

## First records of Charipinae (Hymenoptera, Cynipoidea, Figitidae) aphid hyperparasitoids from Malta

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**ABSTRACT.** Charipinae material has been collected from different localities in Malta. Three species have been identified: *Alloxysta citripes*, *Alloxysta pilipennis* and *Phaenoglyphis villosa* in association with two aphids and one parasitoid species. Diagnosis and information about distribution and hosts of each species is given. Plates with diagnostic features of these three species are also included. These findings represent the first record of the subfamily Charipinae in Malta.

**KEY WORDS.** Mediteranean, *Alloxysta*, *Phaenoglyphis*.

### INTRODUCTION

Members of the subfamily Charipinae are very small parasitic wasps (0.8–2.0 mm) widely distributed around the world, and characterized biologically as hyperparasitoids of aphids and psyllids (Hemiptera). Taxonomically, eight valid genera are documented including: *Alloxysta* Förster, 1869 (cosmopolitan), *Phaenoglyphis* Förster, 1869 (cosmopolitan), *Lytoxysta* Kieffer, 1909 (North America), *Lobopterocharips* Paretas-Martinez & Pujade-Villar, 2007 (Nepal), *Dilyta* Förster, 1869 (cosmopolitan except Australia), *Apocharips* Fergusson, 1986 (Eastern Palaearctic and Neotropical regions), *Dilapothor* Paretas-Martinez & Pujade-Villar, 2006 (Australia), and *Thoreauana* Girault, 1930 (Australia). Concretely, *Alloxysta* and *Phaenoglyphis* genera are hyperparasitoids of aphids (Hemiptera: Aphididae) via Aphidiinae (Hymenoptera: Ichneumonoidea: Braconidae) and Aphelininae (Hymenoptera: Chalcidoidea: Aphelinidae) (MENKE & EVENHUIS, 1991). According to CARVER (1992) the former Alloxystinae (*Alloxysta* + *Phaenoglyphis*) are the only true hymenopterous hyperparasitoids of aphids, and are economically important in reducing the efficiency of Aphidiinae and *Aphelinus* Dalman, 1820 as parasitoids of the pest aphids.

Many taxonomic problems encountered in the Charipinae is a result of their overlapping or great intraspecific variability in morphological characters, their small size and relatively few diagnostic characters. Consequently, the exact identification at species level is a rather difficult task. The distribution of *Alloxysta* and *Phaenoglyphis* is mainly in the Palaearctic and Nearctic regions, but there are species cited from all biogeographical regions.

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Previous to the present study, we found an unpublished record by FARRUGIA (1995) of *Alloxysta fuscicornis* (Hartig, 1841) (now *A. consobrina* (Zetterstedt, 1838)) reared from *Diaeretiella rapae* on *Brevicoryne brassicae*. *Alloxysta consobrina* is a cosmopolitan species and the above mentioned host records are already known for this species. However, in view of the fact that the material mentioned by FARRUGIA (1995) was not available for study and many identifications of *Alloxysta* spp. made in the past were found to be erroneous, we are not including this record in the present work.

The Maltese archipelago consists of a group of small, low-lying islands located in the Central Mediterranean basin, of which the islands of Malta, Gozo and Comino are inhabited. Malta and Gozo are the main islands with a surface area of 245.7 km<sup>2</sup> and 67.1 km<sup>2</sup> respectively. Human impact on the natural environment of the Maltese Islands is quite severe. The overall population density is currently 1,317 per km<sup>2</sup>, making the archipelago one of the most densely populated regions in the World.

In total three different species of Charipinae have been identified from Malta: *Alloxysta citripes* (Thomson, 1862), *A. pilipennis* (Hartig, 1840) and *Phaenoglyphis villosa* (Hartig, 1841). Information about diagnosis, distribution and hosts of these species are provided below.

## MATERIAL AND METHODS

Aphid colonies from different habitats and from different host plants were collected during 1<sup>st</sup> January and the 30<sup>th</sup> June of 2014. In the laboratory, these samples were kept separate in small plastic containers. Reared Hymenoptera from these samples were then collected in 75% ethanol. Specimens were studied using a stereo microscope (NIKON SMZ-1) and environmental scanning electron microscope (FEI Quanta 200 ESEM) belonging to the scientific technical services of the University of Barcelona. The field-emission gun environmental scanning electron microscope was used for high-resolution imaging without gold-coating of the specimens.

Material studied is deposited in the following institutions:

MZLU: Lund Museum of Zoology (Lund, Sweden);

ZSM: Zoologische Staatssammlung Museum (Munich, Germany);

DMC: David Mifsud, private collection (Malta).

Morphological terminology follows PARETAS-MARTÍNEZ *et al.* (2007). Measurements and abbreviations include F1–F12, first and subsequent flagellomeres. The width of the forewing radial cell is measured from the margin of the wing to the beginning Rs vein. The transfacial line is measured as the distance between the inner margins of compound eyes, measured across the face through the antennal sockets divided by the height of the eye. The malar space is measured by the distance from the lower part of the gena from the mouthparts to the ventral margin of the compound eye, divided by the height of the eye. Females and males of the species shortly described have the same characters except where indicated.

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

## ANNOTATED SPECIES LIST

Superfamily *Cynipoidea* Billberg, 1820Family *Figitidae* Thomson, 1862*Alloxysta citripes* (Thomson, 1862)

**Diagnosis:** *Alloxysta citripes* is mainly characterized by having partially open small radial cell being 2.1 times as long as wide (Fig. 1a), pronotal carinae present, propodeal carinae present forming a plate but not protruding, female antennae with the beginning of rhinaria in F4, F1 subequal to pedicel and longer than F2, F2–F4 subequal in length (Fig. 2a), male antennae with the beginning of rhinaria in F1, pedicel–F3 subequal, F3 slightly shorter than F4. It is similar to *Alloxysta postica* (Hartig, 1841) but they can be differentiated by the shape of propodeal carinae: the carinae are not protruding in *A. citripes* while they are clearly visible and forming a protruding plate in *A. postica*; size of radial cell: 2.1 times as long as wide in *A. citripes* (Fig. 2a) but 2.5 times in *A. postica*.

**Material examined:** Malta, St. Thomas Bay, 14–24.i.2014, 1 ♀ emerged from *Hoplocallis pictus* (Ferrari, 1872) on *Quercus ilex* L.; aphid parasitoid: *Trioxys pallidus* (Haliday, 1833).

**Distribution:** Palaearctic (FERRER-SUAY *et al.*, 2012a).

**Hosts:** Refer to table 1.

**Comments:** *Hoplocallis pictus* represents a new host aphid for this species.

*Alloxysta pilipennis* (Hartig, 1840)

**Diagnosis:** *Alloxysta pilipennis* is mainly characterized by having closed radial cell being 2.5 times as long as wide (Fig. 1b), pronotal and propodeal carinae present, female antennae with the beginning of rhinaria in F3, F1 longer than pedicel and F2, F2–F4 subequal in length (Fig. 2b). It is similar to *Alloxysta pusilla* (Kieffer, 1902) but they can be differentiated by the proportion between flagellomeres: F2 subequal to F3 in *A. pilipennis* female (Fig. 2b) but F2 shorter than F3 in *A. pusilla* female; F1–F3 not subequal and without any flagellomere curved in *A. pilipennis* male but F1–F3 subequal in length and slightly curved in *A. pusilla* male; size of radial cell: 2.4 times in *A. pilipennis* female (Fig. 1b) but 2.7 times as long as wide in *A. pusilla* female.

**Material examined:** Malta, Msida, 29.iii.2014, 1 ♀, emerged from *Macrosiphoniella* sp. on *Artemisia arborescens* (Vaill.) L. No aphid parasitoid emerged.

**Distribution:** Holarctic and Neotropical regions (FERRER-SUAY *et al.*, 2012a).

**Hosts:** Refer to table 2.

**Comments:** The aphid *Macrosiphoniella* is a new host for this species. The number of known hosts of *Alloxysta pilipennis* is very limited.

**Table 1:** Hosts records for *Alloxysta citripes* (Thomson) extracted from the Charipinae catalogue (FERRER-SUAY *et al.*, 2012a).

Charipinae	Plant	Aphid	Parasitoids	Reference
<i>A. citripes</i>	unknown	<i>Aphis tiliae</i>	unknown	DE GAULLE, 1908: 26
	unknown	<i>Dysaphis mali</i>	unknown	BELIZIN, 1966: 6
	<i>Quercus</i> spp.	<i>Tuberculoides annulatus</i>	unknown	EVENHUIS, 1976: 140
	<i>Alnus glutinosa</i>	<i>Pterocallis alni</i>	unknown	
	<i>Corylus avellana</i>	<i>Myzocallis coryli</i>	unknown	
	unknown	unknown	<i>Trioxys pallidus</i>	
	unknown	<i>Tuberculoides</i> sp., <i>Pterocallis</i> sp. and <i>Myzocallis</i> sp.	<i>Trioxys</i> sp.	FERGUSON, 1986: 18
	unknown	<i>Drepanosiphum</i> sp.	<i>Aphelinus</i> sp.	
	unknown	<i>Aphis tiliae</i>	unknown	EVENHUIS & BARBOTIN, 1987: 214
	<i>Tilia cordata</i>	<i>Eucallipterus tiliae</i>	<i>Trioxys pallidus</i>	HÜBNER <i>et al.</i> , 2002: 508
	<i>Juglans regia</i>	<i>Chromaphis juglandicola</i>	unknown	FERRER-SUAY <i>et al.</i> , 2012b: 10

**Table 2:** Hosts records for *Alloxysta pilipennis* (Hartig) extracted from the Charipinae catalogue (FERRER-SUAY *et al.*, 2012a).

Charipinae	Plant	Aphid	Parasitoids	Reference
<i>A. pilipennis</i>	<i>Carthamus tinctorius</i>	<i>Aphis</i> sp.	unknown	GIRAUD, 1877: 416
	<i>Sarothamnus</i> sp.	<i>Aphis</i> sp.	unknown	DE GAULLE, 1908: 26
		<i>Aphis</i> sp.	<i>Pontania vallisnerii</i>	DALLA TORRE & KIEFFER, 1910: 283
	<i>Acer</i> spp.	<i>Periphyllus</i> spp.	<i>Trioxys falcatus</i>	EVENHUIS, 1982: 23

***Phaenoglyphis villosa* (Hartig, 1841)**

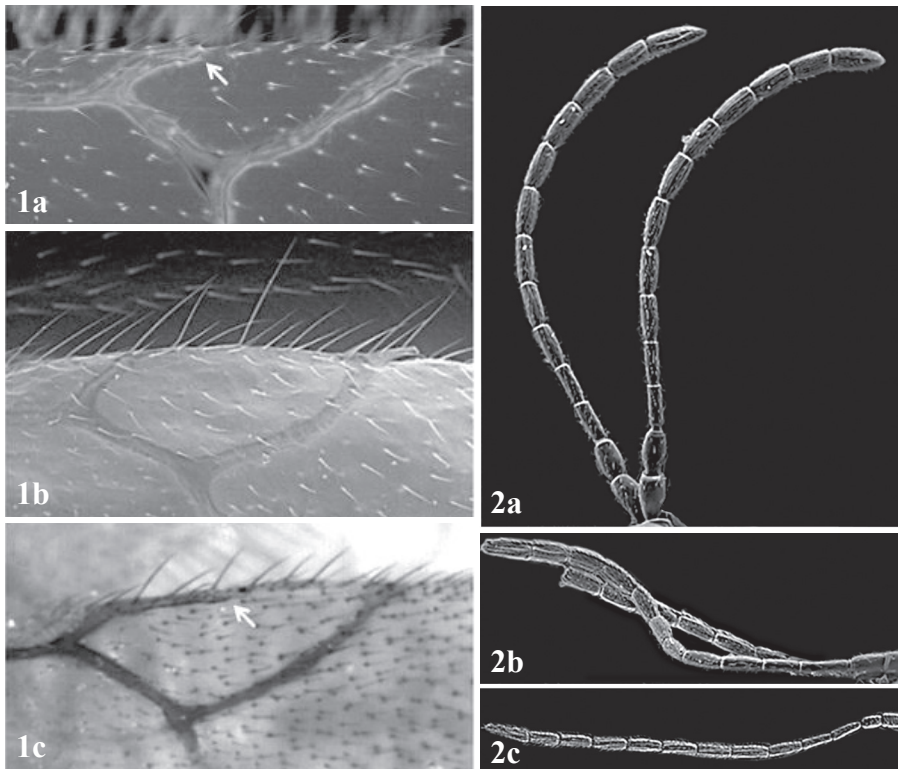
**Diagnosis:** *Phaenoglyphis villosa* is characterized by having partially open radial cell being 2.1–2.7 times as long as wide (Fig. 1c), pronotal and propodeal carinae present, notauli absent, scutellum with two deep oval foveae more or less separated by a carina or completely fused, female antennae with the beginning of rhinaria in F3, F1 as long as pedicel or slightly longer, F1 subequal to F2, F2 shorter than F3, F3 shorter than F4 (Fig. 2c), male antennae with the beginning of rhinaria in F3, F1 subequal to F2, F2 shorter than F3. It is similar to *Phaenoglyphis asiatica* Ferrer-Suay & Pujade-Villar, 2013 and *Phaenoglyphis china* Ferrer-Suay & Pujade-Villar, 2013 but they could be easily differentiated by the presence/absence of scutellar foveae: present in *P. villosa* while they are absent in *P. asiatica* and *P. china*.

**Material examined:** Malta, Msida, 29.iii.2014, 2 ♂♂ & 3 ♀♀, emerged from *Macrosiphoniella* sp. on *Artemisia aborescens* (Vaill.) L. No aphid parasitoid emerged.

**Distribution:** Cosmopolitan (FERRER-SUAY *et al.*, 2012a).

**Hosts:** Refer to table 3.

**Comments:** Despite being a cosmopolitan species known from numerous possible hosts, the aphid *Macrosiphoniella* is a new host for this species.



**Figure 1:** Types of radial cell. **a:** *Alloxysta citripes*; **b:** *A. pilipennis*; **c:** *Phaenoglyphis villosa*.  
**Figure 2:** Types of antenna. **a:** *A. citripes*; **b:** *A. pilipennis*; **c:** *P. villosa*.

**Table 3:** Hosts records for *Phaenoglyphis villosa* (Hartig) extracted from the Charipinae catalogue (FERRER-SUAY *et al.*, 2012a).

Charipinae	Plant	Aphid	Parasitoids	Reference
<i>P. villosa</i>	<i>Sonchus</i> sp.	<i>Aphis</i> sp.	unknown	DE GAULLE, 1908: 26
	<i>Sinapis</i> sp.	<i>Aphis</i> sp.	unknown	
	<i>Aegopodium</i> sp., <i>Alisma</i> sp. and <i>Platanus</i> sp.	<i>Aphis</i> sp.	unknown	
		<i>Aphis ambrosia</i>	unknown	DALLA TORRE & KIEFFER, 1910: 289
	<i>Sinapis alba</i>	<i>Aphis</i> sp.	unknown	DALLA TORRE & KIEFFER, 1910: 269
	<i>Sonchus asper</i>	<i>Aphis</i> sp.	unknown	DALLA TORRE & KIEFFER, 1910: 268
	<i>Platanus</i> sp., <i>Alisma plantago</i> and <i>Aegopodium</i> <i>podagraria</i>	<i>Aphis</i> sp.	unknown	DALLA TORRE & KIEFFER, 1910: 278
	<i>Aulacorthum</i> <i>pelargonii</i>	<i>Myzus ornatus</i> and <i>Rhopalodiphoum</i> <i>padi</i>	unknown	VALENTINE, 1975: 60
	<i>Quercus</i> sp.	<i>Tuberculoides</i> <i>annulatus</i>	<i>Trioxys</i> <i>pallidus</i>	VASILEVA- SUMNALIEVA, 1975: 24
	<i>Berberis</i> sp.	<i>Liosomaphis</i> <i>berberidis</i>	<i>Aphidius</i> <i>hortensis</i>	

Charipinae	Plant	Aphid	Parasitoids	Reference
<i>P. villosa</i>	<i>Quercus robur</i>	<i>Tuberculoides annulatus</i>	<i>Praon flavinode</i>	EVENHUIS & BARBOTIN, 1977: 185
	<i>Acer campestre</i>	<i>Periphyllus</i> sp.	<i>Trioxys falcatus</i>	
	<i>Tilia</i> sp.	<i>Eucallipterus tiliae</i>		
	<i>Malus sylvestris</i>	<i>Rhopalosiphum insertum</i>	<i>Monoctonus cerasi</i>	
	<i>Prunus</i> sp.			
	<i>Phragmites australis</i>	<i>Hyalopterus pruni</i>	<i>Praon volucre</i>	
	<i>Cirsium arvense</i>	<i>Aphis</i> sp.	<i>Lysiphlebus</i> sp.	
	<i>Malus sylvestris</i>	<i>Dysaphis plantaginea</i>	<i>Ephedrus persicae</i>	
	<i>Sinapis arvensis</i>	<i>Brevicoryne brassicae</i>	<i>Diaeretiella rapae</i>	
	<i>Berberis vulgaris</i>	<i>Liosomaphis berberidis</i>	<i>Trioxys hortorum</i>	
	<i>Sonchus asper</i> and <i>Sonchus oleraceus</i>	<i>Hyperomyzus lactucae</i>	<i>Aphidius sonchi</i>	
	<i>Galeopsis tetrahit</i>	<i>Cryptomyzus galeopsidis</i>	<i>Aphidius ribis</i>	
	<i>Rosa</i> sp.	<i>Macrosiphum rosae</i>	<i>Aphidius rosae</i>	
	<i>Campanula</i> sp.	<i>Uroleucon campanulae</i>	<i>Trioxys centaureae</i>	
	<i>Urtica dioica</i>	<i>Microlophium evansi</i>	<i>Aphidius ervi</i>	
	Graminaea	<i>Metopolophium dirhodum</i>	<i>Aphidius uzbekistanicus</i>	
	<i>Poa annua</i>	<i>Rhopalosiphum padi</i>	<i>Ephedrus plagiator</i> , <i>Trioxys auctus</i> and <i>Aphidius</i> sp.	
	<i>Mahonia aquifolium</i>	<i>Liosomaphis berberidis</i>	<i>Aphelinus</i> sp.	
<i>Leontodon</i> sp.	<i>Nasonovia ribisnigri</i>	<i>Aphidius hieraciorum</i>		
<i>Hordeum murinum</i>	<i>Sitobion avenae</i>	<i>Aphidius</i> sp.		

Charipinae	Plant	Aphid	Parasitoids	Reference
<i>P. villosa</i>	<i>Statice</i> sp.	<i>Staticobium</i> sp.	<i>Praon</i> sp.	EVENHUIS & BARBOTIN, 1977: 185
	Cyperaceae	<i>Rhopalosiphum insertum</i>	unknown	
	<i>Lapsana communis</i>	<i>Myzus ornatus</i>	unknown	
	<i>Gomphocarpus fruticosus</i>	<i>Aphis nerii</i>	unknown	
	<i>Artemisia douglasiana</i>	<i>Uroleucon ambrosiae</i>	<i>Lysiphlebus testaceipes</i>	ANDREWS, 1978: 32
	unknown	<i>Myzus persicae</i>	<i>Diaeretiella rapae</i> and <i>Aphidius</i> sp.	HORN, 1984: 19
	unknown	<i>Therioaphis trifolii</i>	<i>Trioxys complanatus</i>	WILSON & SWINCER, 1984: 47
	unknown	<i>Aphis fabae</i>	<i>Ephedrus persicae</i> , <i>Binodoxys angelicae</i> and <i>Lysiphlebus confusus</i>	AL-JASSANI & AL-ADIL, 1986: 59
	unknown	<i>Acyrtosiphon kondoi</i>	<i>Aphidius ervi</i> and <i>Ephedrus plagiator</i>	CARVER, 1992: 770
	unknown	<i>Aphis craccivora</i>	<i>Aphidius colemani</i>	
	unknown	<i>Aphis gossypii</i>	<i>Aphidius colemani</i>	
	unknown	<i>Aphis nerii</i>	<i>Aphidius colemani</i>	
	unknown	<i>Aphis spiraeicola</i>	<i>Aphidius colemani</i>	
	unknown	<i>Brachycaudus helichrysi</i>	<i>Aphidius colemani</i>	
unknown	<i>Brachycaudus persicae</i>	<i>Aphidius colemani</i>		
unknown	<i>Cavariella aegopodii</i>	<i>Aphidius salicis</i>		
unknown	<i>Hyadaphis foeniculi</i>	<i>Aphidius colemani</i>		



Charipinae	Plant	Aphid	Parasitoids	Reference
<i>P. villosa</i>	unknown	<i>Hyperomyzus lactucae</i>	<i>Aphidius sonchi</i>	CARVER, 1992: 770
	unknown	<i>Myzus cerasi</i>	<i>Aphidius colemani</i>	
	<i>Prunus persicae</i>	<i>Myzus persicae</i>	<i>Aphidius colemani</i>	
	unknown	<i>Myzus persicae</i>	<i>Diaeretiella rapae</i>	
	unknown	<i>Myzus persicae</i>	<i>Ephedrus persicae</i>	
	unknown	<i>Rhopalosiphum maidis</i>	<i>Aphidius colemani</i>	
	unknown	<i>Rhopalosiphum padi</i>	<i>Aphidius colemani</i>	
	unknown	<i>Rhopalosiphum padi</i>	<i>Aphidius similis</i>	
	unknown	<i>Therioaphis trifolli</i> f. <i>maculata</i>	<i>Trioxys complanatus</i>	
	unknown	<i>Toxoptera citricidus</i>	<i>Aphidius colemani</i>	HÖLLER <i>et al.</i> , 1993: 15
	unknown	unknown	<i>Aphidius</i> sp., <i>Ephedrus</i> sp., <i>Praon</i> sp. and <i>Trioxys</i> sp.	
	unknown	unknown	<i>Aphidius</i> sp., <i>Praon</i> sp. and <i>Ephedrus</i> sp.	
	<i>Rosa</i> sp.	<i>Macrosiphum rosae</i>	unknown	SUAY <i>et al.</i> , 1998: 106
	<i>Asparagus maritimus</i>	<i>Myzus persicae</i>	unknown	
	<i>Sonchus tenerrimus</i>	unknown	unknown	
unknown	<i>Capitophorus carduinis</i>	unknown	MÜLLER <i>et al.</i> , 1999: 352	
unknown	<i>Sitobion</i> spp.	<i>Aphidius</i> sp., <i>Ephedrus</i> sp. and <i>Aphelinus</i> sp.		

Charipinae	Plant	Aphid	Parasitoids	Reference
<i>P. villosa</i>	<i>Salix caprea</i>	<i>Aphis farinosa</i>	<i>Lysiphlebus confusus</i>	HÜBNER <i>et al.</i> , 2002: 509
	<i>Acer pseudoplatanus</i>	<i>Drepanosiphum platanoidis</i>	<i>Trioxys cirsi</i>	CARVER, 2004: 2
	<i>Rapistrum rugosum</i>	<i>Lipaphis pseudobrassicae</i>	<i>Diaeretiella rapae</i>	
	<i>Quercus canariensis</i>	<i>Myzocallis castanicola</i>	<i>Trioxys tenuicaudus</i>	
	<i>Triticum aestivum</i>	<i>Rhopalosiphum padi</i>	<i>Aphidius colemani</i>	
	<i>Solidago altissima</i>	<i>Uroleucon nigrotuberculatum</i>	<i>Ephedrus plagiator</i>	TAKADA & NAKAMURA, 2010: 270
	unknown	<i>Aphis pisum</i>	unknown	FERRER-SUAY <i>et al.</i> , 2012c: 238
	<i>Nothofagus</i> sp.	unknown	unknown	
	kiwifruit orchard	unknown	unknown	
	<i>Lilium</i> sp.	<i>Macrosiphum euphorbiae</i>	unknown	FERRER-SUAY <i>et al.</i> , 2012d: 40
	<i>Bromus</i> sp.	<i>Rhopalosiphum padi</i>	<i>Lysiphlebus testaceipes</i>	
	<i>Bromus</i> sp.	<i>Metopolophium dirhodum</i>	unknown	
	<i>Bromus</i> sp.	<i>Sitobion avenae</i>	unknown	
	<i>Bromus</i> sp.	<i>Rhopalosiphum padi</i>	unknown	
	<i>Canna</i> sp.	unknown	<i>Aphidius</i> sp.	
<i>Medicago sativa</i>	unknown	<i>Lysiphlebus testaceipes</i>		

## DISCUSSION

Through the study of the above mentioned Charipinae specimens collected from Malta, the distribution patterns of these species have been widened. These three species here identified have a wide distribution range in the Palaearctic region. *Phaenoglyphis villosa* is a very widely distributed species, being cosmopolitan. *Alloxysta pilipennis* was described from Germany and it has been recorded from many Palaearctic countries as well as in the Nearctic and Neotropical regions. It is not yet recorded from Corsica, but its presence in Italy and Malta may suggest that the species may be eventually found also in Corsica. On the other hand, *A. citripes* has been recorded in the three mentioned countries where Charipinae studies have been carried out, and it represents a typical western Mediterranean species.

Prior to this study, few faunistic revisions of Charipinae were carried out in the Mediterranean basin. This subfamily has been recorded from Spain, Corsica, Italy and recently also from Tunisia. In Italy, there are 17 Charipinae species known until now namely *A. arcuata* (Kieffer, 1902), *A. brevis* (Thomson, 1862), *A. castanea* (Hartig, 1841), *A. citripes*, *A. consobrina* (Zetterstedt, 1838), *A. fracticornis* (Thomson, 1862), *A. macrophadna* (Hartig, 1841), *A. melanogaster* (Hartig, 1840), *A. mullensis* (Cameron, 1883), *A. pilipennis*, *A. pusilla* (Kieffer, 1902), *A. ramulifera* (Thomson, 1862), *A. victrix* (Westwood, 1833) and *A. xanthocera* (Thomson, 1862), *P. heterocera* (Hartig, 1841), *P. salicis* (Cameron, 1883) and *P. villosa* (FERRER-SUAY *et al.*, 2014). In Corsica, six species have been recorded namely *A. arcuata*, *A. brevis*, *A. castanea*, *A. citripes*, *A. victrix* and *Apocharipis trapezoidea* (Hartig, 1841) (FERRER-SUAY *et al.*, 2013).

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