on a 6-cm long piece of coconut leaf. This was introduced into the egg-laying chamber containing the adult parasitoids. After 24 h of exposure to the parasitoid the *C. cephalonica* larvae were collected and transferred to glass tubes (10 × 2.5 cm) containing semolina. The tubes were closed with cotton plugs and kept undisturbed on plastic test tube racks. Seven days after parasitisation, the tubes were observed daily for adult emergence. The emerged adults were collected and fed with honey on wax-coated strips of paper. The process of exposure of host larvae was repeated till the death of the parasitoid. The biological parameters of the adult parasitoids, i.e. the egg-to-adult period, progeny sex ratio, the fecundity and longevity of male and female progeny emerged and the percentage parasitism were recorded. Simultaneously, under the same laboratory condition, 10 *O. arenosella* larvae were exposed to the *A. taragamae* as another treatment under the same experimental design and biological parameters, i.e. the egg-to-adult period, progeny sex ratio, fecundity and longevity of male and female progeny emerged and the percentage parasitism were recorded for comparison between the hosts. Thirty replicates were maintained in each case for recording observations. The results were compared between parasitoids reared on natural host *O. arenosella* and an alternate host *C. cephalonica* and statistically analysed using the *t* test.

Effect of host age on parasitism

To study the suitable age of host larvae for optimal parasitism, *C. cephalonica* larvae of different age groups, i.e. up to 7 days, 8 to 14 days, 15 to 21 days and 22 to 28 days were exposed to the parasitoid. Ten larvae of the respective age group were

introduced to the 6-cm long piece of coconut leaf with the *O. arenosella* larval gallery taken in the glass tube (10 × 2.5 cm). One pair of newly emerged mated parasitoids was introduced into the tube. After 24 h, the host caterpillars were removed and reared individually on semolina. Ten replicates were maintained for each treatment. The number of adult parasitoids emerging from the parasitised host was recorded under each treatment. Data were subjected to angular transformation and analysis of variance.

Results and discussion

A. taragamae shows high affinity to the kairomones present in the larval gallery of its natural host *O. arenosella*. Ghosh and Abdurahiman (1996) suggested the potential role of kairomones in host acceptance behaviour of *A. taragamae* and reported some success at egg-laying by *A. taragamae* when second instar *C. cephalonica* larvae were kept inside the second instar larval gallery, but reported that further development was not encouraging. In the present investigation it was noticed that soon after introduction of the piece of leaf containing the host larvae with the gallery the female flew or walked towards it. On reaching the gallery it started poking the gallery with its ovipositor, and on contact with the host it readily oviposited on it. As *A. taragamae* is a koinobiont endoparasitoid, the parasitised larva remained alive and continued to feed till the pre-pupal stage of the parasitoid punctured the host body and comes out. The parasitised *C. cephalonica* larvae transferred to semolina continued to develop feeding on the semolina. White cocoons of *A. taragamae* were visible in the tube after 12–14 days of oviposition. The pupal period lasted for 6–8 days and the adults emerged after 20–26 days of inoculation. When *Corcyra* larvae were provided as host to *A. taragamae* 60.6% parasitism was noticed under laboratory conditions.

The developmental parameters of *A. taragamae* on the two hosts are presented in Table 1. The shortest period observed for the egg to adult period is 18 days and the longest 30 days. Adult parasitoids were fed immediately after emergence, on honey droplets. It was observed that unfed adults die within 12–24 h. Feeding lasted for 45 to 70 s. Ovipositing females feed every now and then. Hence in the lab multiplication programme adult feeding is vital. Male progeny was found to be slightly higher than female progeny (1:0.9) in laboratory-reared parasitoids.

Table 1 Developmental parameters of *Apanteles taragamae* on *Opisina arenosella* and *C. cephalonica* (mean ± SD)

Parameters	Reared on host		*t* value
	O. arenosella	*C. cephalonica*	
Egg-to-adult period (days)	20.0 ± 3.2	23.3 ± 3.2	4.75**
Longevity (days)			
Male	12.3 ± 4.5	15.3 ± 4.8	2.18*
Female	11.0 ± 4.4	13.8 ± 4.6	2.52*
Fecundity/female	14.6 ± 3.4	14.8 ± 4.3	0.26
Percentage parasitism	64.6 ± 5.5	60.6 ± 5.7	2.46*
Sex ratio (male:female)	1:0.94	1:0.98	

* Significant at 5%, ** Significant at 1%

Comparison of biological parameters showed that the egg-to-adult period took a little longer (23.3 ± 3.2 days) on *C. cephalonica* than the development inside *O. arenosella* larva (20.0 ± 3.2 days). Longevity of the parasitoid and fecundity were longer for the *C. cephalonica*-reared parasitoid (Table 1), probably because the parasitised larvae were getting a continuous supply of enough nourishment and kept undisturbed during development.

Effect of host age on parasitism

Age of the host larvae showed a highly significant influence on the percentage parasitism by *A. taragamae*. *C. cephalonica* caterpillars 8–14 days of age were found to be the ideal age group for maximum parasitism (67%). Younger larvae (up to 7 days old) or very old larvae (more than 22 days old) were not preferred by the parasitoid with 5% and 3% parasitism respectively. With larvae aged 15–21 days 39% parasitism was observed. There was a higher percentage of mortality of larvae (42.3%) when very young larvae (up to 7 days) were exposed to the parasitoid.

The comparative efficiency of the performance of the parasitoid under laboratory conditions on two host larvae, the natural host *O. arenosella* and the alternate host *C. cephalonica*, revealed that *C. cephalonica* could be employed as a suitable alternate host for rearing *A. taragamae* in the laboratory with percentage parasitism, fecundity, longevity and sex ratio on a par with the natural host. Longevity of the female was higher in *C. cephalonica*-reared parasitoid because the parasitised larvae were getting a continuous supply of enough nourishment and were kept undisturbed.

Singh (1994) pointed out that the bioagents selected in augmentative biocontrol should be the effective species amenable to mass production. Being a koinobiont parasitoid, a daily supply of fresh food to the host larvae is required for rearing *A. taragamae*. This was difficult when rearing on *O. arenosella*, which involved frequent handling for change of food (coconut leaf). The technique developed in the present investigation to rear the parasitoid in *C. cephalonica* was of high practical value for mass rearing the parasitoid in the laboratory. Once the parasitised larvae were transferred to their natural food (semolina) there was no need for frequent changing of food and hence saved manpower. This method also reduced the chances of mortality of larvae due to handling. As the parasitised larvae were not disturbed, there was a higher rate of recovery of parasitoids. The technique for maintaining a steady supply of early larvae of *C. cephalonica* was also standardised. This method ensured a steady supply of host larvae for continuous mass production.

Literature on mass production techniques of *Apanteles* species is scanty. Inayathullah (1987) studied the suitability of rearing *A. flavipes* Cameron on gram flour diet, compared it with *Chilo partellus* Swinhoe reared on maize grains and found that there was no significant difference. Laboratory rearing methods for the gregarious *A. taragamae* infecting the pumpkin caterpillar *Diaphania indica* Saunders were reported by Peter and David (1992). Ghosh and Abdurahiman (1996) observed some success at egg laying by *A. taragamae* when second instar *Corcyra* larvae were kept inside a second instar *O. arenosella* larval gallery, but reported that further development was not encouraging. Earlier workers (Nirula 1956; Rao et al. 1948; Mohammed et al. 1982) also reported difficulty in lab rearing *A. taragamae* due to the need for a continuous supply of second instar *O. arenosella* larvae. The new rearing method described in this paper overcomes this problem. This method saves

considerable manpower in rearing the parasitised larvae as the *C. cephalonica* larvae are reared in semolina, which does not require frequent food changing.

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