BIOLOGICAL ASPECTS OF THE ECTOPARASITOID, *DIBRACHYS CAVUS* (WALKER) (HYMENOPTERA: PTEROMALIDAE) ON SOME LEPIDOPTEROUS HOST SPECIES

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INTRODUCTION

Dibrachys cavus (Walker) was reported as a gregarious ectoparasitoid on larvae and pupae of the codling moth, *Cydia pomonella* and *Lobesia botrana* (Lepidoptera: Tortricidae) by many authors (Radjabi, 1986; Durdvey, 1987; Dvegachev, 1995 and Athanassov *et al.* 1997) and *Pectinophora gossypiella* larvae, (Chu, 1978). Many authors studied the biology and behavior aspects of different species of *Dibrachys* (Hekal 1990; Mehrnejad 2003; Kandil, 2001 and El- Sayed 2005). Klomp & Tearink (1967) and Le Masurier (1987) showed a positive relationship between host size and clutch size in *Trichogramma embryophagum* and *Apanteles* sp., where the females laid more eggs in larger host than in smaller ones.

This study aimed to better understanding of several biological and behavioral aspects of *D. cavus* on different hosts. In addition, studying the quantitative relationship between the host age and species on the number of parasitoids emerging (progeny) to take the advantage in mass production of this parasitoid.

MATERIAL AND METHODS

I -Insects used

1- Hosts

The three species of insect hosts used in this study belong to order: Lepidoptera,*i.e. Pectinophora gossypiella* (Fam.: Gellechiidae), *Earias insulana* (Fam.: Noctuidae) and *Galleria mellonella* (Fam: Galleridae). Pink and spiny bollworms strain larvae were obtained from the Bollworms Research Department, PPRI. The larvae were reared under controlled conditions (25±1 °C & 70-75% R.H. with complete dark all day time) for several generations on a semi-artificial diet

according to (Rashad and Ammar, 1985). On the other hand, larvae of wax moth, *G. mellonella* were reared on a semi-synthetic diet as described by Ibrahim *et al.* (1984). Different ages and stages of the three hosts (middle larvae, fullgrown larvae and 1st day of pupa or spinning cocoon) were used as hosts.

2 -The parasitoid

Laboratory culture of *D. cavus* began with adults emerged from parasitized pink bollworm diapaused larvae collected from infested dry cotton bolls. Bolls were collected at the end of cotton season from cotton fields at El-Ebrahemia region, Sharkia Governorate, and kept under natural conditions on roof of a farmer's house. The parasitoids were reared for five generations on fullgrown larvae of pink bollworm laboratory strains and 1st day of spinning cocoon of *E. insulana* and two generations on fullgrown larvae of *G. mellonella* to adapt the parasitoid before directing the experiment..

II -Host preference, reproduction, progeny and sex ratio evaluation

To evaluate host preference and/or the preferred host stage, the reproductive capacity, progeny and the sex ratio of the tested parasitoid, laboratory experiment was directed under controlled conditions (25±1 ℃ & 70-75% R.H.) using different stages and ages of the three hosts species.

Newly emerged adults of the parasitoid were sexed (♀&♂) and kept separately in glass jars (1/2 kg). Five individuals from each stage/host were transferred and offered to female parasitoid inside a glass jar as a suitable site for parasitism. Several droplets of honey bee were streaked on surface of the glass jars lid as a source of food for the female wasps. Each glass jar was covered with muslin cloth. Daily examination of host individuals started at the zero time of experiment. The host larvae were carefully transferred to Petri dishes. Number of paralyzed and parasitized hosts and the number of laid eggs by female wasp were recorded daily and kept under the same conditions until death of the parasitoid. Also, percentage of hatchability, pupation %, adult emergence and the sex ratio were estimated. From the recorded data, the preferred host and /or age could be determined.

To determine other biological aspects of the parasitoid, two hundred eggs of the parasitoid were collected for each tested host *P. gossypiella, E. insulana* and *G. mellonella* and were daily inspected several times under a dissecting stereomicroscope to estimate the incubation period, larval and pupal duration and adult emergence and sex ratio.

Adult longevity

Fifteen pairs of newly emerged adult parasitoid reared on *P. gossypiella* larvae, *E. insulana* and *G. mellonella* 1st day of spinning cocoons were used for each treatment (divided into 3 replicates). Five larvae or cocoon / host were confined with a pair of parasitoid in glass jar covered with muslin cloth. After 24 hours, the larvae or cocoon were examined and those carried parasitoid eggs were removed individually and kept in Petri – dish under the same controlled conditions. Fresh larvae or 1st day of spinning cocoon hosts were introduced instead of the parasitoid into the different glass jars and this procedure was continued until mortality of adult parasitoid. The numbers of deposited eggs were counted daily and the pre-ovipostion, ovipostion, post – oviposition period, longevity of females and males and sex ratio were estimated.

Data analysis

The relationship between progeny, sex ratio number of eggs laid, and duration of immature stages, adult emergence and adult longevity per each host were examined by analysis of variance (ANOVA) using Costat program.

RESULTS AND DISCUSSION

1. Effect of species and age of host on parasitoid reproduction, progeny and sex ratio

Mating of *D. cavus* occurred immediately after adult emergence. Females stung the hosts several times to paralyze them and some times caused mortality of the hosts after paralysis without laying eggs. The percentage of paralyzed hosts died after females stung were 43.00, 96.00 and 3.00% when the parasitoid offered middle instar larvae, fullgrown and 1st day of pupa of *P. gossypiella*, while, this percentages were 56.00, 72.00 and 83.00% when offered the middle instar larvae, fullgrown and 1st day of spinning cocoon of *E. insulana*, respectively, also, when offered the middle instar larvae, fullgrown and 1st day of spinning cocoon of *G. mellonella* the percentage of paralysis increased to 60.00, 75.00 and 90.00%, respectively, (Table 1).

The number of eggs laid on one host differed according to host stage and age. The results indicated that females were able to produce high number of eggs on large sized host (the elder larvae were preferred than the middle instar larvae). The highest average mean number of eggs laid recorded 55.40, 28.40 & 24.10 eggs on fullgrown larvae of *G . mellonella, E. insulana* & *P. gossypiella*, respectively while,

the lowest number of eggs was laid on middle sized larvae. On the other hand, when parasitism occurred on the 1st day of spinning cocoon of *G. mellonella* & *E. insulana*, the average mean number of eggs increased to 68.00 & 36.70 eggs/♀, respectively. In contrast, it decreased sharply in 1st day of pupa of *P. gossypiella* (3.80 eggs/♀).

Data indicated that the three different host species were suitable hosts for mass rearing of *D. cavus*. Also, it could be concluded that there are a relationship between the host size and the number of eggs laid on it by female wasp that help it's progeny to complete the development to the adult stage. This result agrees with Godfray (1994) who stated that wasp size is correlated with a parasitoid's reproductive potential, the greater a wasp's size.

Hatchability

The hatchability was high in case of full grown larvae of *P. gossypiella* (91%) followed by 1st day of spinning cocoon of *G. mellonella* (90%) and *E. insulana* (89%), Table (1).

On the other hand, percentage of hatching eggs laid on full grown larvae of *G. mellonella* and on full grown larvae &1st day of spinning cocoon of *E. insulana* reached medium category (86, 75 & 60%, respectively). In contrast, no hatching occurred on middle sized larvae or pupae of *P. gossypiella*.

Pupation percentage

Data in Table (1) show that the pupation percentages of the parasitoid were 86, 81 and 70% on full grown larvae of *P. gossypiella*, *G. mellonella* and *E. insulana*, respectively. It reached 89 & 78% in 1st day of spinning cocoon of *G. mellonella* & *E. insulana*, respectively. Data in Table (1) revealed that the parasitoid failed to complete developing to the adult stage in some cases. The middle larval instar of *P. gossypiella, E. insulana, G. mellonella* & 1st day of pupa of *P. gossypiella* were not suitable at all for pupation of the parasitoid.

Sex ratio

When the parasitoid was reared on pink bollworm full grown larvae, the sex ratio recorded 1.86:1, while it reached to 4.88:1& 3.55:1 on full grown larvae and 1st day of spinning cocoon of spiny bollworm. In addition, it recorded 2.23:1 and 4.00:1 when reared on full grown larvae and 1st day of spinning cocoon of wax moth, respectively (Table 1).

TABLE (I)

Effect of stage and age of *P. gossypiella, E. insulana* and *G. mellonella* on the ectoparasitoid *D. cavus* under constant conditions.

Hosts	Host stage & age	No. of host*	% Paralyzed	Avg. No. of eggs laid on one host	% Hatchability	% Pupation	% adult emergence	Sex ratio	
								♀	♂
P. gossypiella	Middle instar larvae	100	43.00	8.30±1.15	0.00	0.00	0.00	0.00	0.00
	Full grown larvae	100	96.00	24.1±3.60	91.00	86.00	100.00	65.00	35.00
	1st day of pupa	100	3.00	3.80±0.80	0.00	0.00	0.00	0.00	0.00
E. insulana	3rd instar larvae	100	56.00	6.75±0.20	60.00	0.00	0.00	0.00	0.00
	Full grown larvae	120	72.00	28.40±1.60	75.00	70.00	99.00	83.00	17.00
	1st day of spinning	120	83.00	36.70±4.18	89.00	78.00	97.00	78.00	22.00
G. mellonella	Middle instar larvae	100	60.00	28.30±1.50	33.00	0.00	0.00	0.00	0.00
	Full grown larvae	150	75.00	55.40±3.97	86.00	81.00	100.00	69.00	31.00
	1st day of spinning	150	90.00	68.00±4.48	90.00	89.00	100.00	80.00	20.00

* five individuals/ daily from each species

These results, are in agreement with Hekal (1990) and Gulel (1982) who found that the sex ratio of *Dibrachys* sp. was 2.8:1 females: males when reared on the diapausing larvae of *P. gossypiella* and 4:1 females to males of *D. boarmiae* when reared on *G. mellonella*.

The present results indicated that, *D. cavus* was able to develop successfully from larvae to adults on the full grown larvae of *P. gossypiella*, and full grown larvae and 1st day of spinning cocoon of *E. insulana* and *G. mellonella*, because the progeny of the parasitoid received enough food .In case of *E. insulana* and *G. mellonella*, the parasitoid preferred to attack and laid more eggs on 1st day of spinning cocoon than other different stages.

2. Rearing the parasitoid on the suitable stage of the three hosts

Incubation period

Directly, after the female parasitoid deposited eggs on full grown larvae of *P. gossypiella*, or cocoon of *E. insulana* and *G. mellonella*, hosts were incubated under 25±1C° and 70-75 % R.H. The egg hatched after 1.20, 1.17 and 1.30 days, respectively (Table 2). Statistical analyses showed no significant differences between incubation periods of eggs.

Duration of immature stage

Larval stage

Larval duration of the parasitoid *D. cavus*, reared on different species of hosts was given in Table (2). These durations lasted 6.80, 7.70 and 7.20 days, when reared on full grown larvae of pink bollworm, 1stday of spinning cocoon of *E. insulana* and 1st day of spinning the cocoon of *G. mellonella*, respectively. Statistical analysis showed significant difference between reared larvae of parasitoid on the three host species.

Pupal stage

Average durations of pupae were 7.80, 8.50 and 7.37days when parasitoid reared on pink, spiny bollworms and *G. mellonella,* respectively (Table 2).Data indicated that no significant difference appeared between pupal duration of the parasitoid reared on the three hosts.

Immature stage

As shown in Table (2), total periods of immature stage of *D. cavus* were 15.80 days when reared on the full grown larvae of pink bollworm, 17.37 days on

the 1st day of spinning cocoon of spiny bollworm and 15.87 days on 1st day of spinning cocoon of wax moth.

TABLE (II)

Biology of immature stages of the parasitoid *D. cavus* reared on the three lepidopterous hosts under constant conditions.

Host stage	Incubation period Mean± S.D.	Larval duration Mean± S.D.	Pupal period Mean± S.D.	Immature stage Mean± S.D.
Full grown larvae of *P. gossypiella*	1.20±0.49 (1-2)	6.80±0.27b (6-8)	7.80±0.66 (7-8)	15.80±0.50 (14-18)
Cocoon of *E. insulana*	1.17±1.27 (1-2)	7.70±0.3a (7-10)	8.50±0.56 (7-9)	17.37±0.47 (16-19)
Cocoon of *G. mellonella*	1.30±0.1 (1-2)	7.20±0.24ab (7-8)	7.37±0.43 (7-8)	15.87±0.91 (15-17)
F	ns	*	ns	*
LSD	-	0.74	-	1.90

These results indicated that the total period of immature stage of *D. cavus* was longer on spiny bollworm than on pink bollworm and wax moth. Statistical analyses showed significant differences between immature stage periods of the parasitoid when reared on different hosts.

The relationship between host species and longevity and fecundity of parasitoid *D. cavus*

The longevity and fecundity of the females' parasitoid *D. cavus* were investigated under the fore mentioned controlled conditions.

Pre- oviposition period

The pre-oviposition period recorded 1.10, 1.20 and 1.10 days when females of the parasitoid developed from larvae fed on pink bollworm, spiny bollworm and wax moth, respectively. No significant differences concerning this period were found between the female wasps developed from the three hosts.

Oviposition period

The oviposition period of *D. cavus* lasted 13.15, 14.40 and 16.15 days when mated female emerged from larvae reared on pink bollworm, spiny bollworm

and wax moth, respectively. Statistical analysis showed that no significant difference between the oviposition periods of females developed from the three hosts.

These data indicated that the females developed from larvae reared on the *G. mellonella* showed prolonged oviposition period than those reared on pink bollworm and spiny bollworm.

Post oviposition period

The post oviposition period of *D. cavus* females averaged 2.2, 2.7 and 1.1 days when females of the parasitoid wasp developed from larvae reared on pink bollworm, spiny bollworm and wax moth, respectively (Table 3).

Number of deposited eggs/female

Data in Table (3) revealed that the daily and total numbers of deposited eggs/female are affected by the species of host offered to rear the immature stages. It is clear that the highest daily number of eggs/female was recorded when immature stages reared on wax moth followed by spiny bollworm and pink bollworm. Data analyses showed highly significant differences between the daily numbers of deposited eggs. The average numbers were 13.20, 11.25 and 9.90 eggs daily, respectively. Fig (1) revealed that the fecundity of females of *D. cavus* varied between the tested hosts. The oviposition period of this wasp lasted from 8 to 18 days after female's emergence, while the females lived 12 to 25 days; however, the parasitoid laid 80 to 90 % of its eggs during the first 11^{th} days of life, during this period the highest number of eggs were laid at 4 to 15 days. Data analyses showed highly significant differences between the total numbers of deposited eggs in relation to host species. The same trend was observed for the total number of eggs deposited/female; *i.e.*, the mean total numbers of eggs were 154.50, 168.25 and 197.30 eggs/female when females developed from the parasitoid larvae reared on pink bollworm, spiny bollworm and wax moth, respectively. The results of this study are similar to those of Gulel (1988) who reported that the mean total numbers of progeny was 216.9 for mated female when *D. boarmiae* reared on *G. mellonella*.

Adult longevity

Data in Table (3) revealed that the longevity of *D. cavus* females' estimated by 20.46, 18.25 and 17.03 day when females emerged from larvae reared on pink bollworm, spiny bollworm and wax moth, respectively. Longevity of females significantly differed among those developed from larvae reared on different hosts.

TABLE (III)

Biology of adult stages of *D. cavus* developed from larvae of the parasitoid reared on the three host species.

Host stage	Pre oviposition	Oviposition	Post oviposition	Fecundity		Longevity	
				Total No. of eggs/♀	No. of eggs daily	♀	♂
P. gossypiella	1.1±0.05 (1-2)	14.50±0.29 (8-16)	2.20±0.25 (2-3)	154.5±5.3c (61-178)	9.9±1.4b (4-9)	17.03±1.5b (12-20)	11.94±1.8 (8-15)
E. insulana	1.2±0.1 (1-2)	15.4±0.19 (8-16)	2.7±0.17 (2-4)	168.25±2.9b (90-208)	11.25±1.2b (5-22)	18.25±0.3b (13-23)	11.4±0.9 (7-15)
G. mellonella	1.1±0.1 (1-2)	17.15±0.3 (10-18)	1.1±0.2 (0-2)	197.3±3.2a (148-229)	13.2±0.4a (9-23)	20.46±1.8a (13-25)	13.8±0.4 (8-16)
F	ns	ns	ns	***	**	***	ns
LSD	-	-	-	6.022	1.77	0.99	-

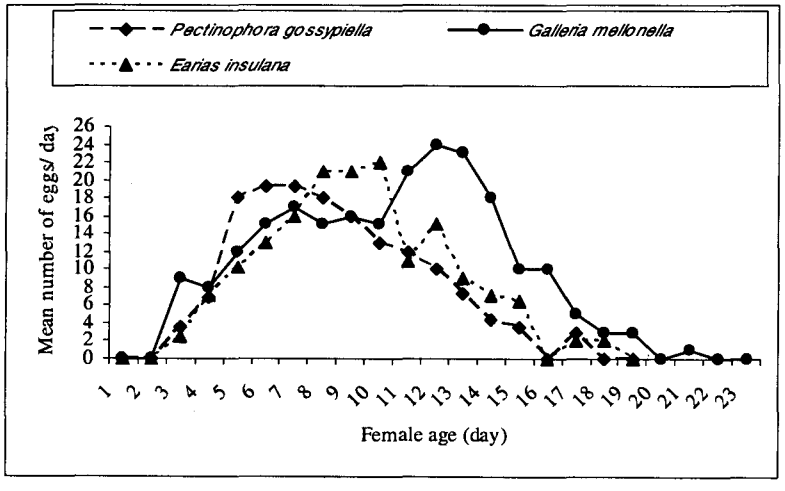

Fig. (1): Fecundity of female *D. cavus* emerged from three host species

Also, male longevity was 11.90, 11.40 and 13.80 days when reared on the same hosts, respectively. No significant differences were found between the males longevity.

The present results indicated that the longevity of females lasted longer (2-3 days) when PBW used as host than SBW & wax moth. In contrast, the longevity of males increased by 2 days when wax moth was used as host than on PBW& SBW.

Generally, the parasitoid *D. cavus* successfully parasitized different ages and stages of the three tested host insects. The parasitoid successfully completed development to adult emergence on the full grown larvae and 1st day of spinning cocoon and failed to complete development on the other stages or ages. The wasp females laid more eggs on the large sized host (*G. mellonella*) compared with pink and spiny bollworms. The biological aspects of *D. cavus* differed when reared on the different hosts. Kandil, (2001) stated that the biological aspects of *Dibrachys* sp. differed when reared on pink and spiny bollworms. Mehrejad, (2003) found that some biological aspects of *Dibrachys boarmiae* were differed when reared on three hosts (*Sitotroga cerealella*, *Galleria mellonella* and *Kermania pistaciella*). El-Sayed, (2005) found that the life cycle for the parasitoid *D. cavus* durated 29.86, 22.99, 18.93, 15.67 and 12.08 days when reared on pink bollworm fullgrown larvae under 19,22,25,28 and 31°C, respectively.

These results cleared that wax moth and spiny bollworm can be used for mass rearing of this parasitoid.

SUMMARY

Dibrachys cavus (Walker) was found as an ectoparasitoid on *Pectinophora gossypiella* diapaused larvae collected from dried cotton bolls during March, 2002 from El-Ebrahemia region, Sharkia Governorate. In the present work some biological aspects of *D. cavus* were studied under controlled conditions (25±1°C and 70-75% R.H.) using different ages and stages of three lepidopterious host species, *i.e.*, *Pectinophora gossypiella, Earias insulana* and *Galleria mellonella.* The parasitoid was able to parasitize all ages and stages of the three hosts but successfully completed development on fullgrown larvae of pink bollworm and first day of spinning cocoon of *E. insulana* and *G. mellonella*. Immature stages of *D. cavus* lasted 15.80, 17.37 and 15.87 days on *P. gossypiella, E. insulana* and *G. mellonella*, respectively. The parasitoid laid the highest numbers of eggs (197.3/♀) on wax moth. The longevity of

parasitoid females was 17.03, 18.25 and 20.46 days on the three hosts, respectively. Sex ratio of progeny differed also according to the host.

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