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Study on the Breeding Biology and Captive Rearing of *Bracon brevicornis*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

The extensive use of synthetic insecticides in agriculture, especially in developing countries, has caused severe environmental and health issues, such as pest resistance and biodiversity loss. This study explores the potential of biological control as a sustainable alternative by examining the life table parameters of the parasitoid wasp, *Bracon brevicornis* (Hymenoptera: Braconidae) on its host, *Corcyra cephalonica* (Lepidoptera: Pyralidae). The research involved the rearing of *C. cephalonica* and *B. brevicornis* under controlled conditions as well as the monitoring of their life cycle stages. Key findings include an incubation period of 1.5 days, a larval period of 4.5 days, and a pupal period averaging of 5 days, with the adult longevity ranging from 23 to 40 days. The study observed high rates of egg hatching (89.3%), pupation (95.8%), and adult emergence (93.8%), and an average fecundity of 200-240 eggs. These results highlight *B. brevicornis* as a promising biological control agent, offering an eco-friendly alternative to chemical pesticides.

Keywords: Bracon brevicornis; biology; biocontrol agent.

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1. INTRODUCTION

"The widespread use of synthetic insecticides in modern agriculture across developing countries has proven effective in quickly reducing pest populations. However, prolonged and indiscriminate application has led to significant issues. These include environmental contamination, biodiversity loss, the emergence of insecticide-resistant pests, pest resurgence, outbreaks of secondary pests, increased reliance on chemical inputs, and toxicological hazards from pesticide residue accumulation in the food chain. Addressing these challenges is crucial for achieving efficient insect control and mitigating environmental and health risks" [1,2].

In recent years, the growing public concern over potential health hazards of synthetic pesticides has led to the exploration of biological control agents due to their environmental feasibility, eco-friendliness and sustainability. Biological control of pest insects by natural enemies may be potential, cost effective and eco-friendly alternative to synthetic pesticides.

"The cosmopolitan parasitoid wasps, *Bracon brevicornis* (Wesmael and *B. hebetor* Say) (Hymenoptera: Braconidae) are specific for lepidopterans. Braconid wasps represent one of the most diverse and abundant of parasitoid groups. These wasps are mostly ectoparasitoids, with the larvae developing on the outside of the body of the host. Recorded hosts include the larvae of many species of lepidopterans like Rice moth, *Corcyra cephalonica*, Corn borer (*Sesamia cretica*), European corn borer (*Ostrinia nubilias*), *Galleria mellonella*, *Helicoverpa armigera* and *Spodoptera litura*, along with some species of beetles, flies, hymenopterans and true bugs. They are idiobionts, halting the development of the host when they lay eggs on its body. They have a single recurrent vein. They often pupate in silken cocoon outside the host. They are either solitary or gregarious in nature" [3,4].

This paper is an attempt to study the life table parameters of the parasitoid*B. brevicornis*) on one of its laboratory host, *Corcyra cephalonica* Stainton under laboratory conditions. "Life table studies of parasitoids and predators provide necessary information on their effectiveness against target pests, rate of population build-up, etc. under laboratory conditions, which can be correlated to natural conditions" [5] and to schedule period of intervals for parasitoid releases. "Life table computation helps in studying the population dynamics of the insect species and is an analytical tool which provide a description of the survivorship, development, etc. and reveal the maximum growth potential of a population" [6,7].

2. MATERIALS AND METHODS

2.1 Rearing *of Corcyra cephalonica*

2.1.1 Materials required for the rearing of *C. cephalonica*

Sterilized sorghum rearing boxes, trays, or jars were constructed using plastic or wood. Each container featured a lid with wire mesh for aeration. Additional equipment included a Corcyra egg-laying cage, black cloth, mosquito net, table, racks for placing Corcyra cages, honey, glycerin, tubes for collecting Corcyra moths, a measuring cylinder, plastic tubs for egg-laying purposes, a brush, and the following ingredients: 100 grams of roasted ground nut powder, 5 grams of yeast, 5 grams of wettable sulfur, and 0.05 grams of streptomycin sulfate.

2.1.2 Preparation of egg-laying cage

We took a plastic bucket with a lid. We cut the lid in a circular shape, leaving space for attaching wire mesh for egg-laying purposes within the circular wire mesh. A hole was made in the center of the bottom of the plastic bucket to pour the collected adults into the bucket. The bucket was then inverted in the plastic tub for egg-laying purposes.

2.1.3 Production of *C. cephalonica*

We sterilized the wooden rearing boxes in a hot air oven at 100 0C for 30 minutes. Plastic trays were washed before use. The broken grains of jowar were dried properly in sunlight and then poured into the sterilized boxes or trays, using 2.5 kg per container. We added 100 grams of roasted groundnut powder, 5 grams of yeast, 5 grams of wettable sulfur, and 0.05 grams of streptomycin sulfate to each box or tray. After mixing all the ingredients thoroughly, we sprinkled 1 cubic centimeter of Corcyra eggs on top of the mixture (culture medium). The boxes were then covered with lids, labeled with the date of inoculation, and placed on racks protected by ant pans. The optimal rearing temperature was maintained at 28 ± 2 0C with a relative humidity of 75 ± 5%. On the 40th day, the moths began to emerge. We prepared the boxes for moth

emergence, collected the moths inside the net using glass tubes, and transferred them to the egg-laying chamber. Cotton soaked in a 20% honey + vitamin E solution was provided as adult food in the egg-laying chamber. The eggs were collected daily and poured into a paper, tilting it slightly downward to allow the eggs to fall to the bottom while the dust particles remained at the top. The eggs were further cleaned by passing them through different-sized sieves (10, 15, and 40 mesh). After four days, the moths were discarded. The Corcyra eggs were utilized for Trichogramma production, as host culture, or stored in the refrigerator at 10 degrees Celsius for 7 days, if needed.

2.2 Rearing of *Bracon brevicornis*

2.2.1 Materials required

The following materials were used for the rearing of *B. brevicornis*:

Bracon spp., *Corcyra* eggs, Honey, Cotton, Containers, Muslin cloth, Rubber bands, Petri dishes, Tissue paper etc.

2.2.2 Production procedure

"B. brevicornis is amenable for mass rearing in the laboratory on the alternate host, *Corcyra cephalonica*. For small scale culture, glass chimney and the 'Sandwich' technique are adequate. About 20 mated females were confined in a glass chimney, covering both sides of the chimney with muslin sheet held in place with rubber bands. A cotton swab soaked in 50% honey water solution was stuck to the side of the chimney to serve as food. With many hymenoptera, adult nutrition is of great importance as it influences sex-ratio. High protein diet at times improves the sex ratio so that more female progeny are produced. For this, Proteinex was used to produce the desired results. Replacing honey with levulose or fructose also is beneficial in some cases. Exposure to sunlight frequently stimulated mating, oogenesis and fertilization of eggs" [6,8].

2.2.3 Life table studies

About 10 full grown larvae of *Corcyra* were placed between two sheets of facial tissue paper and placed over the muslin sheet covering the wider mouth of the chimney. The tissue was again covered with a sheet of muslin and fastened with a pair of rubber bands. The chimney was then placed with the host larvae facing a window or light source. Females of *B. brevicornis* were attracted to the host larvae, probed through the muslin and paralyzed the larvae on each of which they laid about 25 eggs per day. At the end of 24 hours, the tissue sheets bearing parasitized larvae were removed and held in flat plastic containers until the parasitoid grubs hatched, completed development and spined cocoons. Two-day-old adults of *B. brevicornis* were stored for 30 days at 50℃ and 50-60% RH. We had checked the fungal growth on cotton swab if infested and then it was changed accordingly. Frequently we need to re-immerse the cotton swab in 10% honey solution. We observed the eggs daily and calculated the hatching percentage and mortality rate by using the formula as follows (Fig. 1):

$$\text{Hatching}\ (\%) = \frac{No\ of\ eggs\ hatched\ \times 100}{No\ of\ eggs\ laid}$$

$$\text{Mortalityrate} = 100 - \text{Hatching}\ (\%)$$

Larval duration was worked out by making observations daily after the completion of larval stage (cocoon) formation. Later the strips were cleaned and kept into a large box. Pupal duration and pupal percent were worked out, with the following formula:

$$\text{Pupal}(\%) = \frac{No\ of\ pupae\ formed\ \times 100}{Total\ no.of\ larvae}$$

After the emergence of adult, they were provided with cotton swab dipped in 10% honey solution and then mixed with protein X. Number of adults were counted based on the emerged hole left on the cocoons. Percentage of adult emergence was calculated. Field release of emerged adults was done, following the formula as below:

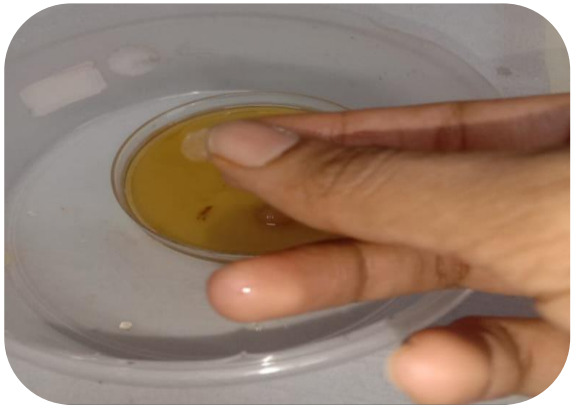
$$\text{Adult emergence}\ (\%) = \frac{No\ of\ adults\ emerged \times 100}{Total\ no.of\ pupae}$$

3. RESULTS AND DISCUSSION

3.1 Biology of *B. brevicornis*

Different developmental and life stages of *B. brevicornis* are discussed below and depicted in Fig. 2.

1. Preparing honey solution



2. Dipping of cotton balls in honey solution and squeezing extra honey

3. Take a wide mouthed jar

4. Release 20 Bracon adults to the jar near light source as they are phototropic in nature

5. Cover the opening with a muslin cloth and tie it

6. Collecting Corcyra larvae

7. Add 10-15 Corcyra bigger larvae on muslin cloth

8. Cover the larvae with a another muslin cloth, tie it &keep as it is for 2 days

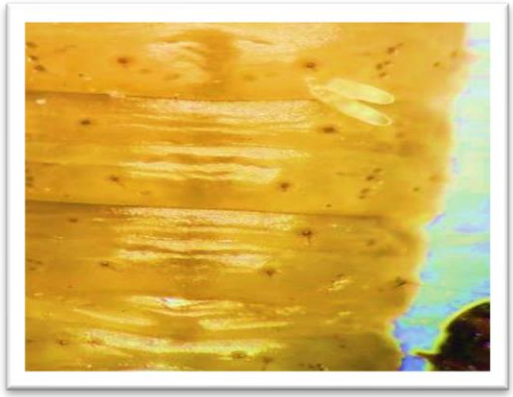
9. After 2 days, transfer the parasitized larvae to the petri dish with a paper

10. Adult emerged

11. Emerged adults released in another container for mating purpose

12. Releasing bracon adults on maize plant

Fig. 1. Laboratory rearing set up of *Bracon brevicornis*



Eggs of *Bracon* on *Corcyra* larvae

Early instars of *Bracon*

Late instars of *Bracon*

Pupa of *Bracon*

Pupa is ready to emerge

Adult of *Bracon*

Fig. 2. Different life stages of *Bracon brevicornis*

Table 1. Life cycle metrics of *B. brevicornis*

Parameters	Range (days)	Mean (days)
Incubation period	1-2	1.5
Larval period	4-5	4.5
Pupal period	3-7	5
Adult longevity	23-40	31.5
% Egg hatching	89.3%	-
% Pupation	95.8%	-
% Adult emergence	93.8%	-
Fecundity	200-240	-
No. of eggs	44-45	-
No. of larvae	40-42	-
No. of pupa	35-40	-
No. of adults	30-39	-

3.1.1 Eggs

B. brevicornis laid maximum numbers of eggs on dorso-lateral side of 5th to 6th abdominal segments of host larvae. The eggs were loosely attached to the host's integument and deposited parallel to the longitudinal axis of the body. The freshly laid eggs on *C. cephalonica* were creamy white in colour and become translucent later [9,10]. The deposited eggs were spindle shaped slightly curved, hyaline colourless and loosely attached to the surface of the host body. *B. brevicornis* laid eggs on lateral side of the host body and eggs were laid on all the segments except the first thoracic and the head region. Majority of eggs were laid close to the intersegmental folds on the lateral aspect, while some were on the dorsal aspect. Pre-oviposition period is was 1-2 days. Egg hatching period was 1-2 days and the average fecundity was found to be 200-240 and number of eggs ranged from 44 to 45. Hatching percentage was found to be 89.0% and mortality percentage was 10.7% (Table 1).

3.1.2 Grubs

The first instar was apodous, white, devoid of any sign of external segmentation and distinguished from the egg only by waves of internal content of gut contraction and the movement of haemolymph within the parasite's body. The later instar larvae were whitish yellow and having clear larval body segmentation. The full-grown larvae showed tapering end and bulging of middle portion of body. Complete developmental period of grub is between 2 and 4 days (Table 1).

3.1.3 Pupae

Final instar larvae ceased feeding then searched suitable place where it remains stationary this forms the beginning of cocoon formation stage. The cocoon of *B. brevicornis* was made loosely woven by silken threads and white in colour with oblong in shape and became tough to attach with substrate. Pupal period was between 3-7days. Percentage of pupation and mortality was found to be 95.0 and 24.5, respectively (Table 1).

3.1.4 Adults

The newly emerged adults were black in colour with transparent membranous wings and bent head. The femur of leg was enlarged. The abdomen of females was bulged at anterior portion and sharp at posterior end with pointed ovipositor. The male abdomen differed from females due to short blunted posterior tip. The length of the male was short as compared to females. Antennae were filiform with 13 segments. Male lifespan was less compared to female. Adult life span was 23-40 days. Percentage of adult emergence and mortality was 93.8% and 6.2%, respectively (Table 1).

The development of immature stages of *B. brevicornis* on *C. cephalonica* from oviposition to adult emergence took 8-10 days at 28.3±0.1 ºC and 59.6±0.6% r.h. and the sex ratio in the present study revealed a slightly male biased population (0.9). Male biased development was earlier reported by Singh et al. (2014) at 30 0C. The female adults had a longevity of 20.4 days while the males a longevity of 3.2 days.

4. CONCLUSION

This study investigated the life table parameters of the parasitoid wasp Bracon brevicornis on its laboratory host, Corcyra cephalonica. The results

revealed that B. brevicornis is a promising biological control agent for lepidopteran pests. The parasitoid exhibited a relatively short generation time, high fecundity, and a high rate of parasitism. These favorable characteristics suggest its potential for effective pest control in agricultural systems. Further studies under field conditions are necessary to assess the efficacy of B. brevicornis in suppressing target pest populations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Armes NJ, Jadhav DR, Bond GS, King ABS. Insecticide resistance in *Helicoverpa armigera* in South India. Pestic Sci. 1992;34:355–364.
2. Kranthi KR, Jadhav DR, Kranthi S, Wanjari RR, Ali SS, Russel DA. Insecticide resistance in five major insect pests of cotton in India. Crop Prot. 2002;21:449–460.
3. Sime KR, Daane KM, Andrews JW, Hoelmer K, Pickett CH, Nadel H, Johnson MW, Messing RH. The biology of Bracon celer as a parasitoid of the olive fruit fly. Biocontrol. 2006;51:553-67.
4. Leung K, van der Meulen H. Revisiting the hymenopteran diploid male vortex: A review of avoidance mechanisms and incidence. Entomologia Experimentalis et Applicata. 2022;170(12):1010-31.
5. Muthukrishnan J, Srinivasaperumal S, Selvan MS. Bioenergetics and life tables of selected parasitoids and predators. In: T. N. Ananthakrishnan (ed.). Biological control of social forest and plantation crops insects. Science Publishers: Lebanon; 1995;193–206.
6. Gabre RM, Adham FK, Chi H. Life table of *Chrysomya megacephala* (Fabricius) (Diptera: Calliphoridae). Acta Oecol. 2004;27:179–183.
7. Farag NA, Ismail IA, Elbehery HHA, Abdel-Rahman RS, Abdel Raheem MA. Life table of Bracon hebetor Say (Hymenoptera: Braconidae) reared on different hosts. Int J ChemTech Res. 2015; 8:123–130
8. Nair MK. Opisina arenosella Wlk. The leaf eating caterpillar of coconut palm. Technical Bulletin No. 27. CPCRI, Kasaragod, India; 1993;12.
9. Narendran TC, Mohammed UVK, Abdurahiman UC, Kumar VVS. Oviposition behaviour of Bracon brevicornis Wesmael (Hymenoptera: Braconidae). Agric Res J Kerala. 1980;18:239–241.
10. Rukshana K, Majeed PP. The effectiveness of bio control of Opisina arenosella (Lepidoptera: Oecophoridae) using Bracon brevicornis (Hymenoptera: Braconidae). J Zool Stud. 2014;1:1–3.

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