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First record and new hosts relationships of *Alloxysta brevis* (Thomson, 1862) (Hymenoptera: Cynipoidea: Figitidae: Charipinae) from Algeria

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Abstract

In the framework of a study on citrus aphids in the North-Western of Algeria, we determined primary and secondary parasitoids on the main citrus aphid's species (*Aphis spiraecola* Patch, 1914 and *Aphis gossypii* Glover, 1877) during the first flushing period on *Citrus sinensis* var. Thomson in spring 2015. Among hyperparasitoids associated to *A. spiraecola*, we recorded the species *Alloxysta brevis* (Thomson, 1862) for the first time in Algeria. Studies in other regions has not found its presence yet.

Key words: *Alloxysta brevis*, aphids, *Aphis spiraecola*, Charipinae, citrus, hyperparasitoids.

Resum

Primera cita d'*Alloxysta brevis* (Thomson, 1862) (Hymenoptera: Cynipoidea: Figitidae: Charipinae) per Algèria

En el marc d'un estudi sobre àfids de cítrics al nord-oest d'Algèria, vam determinar els parasitoides primaris i secundaris sobre les principals espècies d'àfids (*Aphis spiraecola* Patch, 1914 i *Aphis gossypii* Glover, 1877) durant el primer període de la primavera de 2015 a *Citrus sinensis* var. Thomson. Entre els hiperparasitoides associats a *A. spiraecola*, vam registrar l'espècie *Alloxysta brevis* (Thomson, 1862) per primera vegada a Algèria. En els estudis realitzats en altres regions algerianes no s'ha detectat la seva presència.

Paraules clau: *Alloxysta brevis*, pugons, *Aphis spiraecola*, Charipinae, cítrics, hiperparasitoides.

Introduction

Hyperparasitoids are secondary insect parasitoids that develop at the expense of primary parasitoids, thereby representing a highly evolved trophic level (Jacobson, 2011; Sullivan & Volkl, 1999). They are divided in two categories: endophagous (indirect-hyperparasitoids) have larvae that feed inside the host, while ectophagous (direct-hyperparasitoids) can be secondary or tertiary parasitoids and the larvae feed externally (Sullivan, 1987; Sullivan, 1972). Hyperparasitoids have major implications for the biological control of pest aphids because of its negative effects on the population dynamics of beneficial primary parasitoids (Müller & Godfray, 1998; Sullivan & Volkl, 1999).

Aphid hyperparasitism is restricted to three hymenopteran superfamilies: Chalcidoidea, Ceraphronoidea and Cynipoidea (Sullivan, 1987). This last, recognize five families: Austrocynipidae, Ibalioidea, Liopteridae, Cynipidae and Figitidae

(Ronquist, 1999). The Cynipidae and Figitidae are called microcynipoids, smaller insects that are gall inhabitants (inducers or inquilines) or endoparasitic koinobionts of endopterygote insect larvae (Ferrer-Suay *et al.*, 2012a)

Charipinae (Hymenoptera: Cynipoidea: Figitidae) is a widely distributed subfamily of very small wasps (0.8 - 2.0 mm), with smooth and shiny body (Ferrer-Suay *et al.*, 2014a). Taxonomically, it includes eight genera: *Alloxysta* (Förster, 1869), *Phaenoglyphis* (Förster, 1869), *Lytoxysta* (Kieffer, 1909), *Loboptercharips* (Paretas-Martinez & Pujade-Villar, 2007), *Dilyta* (Förster, 1869), *Apocharips* (Fergusson, 1986), *Dilapothor* (Paretas-Martinez & Pujade-Villar, 2006) and *Thoreauana* (Girault, 1930) (Ferrer-Suay *et al.*, 2015a).

Species of the genus *Alloxysta* are biologically characterized as aphid hyperparasitoids (Hemiptera: Aphididae) via Aphidiinae (Hymenoptera: Braconidae) and Aphelininae (Hymenoptera: Aphelinidae) (Ferrer-Suay *et al.*, 2014a). This genus is characterized being koinobiont endohyperparasi-

toids which attack their host larvae within living aphids (Sullivan, 1987).

Until now only eight Charipinae species have been recorded from Algeria: *Alloxysta arcuata* (Kieffer, 1902), *A. consobrina* (Zetterstedt, 1838), *A. fracticornis* (Thomson, 1862), *A. pilipennis* (Hartig, 1840), *A. quedenfeldti* (Kieffer, 1909), *A. victrix* (Westwood, 1833), *Phaenoglyphis villosa* (Hartig, 1841) and *P. heterocera* (Hartig, 1841) (Ferrer-Suay *et al.*, 2017). In this study, a new *Alloxysta* species, *A. brevis* (Thomson, 1862) is cited for the first time on *Aphis spiraeicola* (Patch, 1914) from Algeria.

Material and Methods

During early spring (2015), aphid populations were monitored weekly on 10 trees, using only leaf count method. Samples were taken from *Citrus sinensis* Var. Thomson orchard in Messergin region in wilaya of Oran (Algeria).

In the laboratory, full mummies were taken from leaf with precaution and each one was put in individual small transparent box until emergence of wasps. Parasitoids and hyperparasitoids were observed and morphologically identified using different identification keys (Ferrer-Suay and Garrido-Salas, 2014; Kavallieratos *et al.*, 2001; Michelena *et al.*, 2004; Rakshani *et al.*, 2007).

Host data follows: HP: host plant; HA: host aphid; HW: primary host parasitoid (wasp); when any of these categories is not known, «unknown» is inserted into the corresponding trophic level.

Results and Discussion

Aphis spiraeicola was the predominant species in all samples. We have determined only two primary parasitoids on this aphid species: *Lysiphlebus testaceipes* (Cresson, 1880) and *Binodoxys angelicae* (Haliday, 1833). At least, 4 hyperparasitoids were found: *Pachyneuron aphidis* (Bouché, 1834), *Asaphes vulgaris* (Walker, 1834), *A. victrix* (Westwood, 1834) and *A. brevis*, which means the first record for this species.

Alloxysta brevis (Thomson, 1862)

Allotria brevis Thomson, 1862

Charips leguminosa (Weld, 1920)

Allotria megourae (Ashmead, 1887)

Alloxysta rauchi (Andrews, 1978) in Ferrer-Suay *et al.* (2013a)

Studied material

1 ♀: Messergin, Wilaya of Oran, ALG., v.2015, On *Citrus sinensis* Var. Thomson, Ex. *Aphis spiraeicola*, Leg. Labdaoui Zine Eddine.

The trophic relationship here recorded: *Citrus sinensis* Var. Thomson - *Aphis spiraeicola* is new for *A. brevis*.

Distribution

Alloxysta brevis is known from the Palaearctic and Neotropical regions (Ferrer-Suay *et al.*, 2012b). In the Mediterranean basin, this species has been recorded in France (De



Figure 1. Habitus of *Alloxysta brevis* ♀ (Thomson 1862), photo from first author.

Gaule, 1908; Ferrer-Suay *et al.*, 2015b; Kieffer, 1904), Italy (Ferrer-Suay *et al.*, 2014b), Morocco (Ferrer-Suay *et al.*, 2013b), Spain (Bertolaccini *et al.*, 2004; Ceballos, 1941; Tizado & Nuñez-Pérez, 1993) and Portugal (Borges *et al.*, 2008).

Diagnosis

Alloxysta brevis (Fig.1) is characterized by having a small closed radial cell, 2.1 × longer than wide, pronotal carinae absent, propodeal carinae present forming a plate; female and male antenna with rhinaria beginning from F4; F1 shorter than pedicel and F1-F3 subequal in length. It is similar to *Alloxysta darci* (Girault, 1933), but could be differentiated by: antenna shorter than body in *A. brevis*, versus longer in *A. darci*; forewing with marginal setae shorter in *A. brevis* than those in *A. darci* (Ferrer-Suay *et al.*, 2015b).

Hosts

The known hosts of *A. brevis* are the following: (HP: Plant, HA: Aphid, HW: parasitoid); HP: *Solanum lycopersicum* L. (= *Lycopersicon esculentum* Mill.)/HA: unknown/HW: unknown (Dalla Torre & Kieffer, 1910). HP: *Populus trichocarpa* Torr. & A.Gray ex. Hook. /HA: *Chaitophorus populicolus* (Thomas)/HW: *Aphelinus* sp. (Andrews, 1978). HP: unknown/HA: *Myzus persicae* (Sulzer, 1776) /HW: *Diaretiella rapae* ((M'Intosh, 1855) and *Aphidius* sp. (Horn, 1984). HP: unknown/HA: *Aphis* spp./HW: *Lysephedrus* sp.; HP: unknown/HA: *Myzus cerasi* (Fabricius, 1775) and *Dysaphis plantaginea* (Passerini, 1860) /HW: *Ephedrus persicae* Froggatt (Ferguson, 1986). HP: unknown/HA: *Aphis* sp./HW: *Lysephedrus* sp.; HP: unknown/HA: *Myzus cerasi* and *Dysaphis plantaginea*/HW: *Ephedrus* sp. (Barczak, 1991). HP: unknown/HA: *Hyperomyzus lactucae* (Linnaeus, 1758) /HW: *Praon volucre* (Haliday, 1833) (Tizado & Nuñez-Pérez, 1993). HP: unknown/HA:

Eucallipterus tiliae (Linnaeus, 1758) /HW: *Trioxys curvicaudus* Mackauer, 1967 and *Trioxys tenuicaudus* Stary, 1978 (Zuparko & Dahlsten, 1995). HP: Citrus/HA: *Aphis* (*Toxoptera*) *citricidus* (Kirkaldy, 1907) (= *Toxoptera citricida*), 1907/HW: *Lysiphlebus testaceipes* (Cresson, 1880) (Evans and Stange, 1997). HP: unknown/HA: *Capitophorus carduinis* (sic) and *Sitobion* spp. (Müller et al., 1999). HP: *Euonymus europaea* Linnaeus/HA: *Aphis fabae* Scopoli, 1763 /HW: *Binodoxys angelicae* (Haliday, 1833) (= *Trioxys angelicae*) (Hübner et al., 2002). HP: *Solidago altissima* L./HA: *Uroleucon nigrotuberculatum* (Olive, 1963) /HW: *Aphelinus albipodus* Hayat & Fatima, 1992 (Takada & Nakamura, 2010). HP: *Cassia* sp. /HA: *Aphis gossypii* Glover, 1877/HW: unknown; HP: *Yucca* sp. /HA: *Aphis helianthi* Monell, 1879/HW: unknown (Ferrer-Suay et al., 2012a). HP: *Salix* sp./HA: *Aphis farinosa* Gmelin, 1790/HW: *Binodoxys angelicae*; HP: *Philadelphus* sp./HA: *Aphis fabae*/HW: unknown; HP: *Euonymus europaeus* L./HA: *Aphis fabae*/HW: unknown; HP: *Spirea* sp./HA: *Aphis* sp./HW: unknown; HP: *Beta vulgaris* L./HA: *Aphis fabae*/HW: *Binodoxys aculephae* (Marshall, 1896); HP: *Sambucus nigra* L./HA: *Aphis sambuci* Linnaeus, 1758 /HW: unknown; HP: *Lappa major* L./HA: *Aphis fabae*/HW: *Lysiphlebus fabarum* (Marshall, 1896); HP: *Euonymus europaeus*/HA: *Aphis fabae*/HW: unknown; HP: *Evonymus europaeus*/HA: *Aphis fabae*/HW: *Binodoxys angelicae*; HP: *Euonymus europaeus*/HA: *Aphis fabae*/HW: unknown; HP: *Viburnum* sp./HA: unknown/HW: unknown; HP: *Spirea* sp./HA: *Aphis* sp./HW: *Binodoxys angelicae*; HP: *Viburnum opulus* L./HA: *Aphis viburni* Scopoli, 1763 /HW: *Binodoxys angelicae*; HP: *Malus domestica* Borkh.1803 (= *Malus communis*)/HA: *Aphis pomi* de Geer, 1773 /HW: *Binodoxys angelicae*; HP: *Campanula rapunculoides* L./HA: *Aphis fabae*/HW: *Lysiphlebus fabarum*; HP: *Euonymus europaeus*/HA: *Aphis fabae*/HW: *Binodoxys angelicae*; HP: *Galium mollugo* L./HA: *Hyadaphis* sp./HW: *Aphidius matricariae* Haliday, 1834; HP: *Onobrychis sativa* Scop./HA: *Aphis* sp./HW: *Binodoxys aculephae*; HP: *Pinus uncinata* Raymond ex A.DC. /HA: *Cinara* sp./HW: unknown; HP: *Urtica dioica* L./HA: *Aphis urticata* Gmelin, 1790 /HW: *Binodoxys aculephae*; HP: *Arctium* sp./HA: *Aphis fabae*/HW: *Binodoxys angelicae*, *Lysiphlebus fabarum*; HP: *Polygonum amphibicum* L./HA: unknown/HW: unknown; HP: *Trifolium fragiferum* L./HA: unknown/HW: unknown; HP: *Salix repens rosmarinifolia* L./HA: *Aphis farinosa*/HW: *Binodoxys angelicae*, *Lysiphlebus cardui* (Marshall, 1896); HP: *Beta vulgaris*/HA: *Aphis fabae*/HW: *Lysiphlebus fabarum*; HP: *Rumex* sp./HA: *Aphis fabae*/HW: *Binodoxys angelicae*, *Lipolexis gracilis* Forster, 1862, *Lysiphlebus fabarum*; HP: *Beta vulgaris*/HA: *Aphis fabae*/HW: unknown; HP: *Salix* sp./HA: *Aphis farinosa*/HW: *Lysiphlebus cardui*; HP: *Prunus persica*/HA: *Brachycaudus* sp./HW: *Binodoxys angelicae*, *Ephedrus persicae* (L.) Batsch; HP: *Rubus idaeus* L./HA: *Aphis idaei* van der Goot, 1912 /HW: unknown; HP: *Laburnum anagyroides* Medik./HA: *Aphis* sp./HW: *Binodoxys angelicae*; HP: *Medicago sativa* L./HA: *Aphis* sp., *Therioaphis* sp./HW: *Lipolexis gracilis* HP: *Arnica sachalinensis* (Regel) A.Gray/HA: *Aphis* sp./HW: unknown; HP: *Tropaeolum majus* L./HA: *Aphis* sp./HW: *Binodoxys angelicae*; HP: *Rumex conglomeratus* Murray/HA: *Aphis* sp./HW: *Binodoxys aculephae*; HP: *Rumex flexuosus* Sol. ex G.Forst./HA: *Aphis* sp./HW: unknown; HP: *Rumex balcanicus* Rech.f. /HA: *Aphis* sp./HW: *Praon abjectum* (Haliday, 1833); HP: *Rumex nepalensis* Spreng./HA: *Aphis* sp./HW: unknown; HP: *Rumex salicifolius* Weinm./HA: *Aphis* sp./HW: unknown; HP: *Rumex compactum* L./HA: unknown; HW: unknown; HP: *Beta vulgaris*/HA: *Aphis fabae*/HW: unknown; HP: *Artemisia vulgaris* L./HA: *Cryptosiphum* sp./HW: *Ephedrus nacheri* Quilis, 1934; HP: *Rumex* sp./HA: *Aphis* sp./HW: *Lysiphlebus fabarum*; HP: *Conium maculatum* L./HA: *Hyadaphis* sp./HW: *Ephedrus plagiator* (Nees ab Esenbeck, 1811), *Binodoxys brevicornis* (Haliday, 1833), *Praon volucre* (Haliday, 1833); HP: *Robinia pseudoacacia* L./HA: *Aphis* sp./HW: *Binodoxys angelicae*, *Lysiphlebus cardui*; HP: *Salix* sp./HA: *Aphis farinosa*/HW: *Lysiphlebus cardui*; HP: *Rhamnus cathartica* L./HA: *Aphis* sp./HW: unknown; HP: *Achillea millefolium* L./HA: *Brachycaudus* sp./HW: *Aphidius absinthii* Marshall, 1896; HP: *Cichorium intybus* L./HA: *Uroleucon cichorii* (Koch, 1855) /HW: *Lipolexis gracilis*; HP: *Spirea* sp./HA: *Aphis* sp./HW: unknown; HP: *Crataegus monogyna* Jaqu./HA: *Aphis pomi*/HW: *Ephedrus plagiator*; HP: *Conium maculatum*/HA: *Hyadaphis*/HW: *Binodoxys brevicornis*; HP: *Philadelphus coronarius* L./HA: *Aphis fabae*/HW: *Binodoxys angelicae*; HP: *Viburnum opulus*/HA: *Aphis* sp./HW: *Binodoxys angelicae*, *Praon abjectum*; HP: *Lonicera caprifolium* L./HA: *Hyadaphis passerinii* (del Guercio, 1911)/HW: unknown; HP: *Cirsium* sp./HA: *Aphis fabae*/HW: *Lysiphlebus fabarum*; HP: *Valeriana officinalis*/HA: *Macrosiphum rosae*, *Aphis fabae*/HW: *Ephedrus plagiator*; HP: *Nasturtium* sp./HA: *Aphis nasturtii* Kaltenbach, 1843 /HW: *Binodoxys aculephae*; HP: *Anthriscus silvestris* (L.) Hoffm. /HA: *Aphis brohmeri* Börner, 1952 /HW: *Lysiphlebus cardui*; HP: *Urtica dioica* /HA: *Aphis urticata*/HW: *Lysiphlebus fabarum*; HP: *Yucca* sp./HA: *Aphis fabae*/HW: *Lysiphlebus fabarum*; HP: *Lonicera xylosteum* L./HA: *Hyadaphis foeniculi* (Passerini, 1860)/HW: unknown; HP: *Cichorium intybus*/HA: *Aphis intybi* Koch 1855 /HW: *Lysiphlebus fabarum*; HP: *Urtica dioica*/HA: *Aphis urticata*/HW: *Binodoxys aculephae*; HP: *Spirea* sp./HA: *Aphis spiraeophaga* F.P. Müller, 1961/HW: *Binodoxys angelicae*; HP: *Artemisia vulgaris*/HA: *Cryptosiphum* sp./HW: *Lipolexis gracilis* sp. HP: *Ligustrum* sp./HA: *Myzus ligustri* (Mosley, 1841) /HW: *Ephedrus plagiator*; HP: *Caltha palustres* L. and other aquatic plants/HA: *Rhopalosiphum nymphaeae* (A. N. Tissot, 1933)/HW: *Praon necans* Mackauer, 1959; HP: *Sagittaria*/HA: *Rhopalosiphum nymphaeae*/HW: *Aphidius colemani* (Dalman, 1820), *Praon necans*; HP: *Urtica dioica*/HA: *Aphis urticata*/HW: *Binodoxys aculephae*; HP: *Chenopodium* sp./HA: *Hayhurstia atriplicis* (Linnaeus, 1761)/HW: *Diaeretiella rapae*; HP: *Cirsium arvense* (L.) Scop. /HA: *Aphis fabae*/HW: unknown; HP: *Senecio*/HA: *Aphis jacobaeae* Schrank, 1801 /HW: *Lipolexis gracilis*; HP: *Vicia cracca* L./HA: *Aphis cracciae* Linnaeus, 1758 /HW: *Binodoxys aculephae*, *Praon abjectum*; HP: *Colorado*, *Artemisia vulgaris*/HA: *Cryptosiphum*/HW: *Aphidius arvenses* (Stary, 1960), *Ephedrus nacheri*; HP: *Cirsium arvense*/HA: *Aphis fabae*/HW: *Binodoxys angelicae*, *Lysiphlebus cardui* HP: *Arnica montana* L./HA: *Aphis* sp./HW: unknown; HP: *Urtica urens* L./HA: *Aphis urticata*/HW: unknown; HP: *Chenopodium* sp./HA: *Aphis fabae*/HW: unknown (Ferrer-Suay et al., 2017).

Until now 3 species of Charipinae hyperparasitoids have been recorded on *A. spiraeicola* on citrus orchards in Algeria: *P. villosa*, *P. heterocera* (Labdaoui & Guenaoui, 2017) and here *A. brevis*.

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