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BIOLOGICAL STUDIES ON THE ECTOPARASITOID, *Goniozus swirskiana* REARED ON THE LARVAE OF GREATER WAX MOTH, *Galleria mellonella*

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ABSTRACT

The larval parasitoid, *Goniozus swirskiana* was reared in the laboratory on larvae of the greater wax moth, *Galleria mellonella*. The incubation period of the parasitoid's egg averaged 36, 19 and 16 hours at 20, 25 and 30 °C, respectively. The larval stage lasted 10.5 days at 20 °C, 5.2days at 25 °C and 4.4days at 30 °C. The respective figures were 40, 21 and 18 hours for the pre pupa and 21.1, 6.4, and 4.4 days for the pupa. The total developmental period of the parasitoid ranged 25-28 days at 20 °C, 13-15 days at 25 °C and 9-11 days at 30 °C.

The pre-oviposition period of the parasitoid female averaged 3.0 days, the oviposition period averaged 8.4 days and the post- oviposition period averaged 2.4 days at 25 °C and 65 % R.H. It was found that the female did not deposit eggs daily and the period between two successive ovipositions reached up to 4 days with an average of 2.2 days. The number of eggs laid by female / oviposition ranged from one to 12 eggs. The total number of eggs deposited by a single female during her lifetime varied from 9 to 39 with an average of 21.5 eggs. At 25 °C, the female *G. swirskiana* , fed on honey , lived for 12.9 days (6-16) while the male lived for 4.8 days (3-7). Sex ratio was found to be 1 male :9 females .

Keywords: ectoparasitoid - *Goniozus swirskiana* - *Galleria mellonella* – Biological studies

INTRODUCTION

Family Bethylidae belonging to Order Hymenoptera includes a large number of parasitoid insects which attack coleopterous, lepidopterous and hymenopterous species. The genus *Goniozus* is one of the most important genera of Bethylidae and its species are known as ectoparasitoids of leafgallers, leafrollers, stemborers and fruitborers. The second author found *Goniozus swirskiana* parasitizing the lesser date moth, *Batrachedra amydraula* infesting unripe fruits of the date palm in Sultanate of Oman and was sent to identification in the Britich Museum. The parasitoid could be used as a biocontrol agent against such a pest in date palm plantations to avoid the harmful side effects of the chemical insecticides .For rearing *G. swirskiana*, a factitious host should be utilized as the mass production of its natural host , *B. amydraula* is not easy. In this respect, different species of *Goniozus*,were reared on factitious hosts; i.e. the greater wax moth , *Galleria mellonella* for rearing *G. nephantidis* (Venkatesan *et al.* 2003 and 2004); Chanolrika,Shameer, 2003), *Corcyra cephalonica* for rearing *G. nephantidis* (Remadevi *et al.*,1981; Kapadia & Mittal, 1986; Hardy and Cook,1995; Radhika & Chitra,1999), *Ephestia kuehniella* for rearing *G. legneri* (Sarhan, 1989; Shoeb *et al*, 2005), *Ephestia cautella* for rearing *G.legneri* (Abul Fadl, 2002).

The present study deals with the biology on G. *swirskiana* when reared on larvae of *Galleria mellonella* in order to thorough lights on the parasitoid as a promising biological control agent of the lesser date moth , *Batrachedra amydraula* .

MATERIALS AND METHODS

Rearing of *G. mellonella* .

G. mellonella was obtained from infested wax combs of the bee hives. These combs were kept, in cages (40x40x40 cm) made of wooden frames covered with cotton- cloth from all sides and left under laboratory conditions. The cages were checked daily to collect the newly emerged mothes which were confined in plastic oviposition jars.

The oviposition jar, 20 cm high and 12 cm diameter, was provided with a piece of cotton-wool soaked in 20% honey solution, as food for moths, and covered with tissue paper for egg deposition. The eggs, on the tissue paper, were collected at 3-day interval and placed on artificial diet, as food for the hatched larvae. The artificial diet consisted of a mixture of the following parts (by volume) : 6 Whole wheat flour – 2 Powder milk - 1.5 Honey - 1.5 Glycerol - 1 Powdered dried yeast -3 ml Formaldhyde (38 %). Larval rearing took place under laboratory conditions of 25 ± 2 °C and 60-70 %R.H.

Rearing of *G. swirskiana*

It is well known that *G swirskiana* females paralyzes the host larvae by injecting such larvae by a venom through the ovipositor. The injected larva becomes paralyzed within 2-3 hours, after which the female parasitoid starts to deposit its eggs on any part of the paralyzed larva.

The parasitoid was maintained under laboratory on larvae of *G. mellonella* (2^{nd} ,3^{rd} or 4^{th} instars). The parasitoid females were kept, individually , in plastic vials , 7x2 cm, stoppered with pieces of cotton –wool . A droplet of honey was put on the inner surface of the vial just below the cotton-wool as food for *G. swirskiana*. One larva of *G. mellonella* was introduced to each parasitoid female for 2 days and then replaced by another larva until the death of the parasitoid . The paralyzed –parasitized larvae were kept in similar vials until emergence of adult parasitoids. Rearing took place under previous laboratory conditions.

Durations of the immature stages:

G. swirskiana females were kept in plastic vials, 7x2cm, each (one female / vial) stoppered with pieces of cotton – wool and provided with droplets of honey, on the inner surface of the vials .Larvae of *G. mellonella* ; in the 2^{nd} ,3^{rd} or 4^{th} instars , were introduced to the parasitoids .The larvae were checked by aid of a stereo-microscope at 2-hour interval until parasitized (harboured parasitoids eggs). The parasitized larvae were then removed and kept in Petri-dishes, 5 cm in diameter,lined with filter paper ,and examined at 2-hour interval for egg-hatching and larval development.

The parasitoid cocoons wereobserved daily until emergence of adults. This experiment was carried out in an electric incubators held at 20,25 and 30 °C each combined with approximately 65 %R.H .

Oviposition of experimental parasitoid:

Fifteen *G. swirskiana* females were confned , each, in plastic vials,7x2 cm, with a droplet of honey as food . Larvae of *G. mellonella*, in the 2 nd ,3rd or 4th instars ,were introduced to the female parasitoid , kept for 24 hours and then removed and replaced by anther larva until the death of the parasitoid. The removed larvae were kept in Petri-dishes, 5 cm diameter, lined with filter paper. Such larvae were checked ,by aid of a stereo-microscope for the parasitoids eggs .The pre- oviposition period, oviposition period, periods between every two ovipositions and post- oviposition period were recorded. Also, the number of eggs deposited per female were calculated. Such study was carried out in an electric incubater at 25 ± 1 °C and 65% R.H

Longevity of the experimental parasitoid:

Longevity of *G. swirskiana* male and female was recorded at 25 ± 1 °C and 65% R.H. by rearing the adults, individually, in plastic vials, 7x 2 cm, provided with honey droplets as food .15 individualls were used for each sex.

Sex ratio of the parasitoid:

Sex ratio in *G. swirskiana* was estimated in 560 adults collected during the study.

RESULTS

Durations of the Immature Stages

As presented in Table (1) , of 36± 1.3, 19 ± 1.1 and 16 ± 0.9 were recorded for the incubation periods of *G. swirskiana* eggs, 10.6 ± 0.8, 5.2 ± 0.6 and 4.4 ± 0.5 days,for the larval stage, 40±2.4 , 21±0.9 and 18±0.9 hrs for the prepupal stage, . 12.1±0.6, 6.4±0.5 and 4.4±0.5 days for the pupal stage when they were recorded under constant temperatures of 20,25 and 30 °C each combined with 60-70 % R.H.. The total development period of *G. swirskiana* on larvae of *G. mellonella* ranged 25-28 days at 20°C ,13-15 days at 25 °C and 9-11days at 30 °C.

Table (1): Durations of *G. swirskiana* immature stages* on *G. mellonella* larvae reared under different constant temperatures

Stages	Constant Temperature		
	20°C	25°C	30°C
Egg (hrs)	36.0±1.3 (34-38)	19.0±1.1 (17-20)	16.0±0.9 (15-18)
1st instar larva (hrs)	62.0±3.3 (58-67)	31.0±3.8 (25-37)	26.0±1.5 (24-29)
2nd instar larva (hrs)	48.0±2.5 (44-51)	24.0±2.4 (21-29)	20.0±1.4 (18-22)
3 rd instar larva days)	5.4±2.5 (5-6)	2.8±0.4 (2-3)	2.2±0.4 (2-3)
Larval stage (days)	10.6±0.8 (10-12)	5.2±0.6 (4-6)	4.4±0.5 (4-5)
Pre-pupa (hrs)	40.0±2.4 (37-45)	21.0±0.9 (20-23)	18.0±0.9 (16-19)
Pupa (days)	12.1±0.6 (11-13)	6.4±0.5 (6-7)	4.4±0.5 (4-5)
Total Developmental period (days)	26.6±0.9 (25-28)	13.9±0.7 (13-15)	9.8±0.6 (9-11)

***Values between brackets represent the ranges**

Oviposition

Data presented in Table (2) indicate that the pre- oviposition period of *G .swirskiana* at 25 °C ranged from 2 to 4 days with a mean of 3.0± 0.7 days .The oviposition period lasted 3 to 12 days with a mean of 8.4± 2.6 days. The post- oviposition period varied from one to 5 days with a mean of 2.4± 1.1 days. It was found that the female did not deposit eggs daily and it might paralyze the host larva but deposit the eggs on the following day(s). The period between two successive ovipositions reached up to 4 days with a mean of 2.2± 0.9 days. The number of ovipositions / female during its lifetime ranged from 2 to 8 with a mean of 4.4±2.1. The number of eggs laid / oviposition was 1-12 with a mean of 2.7 ± 0.9 eggs. The total number of eggs deposited by a single female during its lifetime varied from 9 to 39 with a mean of 21.5 ± 10.2 eggs.

Longevity

At 25 °C, *G. swirskiana* female , fed on honey lived for 6-16 days with a mean of 12.9 ± 2.9 ays. The males, in contrast, lived for 3-7 days (when fed on honey) with a mean of 4.8± 1.1 days.

Sex ratio

Sex ratio in *G. swirskiana* was found to be 1 male : 6 females.

Table (2): Ovipositional periods,period between two ovipositionas, number of eggs/oviposition,total number of eggs/female, longevity and sex ratio of the *Goniozus swirskiana* reared on larvae of *Galleria mellonella* at 25°C and 65 %R.H.

Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)	Period between two ovipositions	No. of eggs/ oviposition	Tatal no.of eggs/ female	Longevity		Sex ratio	
						♀	♂	♀	♂
3.0±0.7 (2-4)	8.4±2.6 (3-12)	2.4±1.1 (1-5)	2.2±0.9 (1-4)	2.7±0.9 (1-12)	21.5±10.2 (9-39)	12.9±2.9 (6-16)	4.8±1.1 (3-7)	6	1

DISCUSSION

The present study revealed that the total developmental period (from egg to adult) of *G. swirskiana* averaged 26.6, 13.9 and 9.8 days at 20, 25 and 3o°C , respectively when reared on larvae of *Galleria mellonella* . The female laid an average of 21.5 eggs during its lifetime .In comparison, Eitam (2001) reported that the total developmental period in *G. swirskiana* reared on *Batrachedra amydraula* averaged 13.6 days at 26°C and the female laid an average of 60.4 eggs during its lifetime at the same temperature. This variation in fecundity is probably due to the type of host on which *G. swirskiana* was reared. What supports this claim is that almost similar results were obtained in *Goniozus legneri*; Abbas (1999) reported that in *G. legneri* reared on *Amyelois transitella* at 27 °C, the total developmental period of the parasitoid averaged 11.3 days and the female laid an average of 260.8 eggs

during its lifetime. Abul Fadl (2002) mentioned that *G. legneri* female laid an average of 126.4 eggs when reared on *Ephestia cautella* at 25°C. In controst, Shoeb *et al.* (2005) found that when *G. legneri* was reared on three different hosts, *Pectinophora gossypiella* , *Ephestia kuehniella* and *Phthorimaea operculella* at 27°C, the total developmental period of the parasitoid ranged between 13.6 and 14.8 days and the female deposited 42.1- 44.7 eggs during its lifetime.

This study revealed also that *G .swirskiana* did not deposit eggs daily and the period between every two ovipositions reached up to 4 days with an average of 2.2 days .The number of ovipositions / female during its lifetime averaged 4.4. Eitam (2001) reported that *G .swirskiana* females oviposited an average of 11.6 times during its lifetime when reared on *Batrachedra amydraula*. Similarly,*G. pakmanus* oviposited 12.4 times during its lifetime which averaged 37.2days (Ggordh & Medved,1986), *G. nigrifemar* oviposited 9-24 times during the female lifetime which averaged 90.2 days laying an average of 184.4 eggs (Luft, 1996), *G.indicus* female laid eggs at 1-8 days interval and the total number of eggs deposited / female was 15-52 at 25°C (Takasu &Overhoit,1998). Our study revealed that longevity of *G .swirskiana* was 12.9 days in female and 4.8 days in male .However , Eitam (2001) reported that longevity in *G .swirskiana* was 34.9 days in female and 20.5 days in male when reared on its natural host *B. amydraula* at 26 °C. Similar results were obtained in other species of *Goniozus* when reared on different host species; *G. triangulifer* female lived for 22 days when reared on its pyralid host larvae *Cnaphalocrocis medinalis* and *Marsamia patnalis* at 25 °C (Legaspi *et al.*, 1987 in Philippines) and for 11.1 days when reared on *C.medinalis* larvae at 25 °C (Mishra &Senapati, 1996 in India).Likewise, longevity of *G.legneri* female was 20.1 days when reard on the gelechiid, *Pectinophora gossypiella* (Butler&Schmidt, 1985) and 69.4 days when reared on the pyralid host, *Amyelois transitella* at 27 °C (Abbas,1999),and 15.2 days when reared on *Ephestia kuehniella* at 27°C (Shoeb *et al* ., 2005) .

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دراسات بيولوجيه على الطفيل الخارجى *Goniozus swirskiana* المربى على يرقات دوده الشمع الكبيرة *Galleria mellonella*

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تم تربيه طفيل الجونيوزس على يرقات دوده الشمع الكبيرة تحت ثلاث درجات حرارة مختلفة ٢٠، ٢٥ ،٣٠ °م. وكانت فترات وضع البيض ٣٦ ، ١٩،١٦ ساعه على التوالى . استغرق الطور اليرقى ٥,١٠و ٢,٥ و ٤,٤ يوم على التوالى . اما بالنسبه لطور ماقبل العذراء فقد استغرق ٤٠،٢١، ١٨ ساعه على التوالى ، و استغرق طور العذراء ١,٢١، ٦,٤، ٤,٤ يوم على التوالى. وبذلك تراوحت دوره حياه الطفيل مابين ٢٥ – ٢٨ يوم عند التربيه على ٢٠ °م و ١٣– ١٥ يوم عند التربيه على ٢٥ °م و ٩– ١١ يوم عند التربيه على ٣٠ °م. اما فترة ماقبل وضع البيض بالنسبه لانثى الطفيل فقد استغرقت ٣ ايام و استغرقت فترة وضع البيض ٨,٤ يوم وفترة مابعد وضع البيض حوالى ٢,٤ يوم عند ٢٥ درجه مئويه ،٦٥%رطوبه و قد وجد ان الانثى لا تضع البيض يوميا حيث استغرقت الفترة اللازمه لوضع البيض ٤ ايام بمتوسط ٢,٢ يوم و يتراوح عدد البيض التى تضعه الانثى الواحده خلال فترة وضع البيض مابين ١– ١٢ بيضه و يصل العدد الكلى للبيض لكل انثى خلال فترة حياتها من ٩– ٣٩ بمتوسط ٢١,٥ بيضه/ انثى عند ٢٥ درجه مئويه . عند تغذيه انثى طفيل الجونيوزس على عسل تعيش ١٢,٩ يوم (٦– ١٦) بينما يعيش الذكر ٤,٨ يوم (٣–٧) . و قد وجد ان النسبه الجنسيه ١ ذكر : ٩ اناث.