

**ON THE POTENTIAL OF THE PARASITOID SPECIES,
LYSIPHLEBUS TESTACEIPES (CRESSON)
(HYMENOPTERA: APHIDIIDAE) ON APHID HOST SPECIES**

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Abstract

Potentiality of the aphid parasitoid species, *Lysiphlebus testaceipes* (Cresson) (Hymenoptera: Aphidiidae) against three species of aphids was studied. All biological studies of the parasitoid on its host, *Rhopalosiphum padi* (L.) were also studied under laboratory conditions. Developmental periods were estimated on *R. padi*, *Aphis craccivora* Koch. and *Schizaphis graminum* Rond.. Number of ovarian eggs, total number of eggs laid and number of mummies/ female of *L. testaceipes* when parasitized *R. padi* were estimated as 164 ± 41.08 and 43.85 ± 20.22 (eggs/ female) and 34.23 ± 13.74 mummies/ female, respectively. Respective percentages of adults' emergence and sex-ratio were 61.62% and 1:1.12 (female: male). Shortest longevity was recorded when the adults were starved. Life table studies showed that the intrinsic rate of increase for *R. padi* was faster than that of its parasitoid on *R. padi*. Host preference indicated that the parasitoid preferred *S. graminum*, followed by *R. padi* and then *A. craccivora*.

INTRODUCTION

The aphid parasitoid *Lysiphlebus testaceipes* (Cresson) (Hymenoptera: Aphidiidae) is a primary, solitary and generalist parasitoid which has an extremely broad range of hosts (Mackauer and Stary, 1967), with different preference rates for different aphid hosts on various plants (Sekhar, 1960). Its host range reaches more than 100 aphid species on numerous plants (Pike *et al.* 2000). This parasitoid has been introduced to southern France from Cuba in the 1970s. It spread rapidly over Mediterranean France, Italy and Spain (Stary *et al.*, 2009) and evidence that it had become a dominant parasitoid in some areas, displacing native species (Stary *et al.*, 2004 and 2009).

Through the Egyptian-American collaborative project, Agricultural Technology Utilization and Transfer (ATUT), "Wheat crop protection based on plant resistance and biological control", carried out during 1997-2001, certain cereal aphid exotic parasitoid

species were introduced from different countries to provide additional mortality factors to the indigenous ones, against the key cereal aphid species in Egypt as well as in the US (Final report of project, 2001). *L. testaceipes* was one of those exotic parasitoids. The parasitoid was provided by Dr. P. Stary (Institute of Entomology, Academy of Science of the Czech Republic) through a personal contact. Its culture has been maintained successfully for years in the Department of Biological Control (DBC), Agriculture Research Center (ARC), Giza, Egypt. This parasitoid species has not been recorded in Egypt before. There were many successful trials for using *L. testaceipes* in biological control programs from late eighties until now (Souza *et al.*, 2009 and Kamel, 2011).

The objectives of this study were to determine the efficiency of this exotic parasitoid species against some aphid species and to study its biological aspects, life table parameters and host preference under laboratory conditions.

MATERIALS AND METHODS

Laboratory cultures and all biological studies of the cereal aphids; *Rhopalosiphum padi* (L.) and *Schizaphis graminum* Rond.; and the cowpea aphid, *Aphis craccivora* Koch. and the parasitoid, *L. testaceipes* were maintained in the laboratory at $22 \pm 1^\circ\text{C}$, 40-60 % R.H. and L: D 16:8 (Adly, 2002).

- 1. Effect of the host stage and instar on the parasitoid:** Immature stage durations of *L. testaceipes* were measured by using one hundred nymphs from each of the 2nd and 4th nymphal instars and adults of *R. padi*, separately, placed on wheat seedlings, cultivated in small pots and kept in small cages (15 replicates/treatment). In each cage, aphids were exposed to 10 mated parasitoid females for 2-4 hours. Afterwards, parasitoid females were removed and parasitized aphids were dissected daily by a very fine needle, in a drop of Ringer's solution and examined using a binocular stereomicroscope.
- 2. Effect of aphid species on the parasitoid:** Effect of different aphid species (*R. padi*, *S. graminum* and *A. craccivora*) on the developmental periods of *L. testaceipes* was measured by using one hundred nymphs, (mostly 2nd and 3rd instars) placed on wheat seedlings cultivated in small pots and kept in small cages (15 replicates/ treatment). In each cage, aphids were exposed to 10 parasitoid females for 2-4 hours. Afterwards, the parasitoid females were liberated.

Parasitized aphids were reared to determine the durations of different parasitoid stages (egg-mummy, mummy-adult and egg-adult).

3. **Fecundity:** The experiment was undertaken only on the aphid species, *R. padi*. Each parasitoid mated female was provided daily with 100 nymphs (2nd and 3rd instars) in a small plastic tray (15 x7 cm) covered with muslin, containing droplets of honey and wheat leaves and their ends were dipped in moistened paper towels, following the technique of Michels *et al.* (1987) until parasitoid's mortality. Parasitized aphids were dissected daily to determine the number of eggs laid/ female per day and the total number of eggs laid by each female (20 replicates/ treatment).
4. **Survival rate and sex-ratio:** It was also estimated only on the aphid species *R. padi*, using the same technique for fecundity, except that the parasitized aphids were gently placed on wheat seedling in the small cages until the parasitoid adults completed their life-cycles. Formed mummies were collected daily, counted and placed individually in small glass vials. Total number of mummies, percentage of adults' emergence and sex ratio were recorded (21 replicates/ treatment).
5. **Longevity:** Formed mummies were placed individually in small glass vials until adult emergence. Five groups, each of 20 newly emerged adults, were received different regimes of nutrition; the 1st group was left unfed, the 2nd was fed on honey bee, the 3rd on droplets of 50% honey, the 4th on droplets of 10% sucrose and the 5th group was fed on honeydew. Longevity of adults in each group was estimated (20 replicates/ treatment).
6. **Life Table:** The life table parameters of *R. padi* and *L. testaceipes* were determined using the equation of Birch (1948), $RML = \sum l_x m_x \exp r_m x = 1$, to obtain an estimate of the intrinsic rate of increase r_m at a study temperature degree, where:
 - x = Age intervals (the female age in days).
 - l_x = Age specific survival (the fraction of females(- alive at age x).
 - m_x = Age specific fecundity (the number of female offspring per female parent).
 - The net reproductive rate $R_0 = \sum l_x m_x$.
 - The mean generation time $T_c = \sum l_x m_x x / R_0$.
 - The intrinsic rate of increase $r_m = \ln R_0 / T_c$.
 - The finite rate of increase $\exp. r_m = e^{r_m}$.
 Analysis of the life table study was made following Birch (1948), using life 48 Basic Computer Program (Abou-Setta *et al.*, 1986) and SAS(Statistical analysis system) (1988).

7. Host preference: *L. testaceipes* females were provided daily with an adequate number of nymphs from each of the aphid species (*R. padi*, *S. graminum* and *A. craccivora*) in a choice experiment for two days. 15 replicates, each consisted of 50 nymphs (2nd and 3rd instars) from each species were exposed for parasitism. Caged plants were placed in a growth chamber. Aphids were kept on wheat and/ or faba bean seedlings until forming mummies. The formed mummies were collected and kept in small glass vials. Proportion of each of the parasitized aphid species was estimated.

Statistical analysis

All the data of the biological experiments on the aphid and on the parasitoid were statistically analyzed using SPSS program (Statistical Package for the Social Sciences).

RESULTS AND DISCUSSION

1. Effect of different aphid instars and adult: The developmental periods of *L. testaceipes* on *R. padi* were nearly equal on 2nd and 4th nymphal instars and adult for all stages except the pupal stage and total developmental period (Table1). Longest developmental time of the pupa and that to adult were on the 4th instar (5.13 ± 0.74 and 12.7 ± 0.47 days, respectively), while the lowest were on the 2nd instar (2.2 ± 0.41 and 8.27 ± 0.46 days, respectively). These results confirmed that the host's stage and nymphal instar had significant effect on the subsequent pupal period. Superparasitism was observed only on the adults of *R. padi* which means that there is some losses in the produced progeny. Developmental period of *L. testaceipes* was influenced by parasitization in nymphal instars and/or adults of *R. padi* and that affected the number of mummies produced by the parasitoid as well percentage of emergence and sex-ratio. In agreement with the present results, Stary (1988) stated that, the female wasps prefer the 2nd and 3rd nymphal instars for oviposition. While, in contrast, Hopkinson (2010) observed that *L. testaceipes* had a preference for older (4th nymphal and adult) stages over the younger (2nd) instar. Developmental period to adult of *L. testaceipes* were 26.9, 14.8, 11.3 and 12.2 days at 15, 20, 25 and 30°C, respectively, of *L. testaceipes* on *A. gossypii* (Rodrigues *et al.*, 2004).

2. Effect of the species of host aphid: Developmental periods egg-mummy and mummy-adult after parasitism on *R. padi* and *A. craccivora* were nearly equal, but in

case of *S. graminum*, it was longer than both of the two others for the period from egg to mummy (7 days) and shorter than the others for the period from mummy to adult (2.6 ± 0.16 days). The total developmental period (from egg to adult) on the three host species were nearly equal (Table 2). Statistical analysis of the durations of *L. testaceipes* showed insignificant differences among periods stage from egg-adult on *R. padi*, *S. graminum* and *A. craccivora* at $22 \pm 1^\circ\text{C}$. In similar studies, Silva *et al.*, (2008b) found that the developmental period of *L. testaceipes* in *R. maidis* and *A. gossypii* were 10.2 and 10.1 days, respectively. While, Huges (2010) recorded that the periods from egg to mummy, from mummy to adult and from egg to adult on *Aphis fabae* were 7.3 ± 0.1 , 4.5 ± 0.2 and 11.8 ± 0.3 , respectively, at 22°C .

3. Fecundity: The newly emerged parasitoid females were able to lay eggs immediately after emergence without a need for feeding or mating. Ovipositional period was 2 ± 0.64 days (Table 3). Number of the ovarian eggs (164 ± 41.08 eggs/female ovary) was much more than that of deposited eggs (43.85 ± 20.22 eggs/female). That mean a loss in the parasitoid potential which may be attributed to the use of unfavorable aphid species (*R. padi*). Superparasitism was not observed in the 2nd and 3rd instars of *R. padi*. Rodrigues *et al.*, (2003) recorded that *L. testaceipes* females deposited 257.8 eggs in the first day in *S. graminum*. While, Silva *et al.* (2008b) recorded 498.8 eggs in *R. maidis*.

4. Survival rate and sex-ratio: Total number of *R. padi* mummies after parasitism by *L. testaceipes* reached 34.23 ± 13.74 (20-63) mummies/ female. Percentage of adults' emergence was 61.62%. The progeny produced from unmated female of *L. testaceipes* was always males (Arrhenotokey). Adult males of *L. testaceipes* usually emerged first before the females. *L. testaceipes* female was fertilized only one time and prevented any more mating. The sex ratio was (1F: 1.12 M) when *L. testaceipes* parasitized *R. padi*. The sex-ratio (male: female) in *L. fabarum* was reported as 1:1.8 (Stary, 1988). Mean lifetime fertility was 122 ± 27.28 offsprings/ female on *A. fabae* (Matin, *et al.*, 2009).

5. Longevity: Shortest longevity was recorded when *L. testaceipes* adults were starved. The longevity increased when the parasitoid was fed on honey (50 and 100%), while the longest longevity was found when the adults were fed on 10% sucrose solution (8.3 ± 2.08 days for female and 8.6 ± 1.98 days for male), which means that the carbohydrates affected the life-span of the parasitoid (Table 4). There was insignificant difference between male and female longevity. Mean longevity reached 3.15 ± 0.81 and 3.15 ± 0.75 days for female and male, respectively, when

fed on honeydew. It could be noted that the mean femlae's longevity (3.15 days) was proportional to the ovipositional period (2 days) recorded in this investigation. This meant that the honey dew as natural food gives the parasitoid its requirement for laying egg. Availability of dietary carbohydrates improved *L. testaceipes* fitness; both lifespan and potential fecundity increased when carbohydrates were available (Hopkinson, 2010).

6. Life- table: The net reproductive rate, mean generation time, intrinsic rate of increase and finite rate of increase for *L. testaceipes* and its host *R. padi* are presented in table (5). Life table parameters of *R. padi* was previously estimated by El-Heneidy *et al.* (2004). The net reproductive rate of *R. padi* was greater than that for *L. testaceipes*, as it was 58.32 and 10.88, respectively. Generation time of the parasitoid (8.5 days) was longer than its host (6.25 days). The intrinsic rate of increase for *R. padi* (0.37) was higher than its parasitoid (0.25). Several factors may influence the ability of a parasitoid to reduce host populations in the field. Any r_m value calculated from laboratory experiments is of use only as an indicator of the potential of a parasitoid (Froud and Stevens, 1997). Further studies on the life table of indigenous species should be conducted to evaluate their efficiency against cereal aphids in Egypt. In this respect, Rodrigues *et al.* (2003) reported that the net reproduction rate and the intrinsic rate of increase of *L. testaceipes* on *S. graminum*, as a host at $25 \pm 1^\circ\text{C}$, were, 301.9 and 0.513, respectively. The finite rate of increase was 1.67 females per day, the mean length of a generation was 11.13 days and the time to duplicate the population was 1.35 weeks.

7. Host preference: Host preference of the parasitoid showed that the greatest mean number of mummies was recorded on *S. graminum* (53.4 ± 34.6), followed by *R. padi* (20.9 ± 10.8) and then *A. craccivora* (18.6 ± 11.5). Sex-ratio was relatively much more in favor to males than females in all cases (Table 6). Statistical analysis showed significant differences among the mean numbers of mummies/ female of *R. padi*, *S. graminum* and *A. craccivora*. Highest number of mummies/ female was recorded on *S. graminum*, while the lowest emergence rate was found in case of *S. graminum*. *S. graminum* seemed to be the most suitable host for rearing the parasitoid *L. testaceipes* under laboratory conditions. This result is in complete agreement with Gilstrap and McKinnon (1988) and Rodrigues and Bueno (2001). Silva *et al.* (2008 a) reported that *S. graminum*, *R. maidis* and *A. gossypii* are preferred hosts for parasitism by *L. testaceipes*.

Table 1. Effect of aphid nymphal instars and adults of *R. padi* on the developmental periods (days)(Mean±SD) of the parasitoid *Lysiphlebus testaceipes*, at 22±1°C, 40-60% R.H. and L: D 16: 8

Stage	2 nd nymphal instar	4 th nymphal instar	Adults
Egg	1.4 ± 0.51 (1-2)	1.8 ± 0.41 (1-2)	1.8 ± 0.67 (1-3)
1 st larval instar	1.27 ± 0.46 (1-2)	1.3 ± 0.49 (1-2)	1.47 ± 0.52 (1-2)
2 nd larval instar	1 ± 0 (1)	1 ± 0 (1)	1 ± 0 (1)
3 rd larval instar	1 ± 0 (1)	1.5 ± 0.51 (1-2)	1.27 ± 0.45 (1-2)
Total larval period	3.27 ± 0.46 (3-4)	3.87 ± 0.64 (3-5)	3.73 ± 0.46 (3-4)
Pre-pupa	1.4 ± 0.51 (1-2)	1.27 ± 0.46 (1-2)	1.47 ± 0.52 (1-2)
Pupa	2.2 ± 0.41(2-3)	5.13 ± 0.74 (3-6)	3.4 ± 0.63 (2-4)
Total developmental period	8.27 ± 0.46 (8-9)	12.7 ± 0.45 (11-13)	10.4 ± 0.82 (9-12)

Table 2. Effect of different host species of aphids on the durations (days) of different immature stages of *L. testaceipes* at 22±1°C, 40-60% R.H. and L:D 16:8

Developmental period	<i>R. padi</i>	<i>S. graminum</i>	<i>A. craccivora</i>
Egg-mummy	5.4 ± 0.84 (5-7)	7 ± 0	5.4 ± 0.84 (5-7)
Mummy-adult	4.3 ± 0.67 (4-6)	2.6 ± 0.16 (2-3)	4.24 ± 0.67 (4-6)
Egg-adult	9.6 ± 0.84 (9-11)	9.6 ± 0.52 (9-10)	9.8 ± 1.3 (9-12)

Table 3. Ovipositional periods and egg reproductivity of *L. testaceipes* female at 22 ± 1°C, 40 - 60% R.H. and L:D 16:8

Ovipositional periods and Fecundity	Days / Average
Pre-oviposition	<24
Oviposition	2 ± 0.64 (1-3)
Post-oviposition	0.9 ± 0.71 (0-2)
Number of eggs / female ovary	164 ± 41.08 (90-215)
Total number of eggs / female	43.85 ± 20.22 (21-81)

Table 4. Longevity of *L. testaceipes* adults when fed on different diets unfed at 22±1°C, 40 - 60% R.H. and L: D 16:8

Parameters	Female	Male
Starvation	1.8 ± 0.62 (1-3)	2.75 ± 0.55 (1-3)
Honey dew	3.15 ± 0.81 (2-5)	3.15 ± 0.75 (2-5)
Honey solution 50%	6.2 ± 2.21 (2-11)	6.85 ± 3.53 (1-12)
Honey bee	6.3 ± 2.05 (3-6)	7.45 ± 1.76 (4-10)
Sucrose solution 10%	8.3 ± 2.08 (2-12)	8.6 ± 1.98 (4-12)

Table 5. Life-table parameters of *L. testaceipes* and its host *Rhopalosiphum padi* on wheat at $22 \pm 1^\circ\text{C}$, 40 - 60 % R.H. and L: D 16: 8

Biological parameters	<i>L. testaceipes</i>	<i>R. padi</i>
Generation time(T)	8.5	6.25
Sex ratio (Female/total)	0.4713	--
Sum of RML	1.000127	
R_0	10.88	58.32
T_c	9.58	10.88
r_m	0.25	0.37
exp. r_m	1.28	1.45

 R_0 = the net reproductive rate T_c = the mean generation time r_m = the intrinsic rate of increase exp. r_m = the finite rate of increase exp.Table 6. Mean numbers (\pm S.D and range) of mummies/ female, emergence rate and sex-ratio of *L. testaceipes* on aphids *R. padi*, *S. graminum* and *A. craccivora*, at $22 \pm 1^\circ\text{C}$, 40 - 60% R.H. and L:D 16:8

Aphid Species	Mean no. of mummies/female	Emergence rate %	Sex ratio F: M
<i>R. padi</i>	20.9 ± 10.8 (11-43)	76.08	1:1.5
<i>S. graminum</i>	53.4 ± 34.6 (17-117)	68.15	1:1.2
<i>A. craccivora</i>	18.6 ± 11.5 (6-38)	75.58	1:1.1

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كفاءة الطفيل (*LYSIPHLEBUS TESTACEIPES* (CRESSON) (HYMENOPTERA: APHIDIIDAE) على عوائله من أنواع المن

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١. معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى - الجيزة

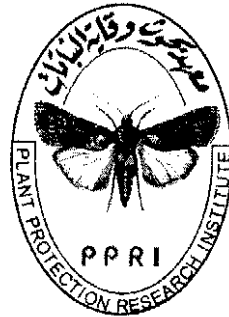
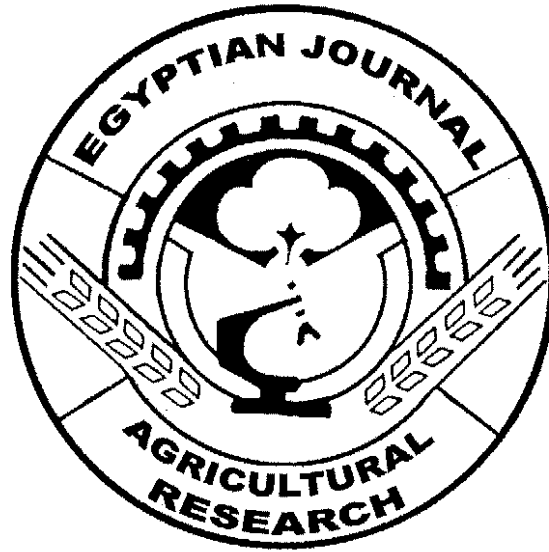
٢. قسم الحشرات الاقتصادية - كلية الزراعة - جامعة بنها

درست كفاءة الطفيل (*Lysiphlebus testaceipes* (Cresson) (Hymenoptera: Aphidiididae) كعامل من عوامل المكافحة الحيوية على ثلاثة أنواع من المن. تمت الدراسات البيولوجية للطفيل على عائله من الشوفان *Rhopalosiphum padi* تحت ظروف المعمل. تمت دراسة تأثير أنواع من مختلفة (*Schazaphis graminum*، *Aphis craccivora*، *R. padi*) على فترات تطور الطفيل. بلغ عدد البويضات /مبيض، عدد البيض الذى وضعتة الانثى وعدد الموميאות 41.8 ± 20.22 ، 43.85 ± 16.4 و 34.23 ± 13.74 مومياء / انثى على التوالي على نوع المن *R. padi*. بلغت نسبة خروج الحشرات الكاملة من الموميאות 61.62 % وكانت النسبة الجنسية 1:1.12 (ذكر: انثى) فى حالة التطفل على نوع المن *R. padi*. أظهرت النتائج أن أقصر طول حياة للحشرة الكاملة كان فى حالة التجويع. اظهرت دراسة جدول الحياة ان اقصى معدل للزيادة لنوع المن *R. padi* كان أعلى من الطفيل *L. testaceipes*. بلغ اعلى انتاج للطفيل عندما تم اكثاره على نوع المن *S. graminum* و يليه *R. padi* وأقلهم النوع *A. craccivora* فى تجربة التفضيل العوائلى.



117

117



Special Issue

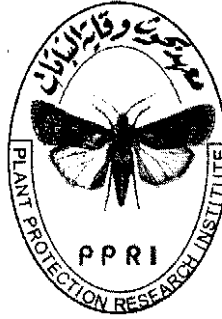
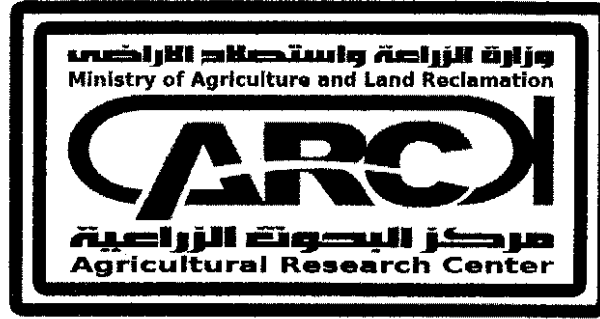
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المجلد ٩٠ - العدد الثاني (٢)

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