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Two new *Encarsia* species (Hymenoptera: Aphelinidae) reared from eggs of Cicadellidae (Hemiptera: Auchenorrhyncha) in Argentina: an unusual new host association

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Males of two undescribed *Encarsia* species were reared from eggs of two cicadellid species during a study of egg parasitoids of corn leafhopper, *Dalbulus maidis* (DeLong and Wolcott) in northwestern Argentina. Samples were collected during the summer of 2004–2007 using sentinel eggs, and several males of a new species of *Encarsia* (Hymenoptera: Chalcidoidea: Aphelinidae) were obtained. A single male of a closely related *Encarsia* species, also previously undescribed, was reared from an egg of another cicadellid on maize, *Plesiommata mollicella* (Fowler). These are the first records of any *Encarsia* species reared from eggs of Cicadellidae. The two new species are described as *Encarsia dalbulae* Polaszek and Luft Albarracin **sp. nov.**, and *Encarsia mollicellae* Polaszek and Luft Albarracin **sp. nov.**

Keywords: *Dalbulus maidis*; heteronomous; heterotrophic; leafhoppers; ooparasitoids; parasitoids; *Plesiommata mollicella*; sharpshooters

Introduction

Aphelinidae (Chalcidoidea) is one of the smaller families of Chalcidoidea in terms of number of genera and species, containing 1300 species belonging to 34 genera (Noyes 2005). Most Aphelinidae are primary parasitoids or hyperparasitoids of Hemiptera, mainly Sternorrhyncha (Aleyrodidae, Aphididae, Coccidae, Diaspididae and Pseudococcidae, among others), although species in several genera are known to be parasitoids of eggs of insects in various orders (Polaszek 1991; Woolley 1997). Polaszek (1991) recorded eight aphelinid genera attacking insect eggs. That number is now reduced to six because of two taxonomic changes since then: *Azotus* Howard has again been synonymized with *Ablerus* Howard (originally by Girault 1913) and *Dirphys boswelli* (Girault) now belongs to *Encarsia* Foerster (Schmidt and Polaszek 2007). A previously overlooked published association between *Eutrichosomella blattophaga* Girault and oothecae of blattid cockroaches (Girault 1915) brings the total number of ooparasitic aphelinid genera to seven. Coccophaginae, the subfamily to which *Encarsia* belongs, is well-known for exhibiting heteronomous parasitism in most species, where females develop as primary parasitoids, while males develop as secondary (hyper-) parasitoids on females of their own, or other, species (Walter 1983; Williams and Polaszek 1996; Hunter and Wooley 2001).

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Previously reported aphelinid parasitoids of Cicadellidae are restricted to four species of *Centrodora* Foerster, in South Africa and Asia (Polaszek 1991; Grandgirard et al., 2007). The genus *Encarsia* is distributed worldwide, and most are parasitoids either of Aleyrodidae (whiteflies) or Diaspididae (armoured scale insects), with the *flavoscutellum*-group specializing on aphids of the Hormaphididae (Evans et al. 1995). *Encarsia* is well-known for many reasons, including the fact that it exhibits heteronomous parasitism, where females lay male (haploid, unfertilized) eggs in hosts that are different from those in which they lay female (diploid, usually fertilized) eggs (Williams and Polaszek 1996). An extreme example of heteronomy is heterotrophic parasitism. *Encarsia porteri* (Mercet), for example, lays female eggs in Aleyrodidae nymphs and male eggs in Lepidoptera eggs (Polaszek et al. 1995; Hunter et al. 1996). At present, 19 species of the genus *Encarsia* occur in Argentina (Ovruski and Frias 1995; Viscarret *et al*. 2000).

The corn leafhopper, *Dalbulus maidis* (DeLong and Wolcott) (Hemiptera: Cicadellidae), is the commonest leafhopper feeding on maize, *Zea mays* L., in Argentina (Luft Albarracin et al. 2008). It causes great losses to the crop in most tropical and subtropical parts of the Americas because of its ability to transmit three important pathogens: Corn stunt spiroplasma, Maize bushy stunt phytoplasma and Maize rayado fino virus (Nault and Ammar 1989). The diseases caused by these pathogens seriously affect the maize crop in Argentina (Giménez Pecci et al. 2002; Virla et al. 2004). Until now, the following egg parasitoids of *D. maidis* were known: *Anagrus breviphragma* Soyka, *A. flaveolus* Waterhouse, *A. nigriventris* Girault, *Anagrus* sp., and *Polynema* sp. (Mymaridae); *Aphelinoidea* sp., *Oligosita* sp., *Paracentrobia* sp. near *subflava* (Girault), *Paracentrobia* sp., *Pseudoligosita* sp. and *Zagella* sp. (Trichogrammatidae); and *Aprostocetus* (*Ootetrastichus*) *infulatus* (De Santis) (Eulophidae: Tetrastichinae) (Virla et al. 2009).

Plesiommata mollicella (Fowler) is widely distributed in South America. In Argentina it is one of the commonest sharpshooters associated with various crops such as maize, wheat, oats and weeds surrounding these crops, as well as weeds surrounding citrus plantations (Remes Lenicov et al. 1999).

Materials and methods

The eggs of the leafhoppers studied are embedded in plant tissue, laid either singly or in groups, according to the species. Sentinel eggs of *D. maidis* and *P. mollicella* were obtained in the laboratory by exposing leaves of potted maize plants in the vegetative stage (three to six leaves), to 6–10 females during 24 h for oviposition. Females of each leafhopper species were kept in cylindrical PET (polyethylene-terephthalate) cages (35 cm high, 18 cm diameter) attached to one or two leaves, according to the phenological stage. The individuals of both species of leafhoppers came from laboratory colonies maintained at room temperature (25 ± 2°C), 60–70% relative humidity and natural photoperiod. All the exposed eggs were 24–72 h old and were placed inside the maize crops not more than 3 m from the edge of the field. After 8 days, the leaves with exposed eggs were cut from the plant and transferred to Petri dishes containing a layer of wet tissue. Dishes were then covered with polyethylene film to avoid desiccation of eggs and leaves and to prevent any emerging wasps from escaping. Once in the laboratory, parasitized eggs were checked daily to ensure leaf quality until emergence of all the adult wasps.

Emerged specimens were either slide mounted in Canada balsam using a standard procedure modified from Noyes (1982), or mounted on card points. Card-pointed specimens were later processed for genomic DNA extraction using a non-destructive protocol, and slide mounted in Canada balsam.

Morphological terminology follows Schmidt and Polaszek (2007). The measurements reported are relative, except for the total length (head to abdominal tip, without the antennae), which is expressed in millimetres. All specimens studied in this paper are deposited in the following collections: IMLA, Fundación e Instituto Miguel Lillo, San Miguel de Tucumán, Tucumán, Argentina; MLPA, Museo La Plata, Buenos Aires, Argentina; NHM, Natural History Museum, London, UK; UCRC, University of California, Riverside, CA, USA.

Results

A total of 12 specimens, all males, emerged: four from eggs exposed at El Manantial (26°49′50.2″ S, 65°16′59.4″ W, 495 m) five from Los Nogales (26°42′27.5″ S, 65°13′3.9″ W, 585 m), both locations within Tucumán province, and three from El Naranjito (27°33′24.9″ S, 64°46′12.3″ W, 280 m) Santiago del Estero province. This *Encarsia* appears to be a rare species associated with *D. maidis* eggs, being obtained on only six occasions, and always in small numbers. A single additional male *Encarsia* specimen was reared from an egg of *Plesiommata mollicella*. This is the first time that any *Encarsia* species has been recorded emerging from leafhopper eggs.

Taxonomy

Encarsia dalbulae Polaszek and Luft Albarracin **sp. nov.**

(Figures 1, 2)

Description (Holotype)

Male: 0.57 mm.

Colour. Head and body largely brown. Lower occiput and stemmaticum darker than the rest of the head (Figure 1A). Antennae uniformly pale brown. Scutellum and distal side lobes paler than mid-lobe and axillae (Figure 1B). Legs pale yellow, except coxae and distal tarsal segments, brown. Fore wings slightly infuscate below marginal vein (Figure 1C).

Morphology. Antenna with seven antennomeres (Figure 1D), the flagellum with five, one fewer than is usual for the genus. Scape three times as long as wide. Flagellomeres F1–F4 approximately equal in length, lengths of F1–F5 in the following ratios: 1 : 1.1 : 1.1 : 1.1 : 1.5. F1 with two basiconic sensilla subapically; F2 and F3 with a ventral row of four and two basiconic sensilla respectively (Figure 2; but see below under “Variation”); stemmaticum with distinct reticulate sculpture, frons laterally striate (Figure 1A). Mid-lobe of mesoscutum with four pairs of setae, side lobes with two setae each (Figure 1B). Scutellar sensilla separated by three times the maximum width of a sensillum (though slightly distorted in holotype). Distance between bases

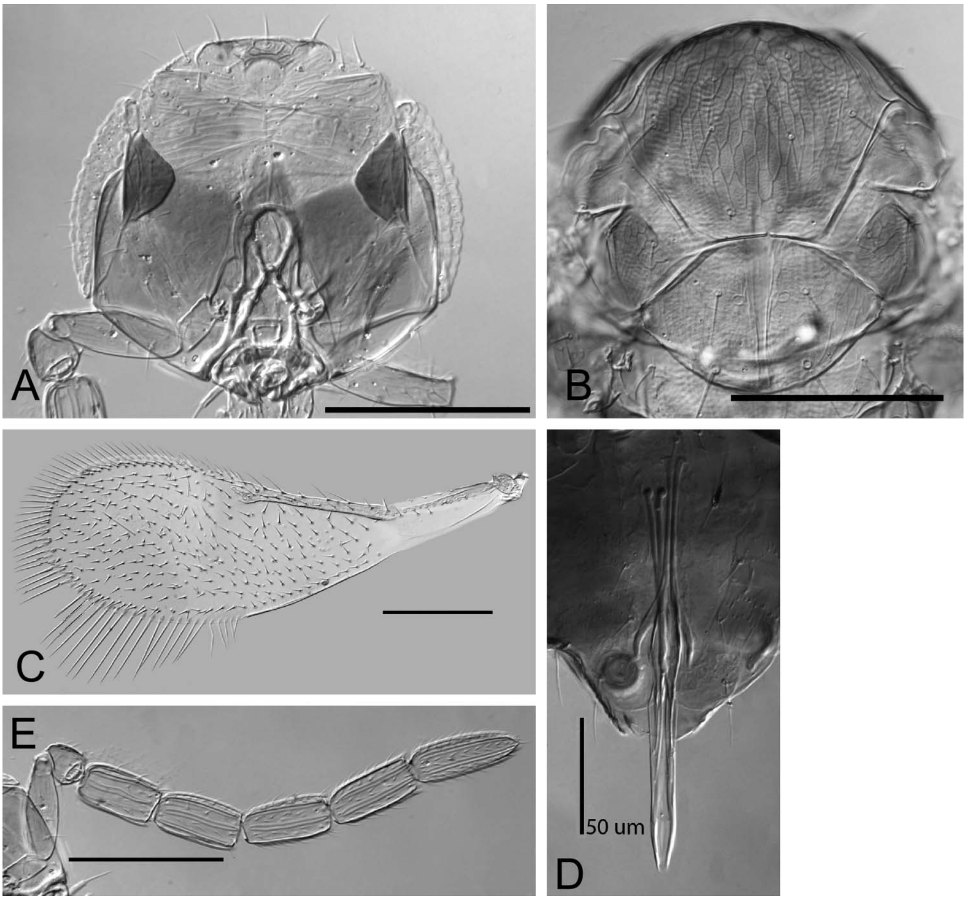

Figure 1. *Encarsia dalbulae* sp. nov. (A) Head; (B) dorsal mesosoma; (C) forewing; (D) male genitalia; (E) antenna. Scale bars: 0.1 mm.

of anterior scutellar setae slightly less than that between posterior pair; anterior setae slightly shorter than posterior pair. Fore wing three times maximum width of wing disc, uniformly setose (no asetose area around stigmal vein). Marginal fringe 0.55 times as long as maximum width of disc. Basal cell with three setae arranged in a row. Submarginal vein with two small setae, situated close to the wing base. Marginal vein anteriorly with seven long setae. Tarsal formula 5-5-5. Mid-tibial spur as long as the shorter side of the mid-basitarsus (observed in paratype specimen, as holotype has both mid-legs missing). Metasomal terga with the following numbers of setae: T1, 0; T2, 1; T3, 1; T4, 1; T5, 1; T6, 0. T5 and T6 with a pair of setae centrally. T7 with two setae, and with five rows of transverse denticles. Male genitalia as in Figure 1D.

Variation

Very little in the limited material examined ($n = 10$). Some specimens have a seta fewer on the mesoscutal mid-lobe. At least two paratypes have three basiconic sensilla on F3, and it may be that the third is present but not visible in the holotype.

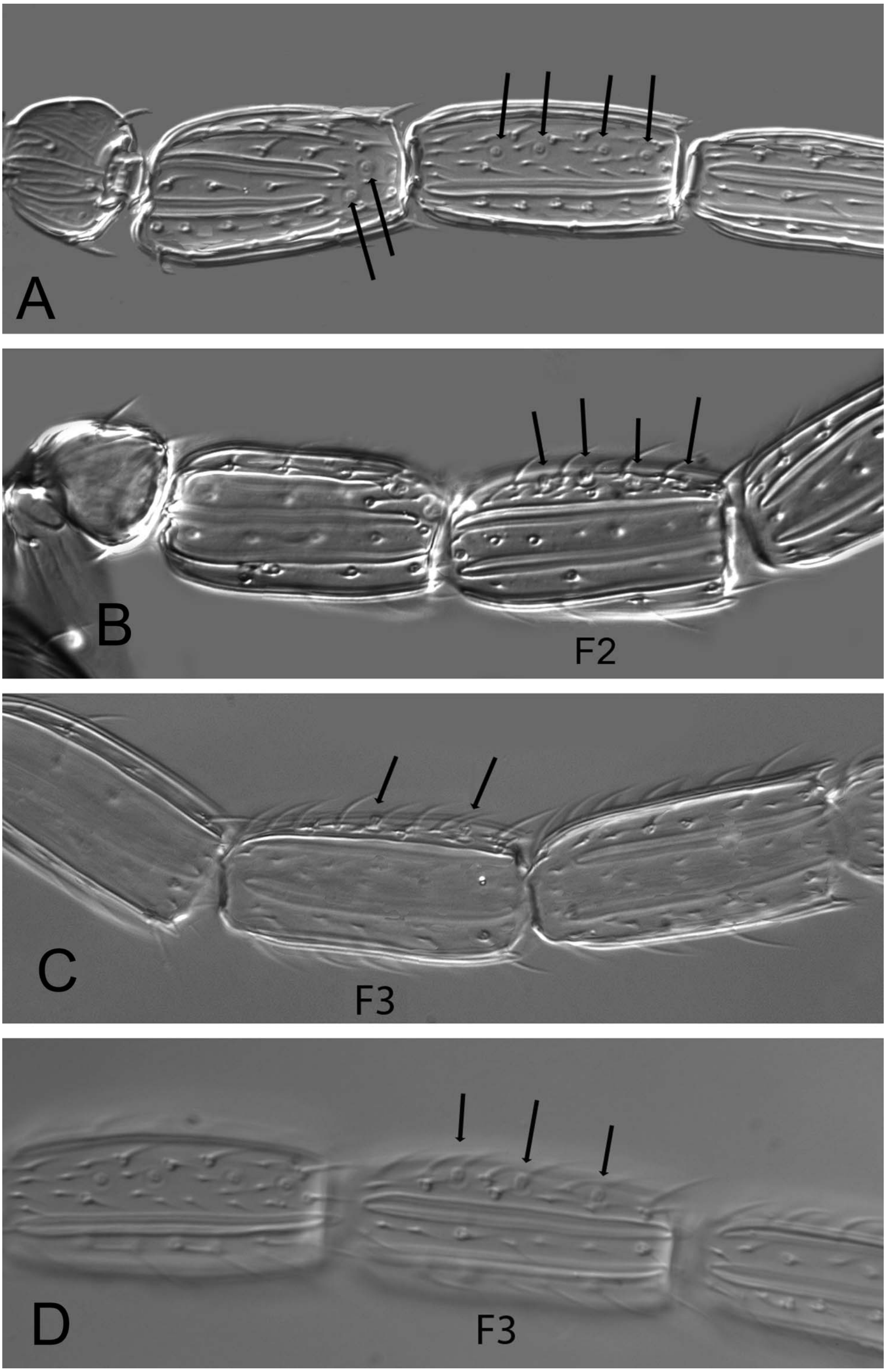

Figure 2. *Encarsia dalbulae* sp. nov. Details of antenna (arrows indicate sensilla).

Female

Unknown.

Distribution

Argentina.

Host

Dalbulus maidis (DeLong and Wolcott) Hemiptera: Cicadellidae.

Material examined

Holotype male. ARGENTINA: Santiago del Estero, Naranjito 20–26 December 2006 (E. Luft Albarracin) ex egg of *D. maidis* (DeLong and Walcott) (IMLA).

Paratypes. Two males, same data as holotype UCRC ENT 75916 (MLPA, UCRC); two males ARGENTINA: Tucumán, El Manantial, (E. Luft Albarracin) ex eggs of *D. maidis* 24 January to 2 February 2005 (IMLA, UCRC); one male ARGENTINA: Tucumán, El Manantial, (E. Luft Albarracin M° 136) ex eggs of *D. maidis* 21–27 January 2005 (NHM); one male ARGENTINA: Tucumán, El Manantial, (E. Luft Albarracin M°16) ex eggs of *D. maidis* 29 December 2005 to 4 January 2006 (NHM); two males ARGENTINA: Tucumán, Los Nogales, 8–12 February 2007 (E. Luft Albarracin) ex eggs of *Dalbulus maidis* (IMLA).

Encarsia mollicellae Polaszek and Luft Albarracin **sp. nov.**
(Figure 3)

Description (holotype)

Male: 0.75 mm.

Colour. Head and body largely brown. Lower occiput and stemmaticum darker than the rest of the head (Figure 3A). Antennae uniformly pale brown. Scutellum and distal side lobes paler than mid-lobe and axillae (Figure 3B). Base of metasoma paler than remainder. Legs (except coxae) pale yellow. Fore wings very slightly infuscate below marginal vein.

Morphology. Antenna (Figure 3F) with seven antennomeres, the flagellum with five, one fewer than is usual for the genus. Scape four times as long as wide. F1 globular, as wide as long. Lengths of F1–F5 in the following ratios: 1 : 1.2 : 1.4 : 1.4 : 1.6. F1–F3 with an array of unusual sensory setae, sensilla and possibly glandular structures, as follows: F1 apically on inner side with several short thick setae, and two basiconic sensilla (Figure 3E); F2 on inner side in apical half with a cluster of four basiconic sensilla in a recessed area of the flagellomere (Figure 3E). Stemmaticum with distinct reticulate sculpture, frons laterally striate. Mandible with socketed peg-like structure clearly present (Figure 3D). Mid-lobe of mesoscutum with three pairs of setae and an additional asymmetrically positioned seta, side lobes with two setae each. Axillar setae placed on the suture beween axilla and posterior side lobe (Figure 3B). Scutellum distorted in holotype, therefore relative positions of scutellar sensilla and

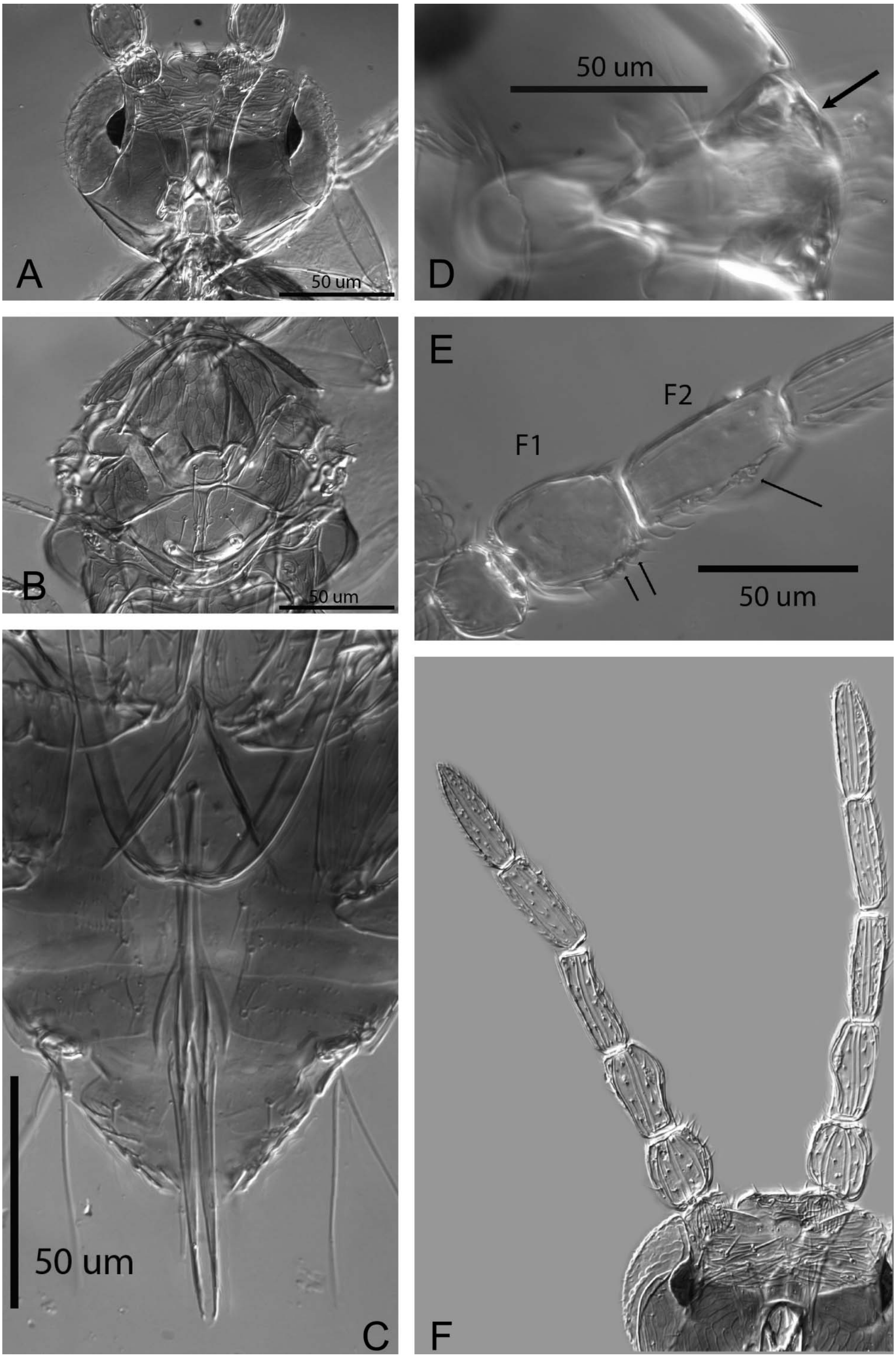

Figure 3. *Encarsia mollicellae* sp. nov. (A) Head; (B) dorsal mesosoma; (C) male genitalia; (D) mandibles; (E) details of antenna (arrows indicate sensilla); (F) antennae.

setae unclear. Fore wing three times maximum width of wing disc, uniformly setose (no asetose area around stigmal vein). Marginal fringe 0.54 times as long as maximum width of disc. Basal cell with three setae arranged in a row. Submarginal vein with two small setae, situated close to the wing base. Marginal vein anteriorly with seven long setae. Tarsal formula 5-5-5. Mid-tibial spur as long as the shorter side of the mid basitarsus. Metasomal terga with the following numbers of setae: T1, 0; T2, 1; T3, 1; T4, 1; T5, 1; T6, 0. T5 and T6 with a pair of setae centrally. T7 with two setae, and with five rows of transverse denticles.

Female

Unknown.

Distribution

Argentina.

Host

Plesiommata mollicella (Fowler) Hemiptera: Cicadellidae.

Material examined

Holotype male. ARGENTINA: Tucumán, El Manantial, (E. Luft Albarracin M° 8) ex eggs of *Plesiommata mollicella* 9–18 January 2006 (IMLA).

Comments

Encarsia dalbulae and *E. mollicellae* are currently known only from male specimens. Male *Encarsia* are often extremely difficult to identify to species in the absence of conspecific females, and it is possible that both species described here represent previously described species that are known so far from females only.

It is extremely unusual for *Encarsia* males to be reared from insect eggs, a biology known for only two described species, *E. boswelli* and *E. porteri*. As stated earlier, *E. porteri* males are obligate ooparasitoids of a range of Lepidoptera eggs. Given that virtually all female *Encarsia* lay unfertilized (male) eggs into already parasitized whitefly hosts, laying an egg into a cicadellid egg, situated more deeply in the plant tissue, could require modifications to the ovipositor, particularly its length. It is probable, but by no means certain, that the hosts of the female *E. dalbulae* and *E. mollicellae* are whiteflies (Aleyrodidae). *Encarsia boswelli* develops in eggs of Plataspidae (Heteroptera), with males emerging alongside their female siblings in the same egg mass (Polaszek and Hayat 1990).

Biologically and in some morphological aspects, *E. dalbulae* and *E. mollicellae* are most similar to *E. porteri*. The males are certainly similar to males of *E. porteri*, having flagellomeres F5 and F6 fused, which is quite unusual in the genus. *Encarsia porteri* males differ, however, in several respects: the two components of the fused F5 and F6 are clearly discernible in *E. porteri* (and hence the fused antennomere is much longer than the others) whereas they form a single antennomere in *E. dalbulae* and *E. mollicellae*; T6 and T7 have four (occasionally more) setae in *E. porteri* (two in

E. dalbulae and *E. mollicellae*). Myartseva and Evans (2007) established the *E. porteri* species-group for two species: *E. porteri* and *E. neoporteri*. The group is defined morphologically by having a short and broad phallobase, and by the presence of basiconic sensilla distributed along flagellomeres 2–5 (i.e. non-apically as in other *Encarsia* males). The former character does not appear to hold true for the two new species, but basiconic sensilla are present in both species on flagellomeres F1–F3 (Figures 2A–D, 3E). Hunter et al. (1996) showed conclusively that *E. porteri* males develop exclusively in Lepidoptera eggs, but according to Myartseva and Evans (2008) at least one male of the closely related *E. neoporteri* was reared from *Bemisia tabaci* (Aleyrodidae). To further confuse the issue, a series of males identified as *Encarsia porteri* in NHM all bear label data that they have been reared from *B. tabaci*. It seems probable that there are yet more cryptic species awaiting discovery within this interesting species group.

Both the new species described here are provisionally assigned to the *E. porteri* species group.

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References

Evans GA, Polaszek A, Bennett FD. 1995. The taxonomy of the *Encarsia flavoscutellum* species-group (Hymenoptera: Aphelinidae) parasitoids of Hormaphididae (Homoptera: Aphidoidea). Oriental Insects 29:33–45.

Giménez Pecci MP, Laguna I, Avila A, Remes Lenicov A, Virla E, Borgogno C, Nome C, Paradell S. 2002. Difusión del corn stunt spiroplasma del maíz (*Spiroplasma kunkelii*) y del vector (*Dalbulus maidis*) en la República Argentina. Rev Fac Agron, La Plata. 105:1–8.

Girault AA. 1913. Australian Hymenoptera Chalcidoidea IV. Mem Qld Mus. 4:140–296.

Girault AA. 1915. Australian Hymenoptera Chalcidoidea VII. The family Encyrtidae with descriptions of new genera and species. Mem Qld Mus. 4:1–184.

Grandgirard J, Hoddle MS, Triapitsyn SV, Petit JN, Roderick GK, Davies N. 2007. First records of *Gonatocerus dolichocerus* Ashmead, *Palaeoneura* sp., *Anagrus* sp. (Hymenoptera: Mymaridae), and *Centrodora* sp. (Hymenoptera: Aphelinidae) in French Polynesia, with notes on egg parasitism of the glassy-winged sharpshooter, *Homalodisca vitripennis* (Germar) (Hemiptera: Cicadellidae). Pan-pacific Entomol. 83(3):177–184.

Hunter MS, Rose M, Polaszek A. 1996. Divergent host relationships of males and females in the parasitoid *Encarsia porteri* (Hymenoptera: Aphelinidae). Ann Entomol Soc Am. 89(5):667–675.

Hunter MS, Woolley JB. 2001. Evolution and behavioral ecology of heteronomous aphelinid parasitoids Annu Rev Entomol. 46:251–290.

Luft Albarracin E, Paradell S, Virla E. 2008. Cicadellidae (Hemiptera: Auchenorrhyncha) associated to maize crops in Argentina northwestern, influence of the sowing date and phenology on the abundance and diversity. Maydica 53: 289–296.

Myartseva SN, Evans GA. 2008. Genus *Encarsia* Förster of Mexico (Hymenoptera: Chalcidoidea: Aphelinidae). A revision, key and description of new species. Serie avispas parasitícas de plagas y otros insectos No 3, 54:142–144.

Nault LR, Ammar D. 1989 Leafhopper and planthopper transmission of plant viruses. Annu Rev Entomol. 34:503–529.

Noyes JS. 1982. Collecting and preserving chalcid wasps (Hymenoptera: Chalcidoidea). J Nat Hist. 16:315–334.

Noyes JS. 2005. Universal Chalcidoidea Database [Internet]. April 2009. London: Natural Nistory Museum; [cited 2010 May 5]. Available from: http://www.nhm.ac.uk/entomology/chalcidoids/index.html.

Ovruski SM, Frias EA. 1995. Presencia de *Encarsia porteri* (Hymenoptera: Aphelinidae) parasitoidizando huevos de lepidópteros noctuidos plagas del cultivo de soja en Tucumán, Argentina. Rev Soc Entomol Arg. 54:25–29.

Polaszek A. 1991. Egg parasitism in Aphelinidae (Hymenoptera, Chalcidoidea) with special reference to *Centrodora* and *Encarsia* species. Bull Entomol Res. 81:97–106.

Polaszek A, Hayat M. 1990. *Dirphys boswelli* (Hymenoptera: Aphelinidae) an egg parasitoid of Plataspidae (Heteroptera). J Nat Hist. 24:1–5.

Polaszek A, Stouthamer R, Hunter MS, Rose M, Ovruski SM, Frias E, Rojas SP. 1995. Heterotrophic parasitoids revisited: preliminary observations on *Encarsia porteri* (Mercet) (Hymenoptera: Aphelinidae). Les Colloques de l'INRA. 73:31–32.

Remes Lenicov AMM de, Paradell S, Coll de O, Agostini, J. 1999. Cicadelinos asociados a citrus afectados por clorosis variegada (CVC) en la República Argentina (Insecta: Homoptera: Cicadellidae). Rev Soc Entomol Arg. 58:211–225.

Schmidt S, Polaszek A. 2007. *Encarsia* or *Encarsiella*? – redefining generic limits based on morphological and molecular evidence (Hymenoptera, Aphelinidae). Syst Entomol. 32:81–94.

Virla E, Díaz C, Carpane P, Laguna I, Ramallo J, Gómez L, Giménez Pecci M. 2004. Estimación preliminar de la disminución en la producción de maíz causada por el "corn stunt spiroplasma" (CSS) en Tucumán, Argentina. Bol San Veg Plagas 30:257–267.

Virla EG, Luft Albarracin E, Moya-Raygoza G. 2009. Egg parasitoids of *Dalbulus maidis* (Hemiptera: Cicadellidae) in Jalisco state, Mexico. Fla Entomol 92:508–510.

Viscarret MM, Botto EN, Polaszek A. 2000. Whiteflies (Hemiptera: Aleyrodidae) of economic importance and their natural enemies (Hymenoptera: Aphelinidae, Signiphoridae) in Argentina. Rev Chil Entomol. 26:5–11.

Walter GH. 1983. Divergent male ontogenies in Aphelinidae (Hymenoptera: Chalcidoidea): a simplified classification and a suggested evolutionary sequence. Biol J Linn Soc. 57:35–45.

Williams T, Polaszek A. 1996. A re-examination of host relations in the Aphelinidae Biol J Linn Soc. 19:63–82.

Woolley JB. 1997. Chapter 5. Aphelinidae. In: Gibson, GAP, Huber JT, Woolley JB, editors. Annotated keys to the genera of Nearctic Chalcidoidea (Hymenoptera). Ottawa, Ontario, Canada: NRC Research Press. p. 134–150.