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 Mediterraneans 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±1°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 (2*rd* and 3*rd* instars) in a small plastic tray (15 ×7 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 1*st* group was left unfed, the 2*nd* was fed on honey bee, the 3*rd* on droplets of 50% honey, the 4*th* on droplets of 10% sucrose and the 5*th* 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), \( R_0 = \sum l \times m \times e^{r_m x} = 1 \), to obtain an estimate of the intrinsic rate of increase \( r_m \) at a study temperature degree, where:

\[
\begin{align*}
    x & = \text{Age intervals (the female age in days)}. \\
    l_x & = \text{Age specific survival (the fraction of females alive at age x)}. \\
    m_x & = \text{Age specific fecundity (the number of female offspring per female parent)}. \\
    \text{The net reproductive rate } R_0 & = \sum l \times m_x. \\
    \text{The mean generation time } T_c & = \sum l \times m_x \times / R_0. \\
    \text{The Intrinsic rate of increase } r_m & = \ln R_0 / T_c. \\
    \text{The finite rate of increase exp. } r_m & = e^{r_m}. 
\end{align*}
\]

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 ± 1°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 (Arrhenotoky). 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 female’s longevity (3.15 days) was proportional to the ovipositional period (2 days) recorded in this investigation. This meant that the honeydew 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* 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 ± 1°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 nymphaul 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

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

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

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

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

<table>
<thead>
<tr>
<th>Ovipositional periods and Fecundity</th>
<th>Days / Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-oviposition</td>
<td>&lt;24</td>
</tr>
<tr>
<td>Oviposition</td>
<td>2 ± 0.64 (1-3)</td>
</tr>
<tr>
<td>Post-oviposition</td>
<td>0.9 ± 0.71 (0-2)</td>
</tr>
<tr>
<td>Number of eggs / female ovary</td>
<td>164 ± 41.06 (90-215)</td>
</tr>
<tr>
<td>Total number of eggs / female</td>
<td>43.85 ± 20.22 (21-81)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation</td>
<td>1.8 ± 0.62 (1-3)</td>
<td>2.75 ± 0.55 (1-3)</td>
</tr>
<tr>
<td>Honey dew</td>
<td>3.15 ± 0.81 (2-5)</td>
<td>3.15 ± 0.75 (2-5)</td>
</tr>
<tr>
<td>Honey solution 50%</td>
<td>6.2 ± 2.21 (2-11)</td>
<td>6.85 ± 3.53 (1-12)</td>
</tr>
<tr>
<td>Honey bee</td>
<td>6.3 ± 2.05 (3-6)</td>
<td>7.45 ± 1.76 (4-10)</td>
</tr>
<tr>
<td>Sucrose solution 10%</td>
<td>8.3 ± 2.08 (2-12)</td>
<td>8.6 ± 1.98 (4-12)</td>
</tr>
</tbody>
</table>
Table 5. Life-table parameters of \textit{L. testaceipes} and its host \textit{Rhopalosiphum padi} on wheat at 22\pm 1^{\circ}\text{C}, 40 - 60\% \text{R.H.} and \text{L: D 16: 8}

<table>
<thead>
<tr>
<th>Biological parameters</th>
<th>\textit{L. testaceipes}</th>
<th>\textit{R. padi}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation time (T)</td>
<td>8.5</td>
<td>6.25</td>
</tr>
<tr>
<td>Sex ratio (Female/total)</td>
<td>0.4713</td>
<td>--</td>
</tr>
<tr>
<td>Sum of RML</td>
<td>1.000127</td>
<td></td>
</tr>
<tr>
<td>(R_0)</td>
<td>10.88</td>
<td>58.32</td>
</tr>
<tr>
<td>(T_c)</td>
<td>9.58</td>
<td>10.88</td>
</tr>
<tr>
<td>(r_m)</td>
<td>0.25</td>
<td>0.37</td>
</tr>
<tr>
<td>(\exp r_m)</td>
<td>1.28</td>
<td>1.45</td>
</tr>
</tbody>
</table>

\(R_0\) = 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

Table 6. Mean numbers (\pm S.D and range) of mummies/ female, emergence rate and sex-ratio of \textit{L. testaceipes} on aphids \textit{R. padi}, \textit{S. graminum} and \textit{A. craccivora}, at 22 \pm 1^{\circ}\text{C}, 40 - 60\% \text{R.H.} and \text{L:D 16:8}

<table>
<thead>
<tr>
<th>Aphid Species</th>
<th>Mean no. of mummies/female</th>
<th>Emergence rate %</th>
<th>Sex ratio F: M</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{R. padi}</td>
<td>20.9 \pm 10.8 (11-43)</td>
<td>76.08</td>
<td>1:1.5</td>
</tr>
<tr>
<td>\textit{S. graminum}</td>
<td>53.4 \pm 34.6 (17-117)</td>
<td>68.15</td>
<td>1:1.2</td>
</tr>
<tr>
<td>\textit{A. craccivora}</td>
<td>18.6 \pm 11.5 (6-38)</td>
<td>75.58</td>
<td>1:1.1</td>
</tr>
</tbody>
</table>
REFERENCES


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

LYSIPHEBUS TESTACEIPES (CRESSON) (HYMENOPTERA: APHIDIIDAE)

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DALIA EL-DALY، عزيزة أحمد عيد

1. معمل بحوث وقاية النباتات - مركز البحوث الزراعية - الدفي - الجيزة
2. قسم الحشرات الاقتصادية - كلية الزراعة - جامعة بنها

Lysiphebus testaceipes (Cresson) (Hymenoptera: Aphidiidae) درست كفاءة الطفل كعامل من عوامل المكافحة الحيوية على ثلاثة أنواع من المن. تمّ التحقيق في البيولوجيا للطفل على عائلة من الشفافين تحت ظروف المعمل. تمّ دراسة تأثير أنواع من مختلفة (Schizaphis graminum، Aphis cracciavora، R. padi) على فترات تطور الطفل. بلغ عدد البيضات/مبيض عدد البيضات الذي وضعته الإناث وعدد الموميوات 4.18±0.36 و4.23±0.84 موبيا ذلك انثى على نوع الموميوات 6.22±0.22 و6.23±0.44. بلغت نسبة خروج الحشرات الكاملة من الموميوات 11.61٪ وكانت النسبة R. padi الجنسية 1:12:1 (ذكر: أنثى) في حالة التطور على نوع المن طول حياة للحشرة الكاملة كان في حالة التحويج. أظهرت دراسة جدول الحيا كان أساسي معدل للزيادة لنوع الممن كان أعلى من الطفل R. padi. بلغ أعلى معدل للطفل عندما تم L. testaceipes عند R. padi أظهره على نوع المن ورديه S. graminum وأقلهم النوع. R. padi. في تجربة التفضيل العوالى.
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