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Effect of adult food on oviposition period, longevity and fecundity of parasitoid, *Goniozus nephantidis* (Muesebeck)

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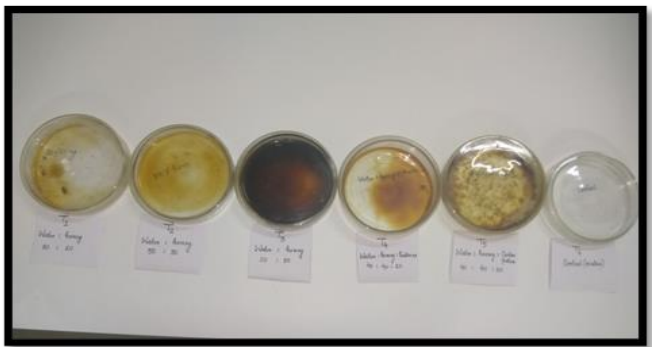
Abstract
An experiment was conducted to study the effect of adult food on the oviposition period, longevity and fecundity of *Goniozus nephantidis* (Muesebeck) in the biological control laboratory of Department of Entomology, College of Agriculture, OUAT, Bhubaneswar from June 2018 to May 2019 on the host, *Corcyra cephalonica* Stainton. The laboratory experiment was conducted with six treatments and four replications in completely randomized design at 27± 3 ^{0}C temperature and 65± 5% RH. Among different adult foods of *G. nephantidis*, the treatment, water : honey : protinex = 40:40:20 produced the highest oviposition period of 26.54 days, adult female longevity of 36.45 days and fecundity of 65.72 eggs per female followed by the treatment, water : honey : castor pollen = 40:40:20 (24.23 days, 35.12 days and 61.36 eggs/female, respectively). These two treatments were at par and superior to all other treatments. Increase in oviposition period, adult female longevity and fecundity in these two treatments over control (water) were 155.93, 124.58, 197.78% and 133.65, 116.39, 178.02%, respectively.

Keywords: *Goniozus nephantidis*, adult food, oviposition period, adult female longevity, fecundity

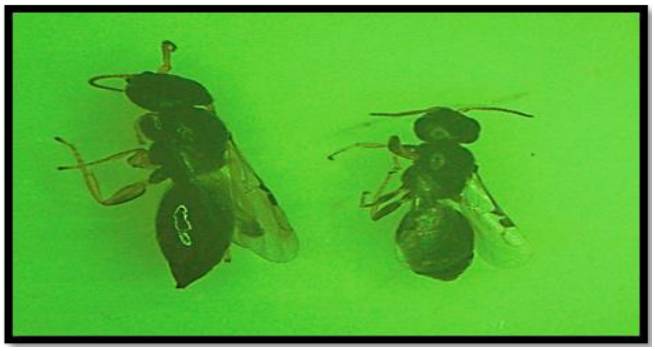
Introduction
Coconut is an important palm of coastal belt in India. India is the largest producer of coconuts in the world, producing 12,597 million nuts from an area of 18.40 lakh hectares with a productivity of 8,622 nuts per hectare against a world average of 4,545 coconuts (Venkatesan *et al.* [11]). Coconut harbours a number of insect pests which cause serious damage to it and making it uneconomical for the growers. Out of the several insect pests attacking coconut palm in India, black headed caterpillar, *Opisina arenosella* Walker is a major one. It is an indigenous, cosmopolitan and outbreak causing pest of coconut in India and Sri Lanka. Severe attack of the pest results in leaves appearing scorched with drastic reduction in yield (Nirula *et al.* [5]; Lever [2] and Ramachandran *et al.* [7]). Hiding nature of black headed caterpillar under gallery made of saliva and frass material and height of the coconut plant make chemical control of the pest a difficult task. In the recent years, parasitologists made an endeavour for achieving a solution to the problem by biological means. Among various Hymenopteran parasitoids, *Goniozus nephantidis* is one of the dominant and effective parasitoid of *O. arenosella* utilized in biological control programme. The parasitization by *G. nephantidis* on *O. arenosella* varies from 3.7 to 47.6% in Kerala (Sathiamma *et al.* [10]) and 48.00% in Karnataka (Nadarajan and Channabasavanna [4]).
Honey is generally provided as alternate adult food for mass culturing of *G. nephantidis* in the laboratory. However, honey is mainly a carbohydrate food (82.0% carbohydrate and 0.3% protein). Thompson and Simpson [9] remarked that insects consume a wide variety of proteins to satisfy their nutritional requirements for amino acids. Earlier workers (Zhang *et al.* [13]; Wang *et al.* [12] and Mashal *et al.* [3]) added pollen grains with honey and observed improved effects as adult food for another important group of hymenopteran parasitoids, *Trichogramma* spp. Keeping these facts in mind, in the present study, protein components were added in the form of protinex (51.4% carbohydrate and 34.0% protein) and pollen grains (13.0-55.0% carbohydrate and 7.0-35.0% protein) with honey and the effects of the adult foods were studied on oviposition period, longevity and fecundity of *G. nephantidis*.

Materials and methods
The laboratory experiment was conducted with six treatments (details in Table1) and four replications in completely randomized design at 27± 3 ^{0}C temperature and 65± 5% RH from

June 2018 to May 2019 in the Biological Control Laboratory of Department of Entomology, College of Agriculture, OUAT, Bhubaneswar. One pair of freshly emerged adults (one male and one female) was placed in a plastic specimen tube of size 3″x1″ and mouth of the tube is secured with small piece of cloth and rubber band. For each treatment four such tubes were prepared. These parasitoids were provided with different nutrients (as per treatments) soaked in cotton and stuck on the inner walls of specimen tube. One fifth instar larva of *Corcyra* was provided in each specimen tube next day. The female parasitoid injected venom in *Corcyra* larva. After paralysis of the host larva, the parasitoid laid eggs on it. The larva of *Corcyra* with parasitoid eggs were removed gently with the help of forceps and transferred carefully to a paper strip. A fresh host larva was provided to the female parasitoid for further oviposition. This process continued till the death of the female parasitoid. The parasitized host larvae on the paper strips were examined under binocular microscope. The number of eggs laid on each larva was counted and recorded. The data were compiled and mean data were calculated. These data were subjected to statistical analysis as suggested by Rangaswamy [8] for drawing meaningful inference.



Different food of parasitoid (*Goniozus nephantidis*) adult



Adult female (left) and Adult male (right) of *G. nephantidis*

Stock culture of *G. nephantidis*

Eggs of *Goniozus* on host (*Corcyra*) larva

Results and Discussion

The data on pre- oviposition period, oviposition period, post-oviposition period, adult female longevity and fecundity have been presented in Table 1.

Oviposition period and adult female longevity

The longest oviposition period of 26.54 days and adult female longevity of 36.45 days were recorded in the treatment, water: honey: protinex = 40: 40: 20 (T_4) followed by the treatment, water: honey: castor pollen = 40: 40: 20 (T_5) (24.23 days and 35.12 days, respectively). These two treatments were found at par among themselves and superior to all other treatments. According to the performance, the next treatments were, water: honey=20:80 (T_3) and water: honey = 50:50 (T_2) where the oviposition period were 20.19 and 19.85 days and adult female longevity 32.66 and 32.58 days, respectively. There was no significant difference among these two treatments. The respective data for the treatment, water: honey = 80:20 (T_1) were 15.91 days and 27.83 days, respectively. The shortest oviposition period of 10.37 days and adult female longevity of 16.23 days were recorded in control (water) (T_6). The increase in oviposition period and adult female longevity over control were highest in T4 (155.93 and 124.58%) followed by T5 (133.65 and 116.39%), T3 (94.70 and 101.23%), T2 (91.42 and 100.74%) and T1 (53.42 and 77.94%).

Pre-oviposition period and post-oviposition period

Among the five treatments comprising different adult foods, the shortest pre-oviposition and post-oviposition periods was found in T_4 (3.73 and 6.18 days) followed by T_5 (3.82 and 7.07 days), T_3 (3.96 and 8.51 days), T_2 (4.18 and 8.55 days) and T_1 (4.37 and 28.88 days). However, among all the six treatments, the shortest pre-oviposition and post-oviposition period of 3.24 and 2.62 days were observed in control (T_6).

Fecundity

The number of eggs laid by *Goniozus* female was observed highest in T_4 (water: honey: protinex = 40:40:20) (65.72) which was significantly on par with T_5 (water: honey: castor pollen =40:40:20) (61.36) and these two treatments were superior to all other treatments. The fecundity of T_3 (water: honey = 20:80) and T_2 (water: honey = 50:50) were 55.69 and 53.14, respectively. The fecundity was low in T_1 (water: honey = 80:20) (41.35). The lowest fecundity was recorded in T_6 (control) (22.07) among all the six treatments.

Increment in fecundity over control was maximum in T4 (197.78%) followed by T5 (178.02%), T3 (152.33%), T2 (140.78%) and T1 (87.36%).

Radhika [6] found that the adult *Goniozus nephantidis* fed with 20% honey produced highest longevity and fecundity. Hegade

et al. [1] reported that the highest longevity of adult *G. nephantidis* was recorded from 50% honey. In the present investigation, 50% honey produced significantly higher longevity of adult female (32.58 days) and fecundity (53.14) than 20% honey (27.83 days and 41.35, respectively). Scanning of literature did not show any work regarding effect of protein-rich adult food on *G. nephantidis*. However, previous workers investigated the effect of pollen (protein-rich food) as adult food component in *Trichogramma* spp., another important hymenopteran parasitoid. Zhang *et al.* [13] reported that the fecundity of *Trichogramma brassicae* was 61.70 for water alone against 95.70 for honey alone and 99.97 for corn pollen and honey. Wang *et al.* [12] observed that maize pollen fed females of *Trichogramma ostriniae* lived significantly longer and produced significantly more progeny than those fed on water alone. Mashal *et al.* [3] evaluated the effects of four honey bee products *viz.*, honey, pollen grains, royal jelly and propolis and their mixtures as adult food for three *Trichogramma* spp. *viz.*, *Trichogramma evanescens*, *T. bourarachae* and *T. cacoeciae* and reported that all diets containing honey improved longevity and fecundity. In the present investigation, the adult food composed of water: honey: castor pollen = 40: 40: 20 produced very high adult female longevity (35.12 days) and fecundity (116.39) in *G. nephantidis.* Hence, the present findings are in conformity with the findings of the previous workers.

Table 1: Effect of food of adult parasitoid on oviposition period and fecundity

Treatments	Pre-oviposition Period (days)	Oviposition Period (days)	Increase (%) in oviposition period over control	Post-oviposition Period (days)	Longevity of adult female (days)	Increase (%) in longevity over control	Fecundity (no.)	Increase (%) in fecundity over control
T_1: Water: honey = 80 : 20	4.37	15.91	53.42	7.55	27.83	77.94	41.35	87.36
T_2: Water : honey = 50 : 50	4.18	19.85	91.42	8.55	32.58	100.74	53.14	140.78
T_3: Water : honey = 20 : 80	3.96	20.19	94.70	8.51	32.66	101.23	55.69	152.33
T_4: Water : honey : protinex = 40 : 40 : 20	3.73	26.54	155.93	6.18	36.45	124.58	65.72	197.78
T_5: Water : honey : castor pollen = 40 : 40 : 20	3.82	24.23	133.65	7.07	35.12	116.39	61.36	178.02
T_6: Control (water)	3.24	10.37	---	2.62	16.23	---	22.07	---
SE (m) ±	0.139	1.264		0.823	1.185		1.517	
CD (p = 0.05)	0.42	3.81		2.48	3.57		4.57	

Conclusion

Two adult foods *i.e.*, water: honey: protinex = 40: 40: 20 and water: honey: castor pollen = 40: 40: 20 are found promising and may be recommended for mass culturing of *Goniozus nephantidis* in the laboratory.

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