

## The parasitoid *Praon volucre* (Hymenoptera: Braconidae: Aphidiinae) as a potential biological control agent of the aphid *Uroleucon ambrosiae* (Hemiptera: Aphididae) on lettuce in Brazil

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**Abstract.** The aphid *Uroleucon ambrosiae* (Thomas) is one of the principal pests found on greenhouse lettuce crops, and there is no efficient biological control agent of this pest in Brazil. This work evaluates the aphid *U. ambrosiae* as a host for the parasitoid *Praon volucre* (Haliday), aimed at using *P. volucre* as a potential biological control agent of *U. ambrosiae* on lettuce. As *Macrosiphum euphorbiae* (Thomas) is a common host of *P. volucre* in the field, the development of the parasitoid was compared on these two aphid species. Twenty nymphs of the 2<sup>nd</sup> instar were kept with *P. volucre* for one hour at 22 ± 1°C, 70 ± 10% RH and a 12 h photophase. The size of the aphid's tibiae at the moment of oviposition indicated that there was no significant size difference between *U. ambrosiae* (0.6 ± 0.02 mm) and *M. euphorbiae* (0.7 ± 0.03 mm). When mummies were formed, *M. euphorbiae* had significantly longer tibia (1.5 ± 0.03 mm) than *U. ambrosiae* (1.4 ± 0.02 mm). No significant differences were detected in the percentage emergence (74.9 ± 7.92 and 87.5% ± 3.31 for *U. ambrosiae* and *M. euphorbiae*, respectively), or proportion of female offspring (56.2 ± 7.62 and 44.2 ± 7.14%). The development time from oviposition to adult and longevity of females and males of *P. volucre* reared on the two host species were not different. High parasitism levels were recorded for both host aphid species, but the percentage parasitism of *M. euphorbiae* (54.4 ± 4.40) was higher than of *U. ambrosiae* (35.6 ± 5.30). Female parasitoids reared on *M. euphorbiae* had longer tibiae (0.78 ± 0.01 mm) than those reared on *U. ambrosiae* (0.72 ± 0.01 mm). Our results demonstrate that the alternative host species *U. ambrosiae*, compared to the natural host species *M. euphorbiae*, affects the female's size, but did not affect parasitoid development time, longevity, emergence or sex ratio. The parasitoid *P. volucre* seems to be a good candidate for using as a biological control agent of *U. ambrosiae* on lettuce in Brazil.

### INTRODUCTION

The aphids *Macrosiphum euphorbiae* (Thomas) and *Uroleucon ambrosiae* (Thomas) are two of the major pests that regularly attack greenhouse lettuce crops (Auaud et al., 2002). *U. ambrosiae* is an aphid from the Nearctic region, which colonizes a range of Compositae plants in South America (Carvalho et al., 1998), and has increased its status as a pest with the increase in the hydroponic production of lettuce in Brazil (Starý et al., 2007). The koinobiont endoparasitoid *Praon volucre* (Haliday), of Palearctic origin, was introduced into Brazil for the biological control of the wheat aphids *Metopolophium dirhodum* (Walker) and *Sitobion avenae* (Fabricius) (Gassen & Tambasco, 1983) and parasitizes several Macrosiphini in the field, including *M. euphorbiae* and *Uroleucon* sp. (Starý et al., 2007). According to Starý et al. (2007) the native Aphidiinae fauna of *Uroleucon* in South America is not well known and although they recorded large colonies of *U. ambrosiae* on lettuce plants without parasitoids they did not recommend the introduction of exotic parasitoids species to control *U. ambrosiae* before acquiring a better knowledge of the indigenous parasitoids of the local fauna. *P. volucre* is not a native species but has become established and makes up part of the parasitoid

guild attacking *Uroleucon* species and might be a good candidate for use as a biological control agent against lettuce aphids in Brazil.

The aim of this work was to determine whether *P. volucre* is as a potential biological control agent of *U. ambrosiae*, with the objective of controlling this aphid without introducing an exotic aphid parasitoid. As *M. euphorbiae* is a common host of *P. volucre* in the field, the development of the parasitoid was compared on these two aphid species.

### MATERIAL AND METHODS

#### Insect rearing

The aphids *M. euphorbiae* and *U. ambrosiae* were evaluated as hosts for *P. volucre*. The insects were collected at the Federal University of Lavras, Brazil. Aphids were collected from a hydroponic lettuce crop and reared in climatic chambers at 22 ± 1°C, 70 ± 10% RH and a 12 h photophase. Pieces of lettuce leaf (*Lactuca sativa* L.) were placed in 15 cm Petri dishes on a layer of 1% agar/water. Parasitoids were collected from *Rhodobium porosum* (Sanderson) and *M. euphorbiae* mummies on rose bushes. Parasitoid rearing was carried out on *M. euphorbiae* maintained in 15 cm Petri dishes in climatic chamber at 22 ± 1°C, 70 ± 10% RH and a 12 h photophase. A male and female parasitoids were kept in 10 × 8 mm glass tubes and the females

used in the experiments came from tubes where mating was observed.

#### Assessing *U. ambrosiae* as host for *P. volucre*

The experiments to test *M. euphorbiae* and *U. ambrosiae* as hosts for *P. volucre* were carried out in climatic chambers at  $22 \pm 1^\circ\text{C}$ ,  $70 \pm 10\%$  RH and a 12 h photophase. Approximately 50 adults of each aphid species were maintained for 24 h in 15 cm Petri dishes on pieces of lettuce leaf on 1% solution agar/water kept in climatic chambers at  $25 \pm 1^\circ\text{C}$ ,  $70 \pm 10\%$  RH and a 12 h photophase. After this period, the adult aphids were removed and 2nd instar apterous nymphs (24 h old) were used in the experiments. The presence and number of exuviae were used as an indication that the nymphs were in the 2nd instar. In order to minimize the chance of 3rd instar nymphs being presented in the experiments, 2nd instar sized aphid nymphs of each aphid species were chosen and presented to each parasitoid.

A single 24–48-h old mated *P. volucre* female, with no previous oviposition experience, was released in a 5 cm Petri dish containing 20 2nd instar nymphs of one of the aphid species on a piece of lettuce leaf on 1% solution agar/water. The parasitoid female was removed after one hour and the aphids were maintained under the same climatic conditions. Fifteen parasitoid females were evaluated for each host species. Five days after the parasitoid was removed the aphids were transferred to new 5 cm Petri dishes with fresh pieces of lettuce leaf until mummies formed. The experiment was checked daily to evaluate the developmental time and adult longevity of the parasitoid. A mummy was considered to be completely formed, once the parasitoid larva had formed the cocoon below the aphid skin. The individual mummies were placed in 10 cm × 8 mm glass vials until adult emergence, when the parasitoids were supplied daily with water and honey drops placed on the walls of the vials.

#### Host and parasitoid size

Aphids from the same dishes of nymphs used in the experiments were used to measure host size at oviposition (initial host size). The right hind tibia was removed from each aphid and placed in a drop of 70% alcohol on a slide covered with a cover slip and then measured under an optical microscope with graded ocular at a 100× magnification. Females of twenty nymphs of each aphid species were measured.

Tibiae of both males and females of the parasitoids reared on each aphid species were measured using the same method. Hind tibial lengths of mummies were also measured (host final size). Forty *P. volucre* adults were measured for each host species, 20 males, 20 females, and their respective mummies.

#### Data analysis

The sex ratio (percentage of female), parasitism and emergence percentages, as well as the developmental time and longevity of the parasitoids reared on each aphid species were

TABLE 1. Hind tibial length of the hosts *U. ambrosiae* and *M. euphorbiae* at oviposition (initial) and mummy formation (final), parasitism and emergence percentages, and percentage of females of *P. volucre* that developed in these aphids.  $22 \pm 1^\circ\text{C}$ ,  $70 \pm 10\%$  RH and a 12 h photophase. Averages ( $\pm$  standard error) for each aphid species followed by the same letter on the same line indicate that they do not differ F test and a 5% probability.

Parameters	Host (n)	
	<i>U. ambrosiae</i>	<i>M. euphorbiae</i>
Host tibia initial size	$0.6 \pm 0.02$ a (20)	$0.7 \pm 0.03$ a (20)
Host tibia final size	$1.4 \pm 0.02$ b (20)	$1.5 \pm 0.03$ a (20)
Percentage parasitism	$35.6 \pm 5.30$ b (15)	$54.4 \pm 4.40$ a (15)
Percentage emergence	$74.9 \pm 7.92$ a (15)	$87.5 \pm 3.31$ a (15)
Females (%)	$56.2 \pm 7.62$ a (15)	$44.2 \pm 7.14$ a (15)

recorded. Parasitoid size as well as initial and final host size were also compared. For calculating percentages data obtained for each *P. volucre* female ( $n = 15$ ) was pooled. When mating is observed sperm may have not passed into the female parasitoid, and only male offspring are produced; to avoid this, the analyses included only the results for Petri dishes where at least one female occurred among the offspring. The production of daughters is the simplest way of confirming that a female parasitoid was mated. For developmental time the results for the parasitoids that emerged were used and for longevity 60 adults were evaluated for each host species, 30 females and 30 males. An analysis of variance was performed and the averages compared using a F test with a 5% level of significance.

#### RESULTS

No significant differences were found in the hind tibial lengths of the second instar host aphids indicating that the initial size of the aphids was similar. However, the final host size in the case of *M. euphorbiae* was larger than that in *U. ambrosiae* (Table 1). The percentage of parasitism of *U. ambrosiae* was lower than of *M. euphorbiae*, indicating a higher successful parasitism by *P. volucre* of the natural host species (Table 1). The percentage emergence and sex ratio (percentage of female offspring) of *P. volucre* did not differ in parasitized *U. ambrosiae* and *M. euphorbiae* (Table 1). The developmental time, from oviposition to mummy formation, for female parasitoids was shorter when they parasitized *M. euphorbiae* than *U. ambrosiae*. However, the developmental times, from oviposition to mummy formation, for males, and oviposition to adult for both parasitoid sexes was the same for both

TABLE 2. Developmental time (from oviposition to mummy formation and from oviposition to adult), longevity, and hind tibial length of the females and males of the parasitoid *P. volucre* at  $22 \pm 1^\circ\text{C}$ ,  $70 \pm 10\%$  RH and a 12 h photophase. Averages ( $\pm$  standard error) of each aphid species followed by the same letter on the same line indicate that for each sex they do not differ, F test and a 5% probability. (UA = *Uroleucon ambrosiae*; ME = *Macrosiphum euphorbiae*).

<i>P. volucre</i> biological parameters	Female (n)		Male (n)	
	UA	ME	UA	ME
Oviposition-mummy (days)	$7.0 \pm 1.43$ a (38)	$7.9 \pm 1.65$ b (45)	$7.7 \pm 0.94$ a (34)	$7.0 \pm 1.30$ a (69)
Oviposition-adult (days)	$15.9 \pm 1.51$ a (38)	$15.3 \pm 2.32$ a (45)	$15.8 \pm 2.25$ a (34)	$15.2 \pm 1.90$ a (69)
Longevity (days)	$18.4 \pm 5.49$ a (30)	$20.3 \pm 6.23$ a (30)	$17.8 \pm 5.00$ a (30)	$19.5 \pm 4.18$ a (30)
Parasitoid tibial length (mm)	$0.72 \pm 0.01$ a (20)	$0.78 \pm 0.01$ b (20)	$0.62 \pm 0.01$ a (20)	$0.66 \pm 0.01$ a (20)

aphid species (Table 2). There were no differences in the longevity of males or females of *P. volucre* when they developed in the different hosts (Table 2). The females of *P. volucre* reared on *M. euphorbiae* were larger than when reared on *U. ambrosiae*. However, there was no difference in the hind tibia size of males of *P. volucre* reared on the two hosts (Table 2).

## DISCUSSION

The percentage of parasitism recorded in this study was a combination of host acceptance and host suitability (Vinson & Iwantsch, 1980). Therefore, it is unknown whether the lower percentage of parasitism of *U. ambrosiae* was due to its lower host acceptance or mortality during the parasitoid's immature stages. However, percentage parasitism and emergence were high, indicating that *P. volucre* readily parasitized this host and that it was suitable for the parasitoid's development. In the field, *P. volucre* parasitizes both the invasive and indigenous species of *Uroleucon* in Brazil, but not *U. ambrosiae* (Starý et al., 2007). The lack of parasitism of *U. ambrosiae* in the field does not appear to be due to incompatibility of the parasitoid with the host.

The developmental time of *P. volucre* on the two host species did not indicate a difference in host quality for the parasitoid. This period was longer when developing in *U. ambrosiae* than *M. euphorbiae* only for the period from oviposition to mummy formation of female parasitoids. Mescheloff & Rosen (1988) found a similar egg-mummy developmental time (7 days), and shorter egg to adult period (12 days) when *P. volucre* developed in *U. sonchi* and *M. rosae* at 22°C. The same was observed by Sigsgaard (2000), with 7.8 and 10.1 days for these periods for *P. volucre* developing in *S. avenae* at 20°C.

We used hind tibial length as an index of aphid and parasitoid body mass. Even though hind tibial length gives only an approximate measure of mass it is a very practical method (Nicol & Mackauer, 1999). The larger size of the female *P. volucre* that developed in *M. euphorbiae* is related to the host size. Although host sizes were similar at oviposition the size at mummification was large for *M. euphorbiae* than *U. ambrosiae*. Large hosts are normally a better quality host and result in the development of larger parasitoids that have a competitive advantage over those developing in smaller conspecifics (Cloutier et al., 2000; Chau & Mackauer, 2001; Ellers et al., 2001). Further studies are needed to determine if the large size of female *P. volucre* when reared on *M. euphorbiae* is associated with an increase in fitness.

The parasitoid *P. volucre* accepted and developed well on *U. ambrosiae*. Although parasitizing the alternative host species, *U. ambrosiae*, compared to the natural host species, *M. euphorbiae*, resulted in a smaller female parasitoid it did not affect parasitoid developmental time, longevity, percentage emergence, or sex ratio. As both aphid species are lettuce pests, the parasitoid *P. volucre* might be a good candidate for testing as a biological control agent of *M. euphorbiae* and *U. ambrosiae* in greenhouse using hydroponic production systems for growing lettuce in Brazil. Therefore, new introductions of aphid parasitoids may not be necessary for the biological control of *U. ambrosiae* in Brazil.

## REFERENCES

- AUAD A.M., FREITAS S. & BARBOSA L.R. 2002: Ocorrência de afídeos em alface (*Lactuca sativa* L.) em cultivo hidropônico. *Neotrop. Entomol.* **31**: 335–339.
- CLOUTIER C., DUPERRON J., TERTULIANO M. & MCNEIL J.N. 2000: Host instar, body size and fitness in the koinobiotic parasitoid *Aphidius nigripes*. *Entomol. Exp. Appl.* **97**: 29–40.
- CARVALHO R.C.Z., BLACKMAN R.L. & SPENCE J.M. 1998: The genus *Uroleucon* Mordvilko (Insecta, Aphidoidea) in South America, with a key and descriptions of four new species. *Zool. J. Linn. Soc.* **123**: 117–141.
- CHAU A. & MACKAUER M. 2001: Preference of the aphid parasitoid *Monoctonus paulensis* (Hymenoptera: Braconidae, Aphidiinae) for different aphid species: female choice and offspring survival. *Biol. Control* **20**: 30–38.
- ELLERS J., BAX M. & VAN ALPHEN J.J.M. 2001: Seasonal changes in female size and its relation to reproduction in the parasitoid *Asobara tabida*. *Oikos* **92**: 309–314.
- GASSEN D.N. & TAMBASCO F.J. 1983: Controle biológico dos pulgões do trigo no Brasil. *Informe Agropec.* **9**: 49–51.
- MESCHELOFF E. & ROSEN D. 1988: Biosystematic studies on the Aphidiidae of Israel (Hymenoptera: Ichneumonoidea) 2. The Genera *Ephedrus* and *Praon*. *Israel J. Entomol.* **22**: 75–100.
- NICOL C.M.Y. & MACKAUER M. 1999: The scaling of body size and mass in a host-parasitoid association: influence of host species and stage. *Entomol. Exp. Appl.* **90**: 83–92.
- SIGSGAARD L. 2000: The temperature-dependent duration of development and parasitism of three cereal aphid parasitoids, *Aphidius ervi*, *A. rhopalosiphii*, and *Praon volucre*. *Entomol. Exp. Appl.* **95**: 173–184.
- STARÝ P., SAMPAIO M.V. & BUENO V.H.P. 2007: Aphid parasitoids (Hymenoptera, Braconidae, Aphidiinae) and their associations related to biological control in Brazil. *Rev. Bras. Entomol.* **51**: 107–118.
- VINSON S.B. & IWANTSCH G.F. 1980: Host suitability for insect parasitoids. *Annu. Rev. Entomol.* **25**: 397–419.

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