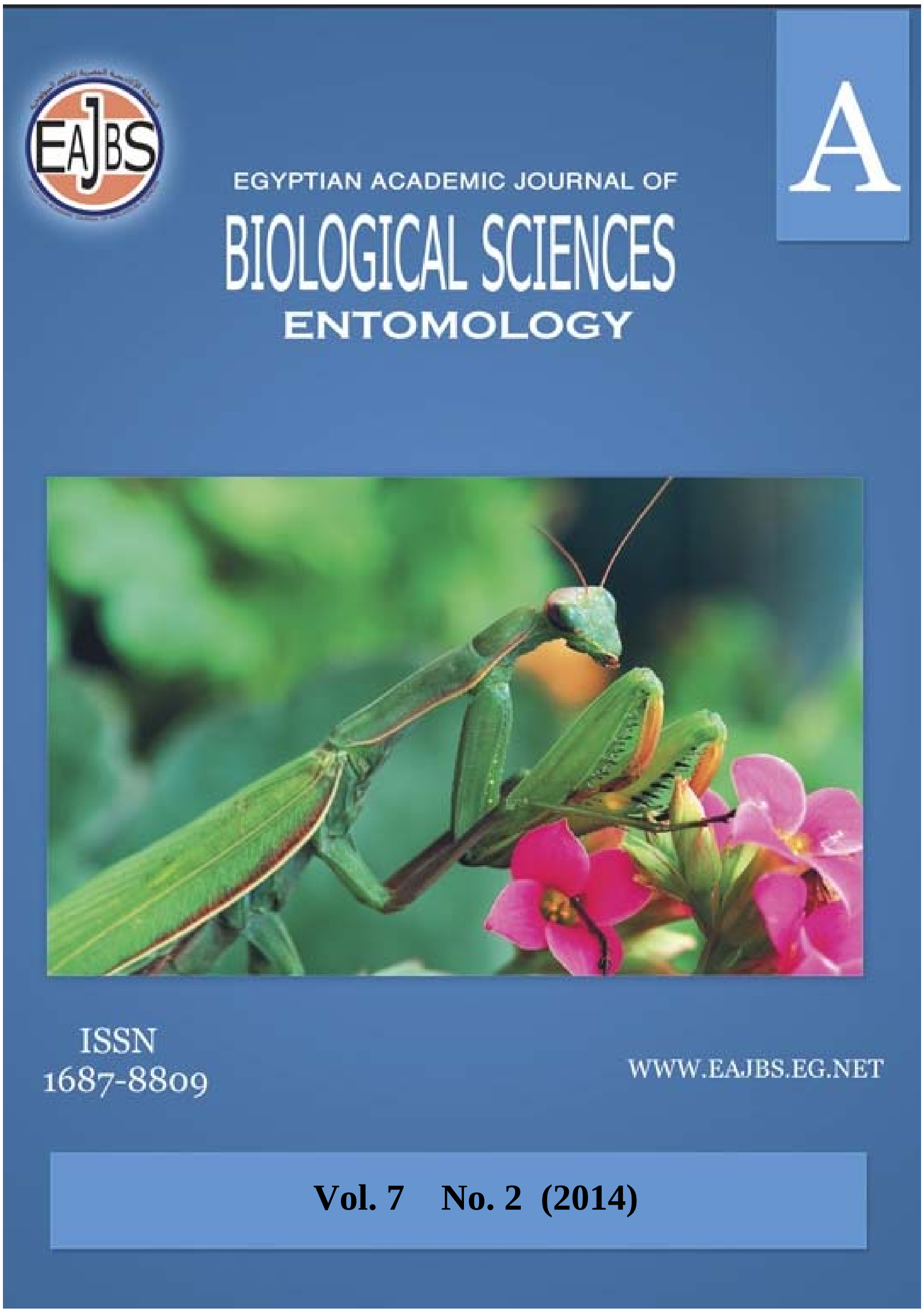

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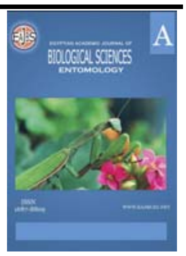

Biological studies on *Bracon brevicornis* (Hymenoptera: Braconidae) reared on different host larvae

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ABSTRACT

The present work was carried out to study the biological aspect of *B. brevicornis* when reared on different hosts (Ephestia kuehniella, Galleria mellonella, Corcera cephalonica, *Sesamia cretica*, *Spodoptera littoralis* and *Pectinophora gossypiella*). Our Results assured that the type of host had great impact on the durations of the immature stages and longevity of the parasitoid. The highest & lowest incubation periods were when reared the parasitoids on *Pectinophora gossypiella* (45.75±1.4hours) and *E. kuehniella* (39.87±0.95 hours) respectively, the difference was insignificant at the other hosts. Duration of larval stages was significant shorter when parasitoid reared on *S. cretica* (1.86±0.079 days) than the rest hosts. The longer pupation period was recorded when parasitoid reared on *Pectinophora gossypiella* (7.6±0.13 days), but was insignificant on the other hosts. The highest duration period of immature stage was when reared *B.brevicornis* on *P. gossypiella* (12.75±0.74 days) but insignificant difference when reared on *G.mellonella* [9.16±0.22 days] and *S. cretica* [9.91±0.14 days]. The mean duration of male longevity of parasitoids was longer when reared on *E. kuehniella* (15.73±0.73 days) and shorter when reared on *C.cephalonica* (11.75±0.51 days). The mean duration of female parasitoids was highest when reared parasitoids on *S. cretica* (19.6±0.51 days). The total number of eggs laid per female of *B.brevicornis* during its life span was highest on *Galleria mellonella* (268.88±19.65 eggs), and lowest on *C.cephalonica* (78.1±10.63 eggs). A percentage of eggs hatchability was significantly lowest when reared on *S. littoralis* (0.09±0.02642 %) than when reared on the other hosts, while percentage of emergence was insignificantly different when reared on *Sesamia cretica* (87.36±3.92 %) and *Pectinophora gossypiella* (87.02±3.85 %).

Keywords: Biological studies - *Bracon brevicornis* – different hosts

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INTRODUCTION

Pest control is an acceptable and necessary part of modern agriculture and is required for increasing crop production and improves natural economy. However, some of the methods used during the past few decades have produced undesirable side effects. The chemical control is highly effective, rapid in action, adaptable to most situations. Nonetheless, it posed real hazards, where some chemicals leave undesirable residues in food, water, and the environment. However the increasing attention for environmental safety and global demand for pesticide free food necessitated the search for eco-friendly methods of pest management. As a result, many researchers are seeking less hazardous alternatives to conventional insecticides. There is a core of important alternatives in insect pest management such as biological control. Among the various groups of biocontrol agents, braconid parasitoids are well known for the management of different pest insects. Braconidae is the second most important family of parasitoid wasps in biological control, having been introduced in successful IPM programmes (Greathead, 1986).

Braconid wasps represent one of the most diverse and abundant of the parasitoid groups (LaSalle and Gauld 1993). Their most common hosts are the larvae of Lepidoptera, Coleoptera, and Diptera (Wharton *et al.*, 1997). The braconid wasp, genus *Bracon* is an ectoparasitoid that attacks larvae of several species of Lepidoptera, mainly pyralid moths. It is an important potential biological control agent of stored product moths (Brower *et al*. 1996). While, it was recorded by several authors over the world on different hosts such as the corn borer, *Sesamia cretica* and European corn borer, *Ostrinia nubilais* Hbn., (saleh1986); *Eublemma amabilis* Sharma *et al*., (2000); *Tuta absoluta, Pectinophora gossypiella,* Kandil (2001); *Corcyra cephalonica* Stainton, *Sitotroga cerealella* Oliv., *Galleria mellonella* Linn., *Maruca testulalis* Geyer, *Helicoverpa armigera* (Hubner) Hardwick, *Spodoptera litura* Fab and *Earias vittella* Dabhi (2011). The biology of the parasitoid differs when reared on different hosts (Landge *et al*., 2009). So we studied the biological aspects of *B. brevicornis* when reared on different hosts to determine the best lepidopteran host for its mass rearing and consequently its profitable utilization in different IPM programs

MATERIAL AND METHODS

Experimental conditions

The test insects were cultured and the experiments were carried out at 28±0.5°C and 70–75% RH, with a photoperiod of 16:8 (L: D).

The full grown larvae of each host were used as hosts for *B. brevicornis*

Stock culture of *Bracon brevicornis*.

One couple (female and male) of *Bracon brevicornis* were placed in cylindrical glass tube (2.0 x 10 cm) maintained on the full grown larvae of, *Galleria mellonella* and covered with muslin cloth then fitted with rubber lids. After 24h, parasitized larvae were removed from the tube, transferred to Petri dishes and kept under the previously mentioned conditions until adult emergence. One-two day old adults were used in the current experiments.

Stock culture of insect hosts

A- *Ephestia kuehniella* (Mediterranean flour moth)

The stock culture of *Ephestia kuehniella* originated from infested dried flour was obtained from a warehouse, located in old Cairo. Moths { 1–2 day-old }were collected from the stock culture and held in 500ml glass vials half filled with dried flour for 24h for oviposition.

B- *Galleria mellonella* (Greater wax moth)

Adults of *G. mellonella*, were collected from the infested bee hives. The adults were released in plastic jars (10 X 30 cm) for mating and comprised folded sheets for the deposition and collection of eggs. The hatched larvae were reared on a semi-natural diet comprising: Wheat flour 350 g, corn flour 200 g, milk powder 130 g, packing yeast powder 70 g, honey 100 ml, and sorbitol 150 ml (Metwally *et al.*, 2013). These jars were incubated under the previously mentioned conditions till larvae reached the target or proposed instar.

C- *Corcyra cephalonica* (The rice moth)

C. cephalonica moths were obtained from naturally infested grains stored in a local warehouse in Cairo Governorate. The collected moths held in 500 ml beakers half filled with wheat germ (97%) and yeast (3%) for 24 h for oviposition (Bernardi *et al.*, 2000).

D- *Spodoptera littoralis* (The cotton leaf worm)

S. littoralis larvae were collected in Egypt from Qaluobia Governorate and reared in the laboratory for three generations before using in the current experiments. Larvae were fed on leaves of Castor in NRC.).

E- *Sesamia cretica* (the greater corn borer)

Full grown hibernated larvae were collected from stored corn stalk from Qaluobia Governorate and confined in glass jars. Jars were covered with muslin cloth and kept until adult emergence, then transferred each couple into a cage set on maize seedling, planted in plastic pot and provided with pieces of cotton moistened with 10% honey solution for feeding and covered with muslin cloths. Deposited eggs were collected and placed among fresh green maize for hatching larvae. The green maize was renewed daily until reaching full grown larvae.

F- *Pectinophora gossypiella* (pink bollworm)

The culture of pink bollworm was based upon non-diapausing larvae, collected from infested cotton fields in Sakha. The collected larvae were reared on artificial diet according to (Rashad *et al*., 1993b). The diet consisted of 215 g dried kidney beans boiled in water, 2.25 g ascorbic acid, 1.25 g methyl-p-hydroxy benzoate, 1.25 g sorbic acid, 32 g dried active yeast, 11.5 g agar to which 500 ml distilled water and 2.5 ml formaldehyde 40% were added.

Experiment:

Newly emerged parasitoid couples (within 24 hours) were placed, each, into a cup (120 ml) with two larvae from each host. A small drop of honey was put on the cup wall to serve as food. *B. brevicornis* was allowed to attack and oviposit on each host larva for 24 hours. Every day the parasitoids were transferred to a new cup prepared with the same new host larvae. Total number of daily laid eggs, and longevity of male and female parasitoids including (pre-, ovi- and post-oviposition periods) were recorded and averaged.

When the male was found to be dead, it was replaced by a male of similar age. The old cup containing eggs of the parasitoid was held further at the same conditions, the duration of each stage (egg, larva and pupa) and the number of parasitoid emerging per cup were recorded daily. Fifteen replicates were carried out for each tested hosts.

RESULTS

The *B. brevicornis* females prefer to attack and oviposit on last instar larvae, once a host is located; the female *B. brevicornis* injects venom that induces complete paralysis of host. After the host is paralyzed, the female, usually placing patch of several eggs on the ventral surface of the host or on the side that is in contact with the substrate. While during case of, *Agrotis ipsilon*, host larvae, the parasitoid did not attack it so we excluded this host. Data for this experiment are represented in Tables (1:3).

Table 1: Duration of immature stages and adult longevity of *B. brevicornis* reared on different hosts.

Host insects	Egg (hour)	Larva (day)	Pupa (day)	Immature(day)	Male longevity	Female longevity
Ephestia kuehniella	39.87±0.95b	2.47±0.53a	6.87±0.09 b	10.99±0.12b	15.73±0.73a	17.7±0.6ab
Galleria mellonella	31.53±1.22d	2.34±0.56a	6.07±0.23c	9.16±0.22c	13.1±041bc	15.47±0.86bc
Corcyra cephalonica	36.69±1.37bc	2.44±0.72a	6.69±0.12 b	10.79±0.14b	11.75±0.51c	13.5±1.02c
Sesamia cretica	35.21±0.56b	1.86±0.079b	6.58±0.11b	9.91±0.14 c	14.67±0.67ab	19.6±0.51a
Spodoptera littoralis	35.47±1.5b	0.0±0.0 c	0.0±0.0 d	0.0±0.0 d	0.0±0.0 d	0.0±0.0 d
Pectinophora gossypiella	45.75±1.4a	2.4±0.04a	7.6±0.13a	12.75±0.74a	12±0.39c	15.78±0.52bc
F value	17.037**	101.255**	290.241**	509.547**	99.952**	70.643**

Means in a Column followed with the same letter(s) are not significantly different at 5% level of probability.
**= Highly significant

Table 2: Oviposition periods (in days) of *B. .brevicornis* adult female parasitoid reared on different hosts.

Hosts insects	Pre (day)	ovi(day)	post(day)	No of eggs	daily
Ephestia kuehniella	1.7±0.21 a	14.1±0.53 b	1.9±0.53a	71.1±7.15 c	5.1 ±0.48721 d
Galleria mellonella	1.71±0.14a	13.12±0.81 b	0.88±0. 19 bc	268.88±19.65 a	20.65±1.05 a
Corcyra cephalonica	2.0±0.21 a	10.4±0.97 c	1.1±0.23 ab	78.1±10.63c	7.49±0.56 bc
Sesamia cretica	1.6±0.24 a	16.8±0.68 a	1.2±0.38 ab	162.00±3.581b	9.81±0. 38 b
Pectinophora gossypiella	1.0±0.29 b	13. 89±0.39b	0.78±0.37 bc	110.44±4.78 c	8.04±0. 48 b
F value	14.383**	57.550**	4.346**	51.235**	97.360**

Means in a column followed with the same letter(s) are not significantly different at 5% level of probability.
**= Highly significant

Table 3: percentage of Hatchability, Pupation and Emergence of *B. brevicornis* reared on the tested hosts

	Mean ± SE		
hosts	Hatchability %	Pupation %	Emergence %
Ephestia kuehniella	89.96±2.16 a	96.32±1.41a	94.96±2.19 ab
Galleria mellonella	90.93±2.398 a	87.61±5.84 a	98.18±1.4 a
Corcyra cephalonica	89.27±4.056 a	88.29±2.98 a	90.32±3.64 ab
Sesamia cretica	95.89±2.131a	88.19±3.32a	87.36±3.92b
Spodoptera littoralis	0.09±0.02642b	0.0±0.0 b	0. 0±0.0 c
Pectinophora gossypiella	86.42±4.98 a	91.90±2.91a	87.02±3.85b
F value	129.189**	61.950**	192.300**

Means in a column followed with the same letter(s) are not significantly different at 5% level of probability.
**= Highly significant

Duration of different stages of *B. brevicornis* reared on different hosts.

1-Incubation period

Incubation of eggs is considered the shortest periods of parasitoid growth. Statistical analysis showed that differences in incubation periods in case of all hosts except *G. mellonella* and *P. gossypiella* were insignificant.where it was 39.87±0.95; 36.69±1.37; 35.21±0.56 and 35.47±1.5 hours when we reared it on *E. kuehniella*, *C. cephalonica*, *S. cretica*, *S. littoralis* respectively (Table 1)**.**

2-Larval instar

Data in Table (1) showed that the mean duration of larval stage of *B. brevicornis*, when reared on *S. cretica* (1.86±0.079 days) was significantly shorter than when reared on the other hosts *E. Kuehniella* (2.47±0.53 days); *G. mellonella*, (2.34±0.56 days); *C. cephalonica* (2.44±0.72 days) and *P. gossypiella* (2.4±0.04 days days). Differences between other hosts were insignificant.

3-Pupal stage

The recorded duration of the pupa of *B. brevicornis* was longer (7.6±0.13days) when reared on *P. gossypiella* than that reared on other hosts; (6.87±0.09days) *E. kuehniella*; (6.07±0.23 days) *G. mellonella*; (6.69±0.12 days) *C. cephalonica* and (6.58±0.11 days) *S. cretica*.

4- Duration of immature stages

The mean duration of the total immature stages of *B. brevicornis* was 10.99±0.12 and 10.79±0.14 days when reared on *E. kuehniella* and *C. cephalonica* respectively being insignificantly different (*P*<0.05) and being also insignificantly different between *G. mellonella* [9.16±0.22 days], and *S. cretica* [9.91±0.14 days], while it was 12.75±0.74 days, when reared on *P. gossypiella.*

5-Adult stage

Based on data recorded in Table (1), it was noticed that the longevity of male parasitoid was *E. kuehniella* (15.73±0.7 days 3); *G. mellonella* (13.1±041 days); *C. cephalonica* (11.75±0.51 days); *S. cretica* (14.67±0.67 days) and *P. gossypiella* (12±0.39 days).

On the other hand, the correspondent female longevity was (19.6±0.51days) when reared on *S. cretica*, showing significant (*P*<0.05) longer longevity than the other hosts. The same trend was noticed for female longevity when reared on *G. mellonella* (15.47±0.86 days) and *P. gossypiella* (15.78±0.52 days), and it was 17.7±0.6 days and 13.5±1.02 days, when reared on *E. kuehniella* and *C. cephalonica*, respectively. As the pre-oviposition period was 1.7±0.21 days; 1.71±0.14 days; 2.0±0.21 days and 1.6±0.24 days, for *E. kuehniella*, *G. mellonella*, *C. cephalonica* and *S.cretica respectively,* being insignificantly different (*P*<0.05). While it was significantly different when reared on *P. gossypiella* (1.0±0.29) days. The recorded oviposition period of *B. brevicornis* when reared on *S. cretica* (16.8±0.68 days) being significantly longer than other hosts. On the other hand it was shorter (10.4±0.97 days) when reared on, *C. cephalonica.* While the same trend was observed for *E. kuehniella, G. mellonella* and *P. gossypiella* 14.1±0.53; 13.12±0.81 and 13.89±0.39 days, respectively.

As noticed from Table (2) Statistical analysis showed that, that the post-oviposition period for female parasitoid was insignificant (*P*<0.05) when reared on *E. kuehniella* [1.9±0.53 days] *Corcyra cephalonica* (1.1±0.23 days) and *Sesamia cretica* (1.2±0.38 days) than the other hosts, *G. mellonella (*0.88±019 days)and *P. gossypiella (*0.78±0.37 days).

Data in Table (2) shows that the total number of eggs laid per female of *B.brevicornis* during its life span was significantly different (*P*<0.05) when reared on when reared on *G. mellonella* (268.88±19.65 eggs) while it was insignificantly different (*P*<0.05) when reared on *E. kuehniella*; *C. cephalonica* and *P. gossypiella* 71.1±7.15 eggs; 78.1±10.63 eggs and 110.44±4.78 eggs, respectively.

The number of eggs laid per female of *B.brevicornis* per day was significantly different (*P*<0.05) on *G. mellonella* (20.65±1.05 eggs) and *E. Kuehniella* (5.1±48721eggs), while the same trend was observed for *C.cephalonica*, (7.49±0.56 eggs); *S.cretica(*9.81±0.38 eggs) and *P. gossypiella*, (8.5±0.54 eggs) (Table 2).

Percentages of eggs hatchability when reared on *S. littoralis* (0.09±0.02642) was significantly shorter than when reared on the other hosts *E. kuehniella* (89.96±2.16); *G. mellonella* (90.93±2.398); *C. cephalonica(* 89.27±4.056); *S. cretica (*95.89±2.131) and *P. gossypiella(* 86.42±4.98). Differences between other hosts were insignificant.

According to data in Table (2) all hatched larvae on *S. littoralis* dead and cannot reach to pupation, while percentage of pupation was insignificantly different (*P*<0.05) when reared on all larval hosts.

Percentage of emergence when reared on *Sesamia cretica(*87.36±3.92)and *Pectinophora gossypiella* (87.02±3.85) was insignificantly different (*P*<0.05) while when reared on the other hosts, *E. kuehniella* (94.96±2.19), *Corcyra cephalonica* (90.32±3.64) and *G. mellonella* (98.18±1.4%) as shown in table 3.

DISCUSSION

Results obtained in the present study assure that the type of host had great impact on the durations of the immature stages and longevity of the parasitoid.

From our observation we found that, when *Spodoptera littoralis* was used as host, it decomposed and became either rotten or dry within few days after oviposition. This result was in accordance with that reported by Gerling and Rotary (1973) who declared that *Spodoptera litoralis* is unsuitable host for *Bracon* spp.

The studies of the biology of parasitoids indicated that the laboratory host, *G. mellonella*, was more suitable for *B. brevicornis*. This disagreed with the report of Sharma and Sarup (1982) for *Bracon* spp. on its laboratory host, *C. cephalonica* and natural host, *Chilo partellus* (Swinhoe) and Temerak (1983) reported that *B. brevicornis* preferred to parasitize and complete its life cycle on *Earias* spp., *H. armigera*, *P. gossypiella* than other host insects offered. Also with Thanavendan and Jeyarani (2010) who reported that *C. cephalonica* and the natural host, *E. vittella* were more suitable for *B. brevicornis*. adult longevity was found to be short on *C. cephalonica* flowed by *G. mellonella* that was in accordance with Mohanty *et al*. (1998) reported that the biology of *B. brevicornis* was faster on *C. cephalonica* than other insects. But disagree with Thanavendan and Jeyarani (2010) who found that adult longevity was found to be more on *E.vittella* and C. *cephalonica* followed by *H. armigera* and also with Dabhi (2011) reported that Maximum duration (44.30 days) to complete one life-cycle of *B. hebetor* female was recorded in *C.cephalonica* followed by *S. cerealella*.

G. mellonella in our results offered the most preferable host for oviposition than other tested hosts that may be due to the contents of larval bodies where larvae rearing on rich diets; while this disagreed with Thanavendan and Jeyarani (2010) who found that progeny production more on *E. vittella* and *C. cephalonica* than other host insects offered. And also with Amir-Maafi and Chi (2006) fecundities of *H. hebetor* were 78.3 eggs/female on *G. mellonella* and 66.3 eggs/female on *E. kuehniella* that fewer than our results.

The difference in results with other studies may be due to differences in hosts, temperature and even nutrition of hosts.

From the aforementioned results, we can conclude that the host affects the biology of the *B. brevicornis* . *G. mellonella* is considered more suitable host for *B. brevicornis* than the others hosts, where the longevity of female was short and total number of eggs deposited was more than others hosts

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