

Further contributions to the tritrophic plant-aphid-parasitoid associations in Malta with special reference to *Aphis nerii* (Hemiptera, Aphidoidea) as a prevalent refugium of Aphidiinae (Hymenoptera, Braconidae)

David MIFSUD¹, Mark ZAMMIT² & Petr STARÝ³

ABSTRACT. Four species of aphid parasitoids, namely *Aphidius colemani*, *Binodoxys angelicae*, *Lysiphlebus fabarum* and *Lysiphlebus testaceipes* were reared from *Aphis nerii* on *Nerium oleander* and/or *Stephanotis floribunda* in Malta. *Aphidius colemani* was the most abundant, occurring in different habitat types. *Binodoxys angelicae* represents a confirmation of a doubtful past record, while *Lysiphlebus testaceipes* is a new record for Malta. *Aphis nerii* is evaluated as a refugium of several aphid parasitoids in Malta. *Praon yomenae*, another new record for Malta is also included in the present work.

KEY WORDS. *Aphidius*, *Binodoxys*, *Lysiphlebus*, *Nerium*, *Stephanotis*.

INTRODUCTION

Aphis nerii Boyer de Fonscolombe, commonly referred to as the nerium or the oleander aphid, is reported to be widely distributed throughout the Old and the New World tropics and subtropics including many Pacific islands. Its host plants are mainly members of the Apocynaceae, occasionally also plants in other families, including Asteraceae and Euphorbiaceae (ROBERTI, 1993). The life-cycle of this aphid is mostly anholocyclic (BLACKMAN & EASTOP, 1994).

In Malta, *Aphis nerii* commonly occurs on *Nerium oleander* L. and *Stephanotis floribunda* Brogn.. *Nerium oleander* is a very common shrub, native to the Mediterranean basin and widely cultivated for landscaping purposes in public areas, in both urban and rural settings. It is however rarely naturalised in the wild. The woody climber *S. floribunda* is frequent and generally planted in external enclosures of private and public gardens.

The Aphidiinae are solitary endophagous parasitoids of aphids (STARÝ, 1976). Their research is well-documented for the Mediterranean area and comprehensive studies have been published in the past decades for Italy (STARÝ, 1966), France (STARÝ *et al.*, 1971), the Mediterranean (STARÝ, 1976), Portugal (CECILIO, 1992), Spain (SANCHIS *et al.*, 1995), South-eastern Europe (KAVALLIERATOS *et al.*, 2001, 2004, 2013), Turkey (UYSAI *et al.*, 2004) and North Africa (LAAMARI *et al.*, 2011, 2012) due to an overdriven interest in integrated pest management. The aphid parasitoids of Malta have only been marginally studied and a total of ten confirmed species are known from the mentioned territory (MIFSUD, 1997; MIFSUD & STARÝ, 2009, 2011, 2012).

¹ Department of Biology, Junior College, University of Malta, Msida MSD 1252, Malta. E-mail: david.a.mifsud@um.edu.mt

² 35 Palm Street, Victoria, Gozo, Malta VCT 1307. E-mail: markzammit87@gmail.com

³ Institute of Entomology, Biology Centre of the Academy of Sciences of the Czech Republic, Ceske Budejovice, Czech Republic. E-mail: stary@entu.cas.cz

Aphis nerii are known to exhibit numerous parasitoid guilds (STARÝ & REJMÁNEK, 1981). The parasitoid guild on *A. nerii* in the Mediterranean was originally known to consist of *Aphidius colemani* Vier., *Binodoxys angelicae* (Hal.), *Diaeretiella rapae* (M'Intosh), (?) *Ephedrus persicae* Frog., *Lysiphlebus confusus* Tr. & Eady and *Lysiphlebus fabarum* (Marsh.). The indigenous guild has also been enriched by an exotic species, *Lysiphlebus testaceipes* (Cress.). This latter species, became also associated with *A. nerii* in a similar way as happened in other parts of the world (STARÝ *et al.*, 1988a, b) and its establishment and ongoing expansion has led to significant interspecific changes within the Mediterranean parasitoid guilds (STARÝ *et al.*, 1988b; CECILIO, 1994; MELIÁ, 1993; SUAY & MICHELENA, 1997; STARÝ *et al.*, 2004).

Research on *Aphis nerii*, was aimed to determine its role in trophic food webs, ecosystem relationships and ecologically friendly management of pest aphids in Malta.

MATERIAL AND METHODS

Aphid samples were taken from *Nerium oleander* and *Stephanotis floribunda* in as many locations as possible in the period between 2012 and 2013. Other material examined and presented in this work includes parasitoids from aphids on *Foeniculum vulgare*, *Rumex conglomeratus*, *Setaria* sp. and *Carthamus lanatus*.

Parasitoids were reared from live aphid colonies on branches transferred into suitable plastic bags. They were kept at room temperature until parasitoid emergence. The parasitoids were preserved in 75% alcohol or dried prior to be identified and deposited in the private collections of the authors.

RESULTS

Aphidius colemani Viereck, 1912

Material examined. MALTA: Żejtun, 26.iv.2013, 2 ♂♂ & 2 ♀♀ emerged 29-30.iv.2013, from *A. nerii* on *Nerium oleander*, leg. D. Mifsud; Żejtun, 3.xii.2012, 1 ♂ & 6 ♀♀ emerged from *A. nerii* on *Stephanotis floribunda*, leg. D. Mifsud; Marsa, 24.iv.2013, 3 ♂♂ & 1 ♀ emerged from *A. nerii* on *Nerium oleander*, leg. D. Mifsud; Birkirkara, 23.iv.2013, 43 ♂♂ & 23 ♀♀ emerged from *A. nerii* on *Nerium oleander*, leg. D. Mifsud; Luqa, 8.v.2013, 3 ♂♂ & 3 ♀♀ emerged from *A. nerii* on *Nerium oleander*, leg. M. Zammit; Birżebbuga, 30.v.2012, 1 ♀ emerged from *A. nerii* on *Nerium oleander*, leg. D. Mifsud; Żebbug, iii.2013, 1 ♀ emerged from *Aphis* sp. on *Setaria* sp., leg. L. Cassar.

Notes. *Aphidius colemani* was introduced in Malta (MIFSUD, 1997) for the control of aphids in greenhouse crops, and in 2011 it was also found to be established in the wild (MIFSUD & STARÝ, 2011).

Binodoxys angelicae (Haliday, 1833)

Material examined. MALTA: Mosta, Wied Speranza, 23.iv.2013, 1 ♂ & 2 ♀♀ emerged from *Aphis rumicis* on *Rumex conglomerates*, leg. M. Zammit; Fgura, 23.iv.2013, 1 ♀ emerged from *Aphis nerii* on *Nerium oleander*, leg. M. Zammit.

Notes. The identification of this parasitoid species confirmed its occurrence in Malta, whereas an earlier record by FARRUGIA (1995) was considered erroneous (MIFSUD & STARÝ, 2009). This association is new for Malta.

***Lysiphlebus fabarum* (Marshall, 1896)**

Material examined. MALTA: Żejtun, 26.iv.2013, 2 ♀♀ emerged 29-30.iv.2013, from *A. nerii* on *Nerium oleander*, leg. D. Mifsud; Żejtun, 6.v.2013, 2 ♂♂ & 1 ♀ emerged from *Aphis* sp. on *Foeniculum vulgare*, leg. D. Mifsud.

Notes. This species was previously reported from Malta by MIFSUD & STARÝ (2009, 2012).

***Lysiphlebus testaceipes* (Cresson, 1880)**

Material examined. MALTA: Birzebbuga, 30.v.2012, 3 ♂♂ & 11 ♀♀ emerged from (?) *A. nerii* on *Nerium oleander*, leg. D. Mifsud.

Notes. This species and its association are new for Malta.

***Praon yomenae* Takada, 1968**

Material examined. MALTA: Xemxija, 26.ii.2013, 1 ♂ & 1 ♀ emerged from *Uroleucon* (*Uromelan*) (?) *aeneum*¹ on *Carthamus lanatus*, leg. D. Mifsud.

Notes. This species and its association are new for Malta.

DISCUSSION

Ornamentals plants can provide a multitude of useful applications in ecologically friendly efforts for pest management (KAVALLIERATOS *et al.*, 2013) and the aphidiinae parasitoids have been considered among the most valuable biological control agents (HAVELKA *et al.*, 2012; STARÝ, 1988; BREWER & ELLIOTT, 2004; VOLKL *et al.*, 2007). Recent studies on aphids and their aphidiinae parasitoids in nearby countries (SE Europe) were mainly targeted to crops and little attention has been paid to ornamental shrubs and herbaceous plants (KAVALLIERATOS *et al.*, 2013).

Evidence on the refugial role of some plants has been emphasized in some Mediterranean countries (LUMBIERRES *et al.*, 2005; TOMANOVIĆ *et al.*, 2006, 2008) in particular *Dittrichia viscosa*, *Rubus ulmifolius*, *Vitex agnus-castus* and *Euphorbia characias* subsp. *wulfenii* (KAVALLIERATOS *et al.*, 2002, 2008; HAVELKA *et al.*, 2012). Ornamental shrubs such as *Philadelphus coronarius* (STARÝ, 1991), *Sambucus nigra* (STARÝ & NEMEC, 1986) and *Spirea vanhouttei* (STARÝ, 1995) have also been considered in the Czech Republic, and many others have also been investigated for South-eastern Europe (KAVALLIERATOS *et al.*, 2013). Similar studies have also been undertaken in transatlantic countries such as Chile (STARÝ *et al.*, 1994).

The aphid parasitoid fauna of Malta has been recently reviewed by MIFSUD & STARÝ (2009, 2011). The newly determined as well as the predicted parasitoid associations of *Aphis nerii* have contributed to the inventory of known aphid parasitoids and their associations with aphids and plants in Malta (MIFSUD & STARÝ, 2009, 2011, 2012). This evidence also enables the advance consideration of ecologically friendly approaches to the management of aphid pests in the area.

Aphis nerii is known to heavily infest its host-plants and as everywhere else in the Mediterranean, its colonies often produce extensive covers of sticky honeydew that enhances the growth of blackish

¹ This aphid record is new for the Maltese fauna.

fungal growth. Therefore, on the one hand, the aphids spoil the foliage and blossoms of both *Nerium oleander* and *Stephanotis floribunda*. However, on the other hand, *A. nerii* is not considered as an economically detrimental pest species and, at the same time, it represents a refugium for some parasitoid wasps. The parasitoid guild of *Aphis nerii* in different habitats in Malta supports its potential role as a refugium for aphidiinae parasitoids. However, the resulting parasitoid guild of *A. nerii* has a slightly lower species number when compared to other parts of the Mediterranean, which probably reflects the insular characteristic of Malta.

The possible presence of *Lysiphlebus testaceipes* in Malta was already predicted by MIFSUD & STARÝ (2009) and wherever it was introduced in the Mediterranean region new associations were reported (STARÝ, *Aphis nerii* on *Nerium oleander*, 1987, Italy-Capri, unpublished; STARÝ *et al.* 1996). In Malta, such associations were also confirmed by samples on *A. nerii* collected during the present study. *Lysiphlebus testaceipes* is an exotic parasitoid species of Nearctic origin, which was introduced in Southern France in 1973-74 and has now spread all over the Mediterranean basin (STARÝ, 1976) and towards Iran (RAKSHANI *et al.*, 2005). Updated research results did not prove any host-associated differentiations/lineages in *L. testaceipes* populations in Europe (MITROVIĆ *et al.*, 2013). Its extensive aphid-hosts includes *Aphis helianthi*, *A. gossypii*, *A. ruborum*, *A. spiraeicola*, *A. craccivora*, *A. fabae*, *A. nerii*, *A. urticata*, *A. chloris*, *A. frangulae*, *A. parietariae*, *A. sedi*, *A. solanella*, *A. umbrella*, *Brachycaudus helichrysi*, *Hyadaphis erysimi*, *Rhopalosiphum padi*, *R. maidis*, *Schizaphis graminum*, *Sitobion avenae* and *Toxoptera aurantii* (COSTA & STARÝ, 1988; FRENCH *et al.*, 2001, KAVALLIERATOS *et al.*, 2004). It is worth to mention that *A. nerii* tends to be its most common host aphid in the Mediterranean (STARÝ *et al.*, 1988b). It can be forecasted that the combined occurrence of *A. colemani* and *L. testaceipes* on *Aphis nerii* might significantly contribute to the ecologically friendly management of some aphid pests in Malta. Besides during the present study, *A. nerii* has shown new associations with *Lysiphlebus fabarum* and *Binodoxys angelicae*, and may be expected to be targeted by other parasitoid species that attack other Aphidiinae aphids in Malta (MIFSUD & STARÝ, 2012). *Binodoxys angelicae* is widely distributed in the West Palaearctic including the warmer parts of the Mediterranean and Central Asia (STARÝ, 1976; RAKSHANI *et al.*, 2005; TALEBI *et al.*, 2009; MOSSADEGH *et al.*, 2011; KAVALLIERATOS *et al.*, 2013). Its aphid-host range is very wide and includes *Aphis affinis*, *A. craccivora*, *A. fabae*, *A. gossypii*, *A. hederiae*, *A. nerii*, *A. polygonata*, *A. pomi*, *A. ruborum*, *A. rumicis*, *A. spiraeicola*, *A. spiraeophaga*, *A. umbrella*, *A. viburni*, *A. viticis*, *Brachycaudus helichrysi*, *Hyalopterus pruni*, *Hyperomyzus* sp., *Lipaphis lepidii*, *Myzus persicae* and *Toxoptera aurantii* (ASLAN *et al.*, 2004; ASLAN & KARACA, 2005; KAVALLIERATOS *et al.*, 2008, 2013; TALEBI *et al.*, 2009; MOSSADEGH *et al.*, 2011).

Although not targeted, *Praon yomenae* was reared and identified during the present study. It is known to occur throughout the West Palaearctic and Eastern Asia and represents an oligophagous parasitoid of *Uroleucon* aphids, including *U. aeneum*, *U. cichorii*, *U. cichorii grossum*, *U. doronici*, *U. jaceae* and *U. sonchi* (KAVALLIERATOS *et al.*, 2004; TALEBI *et al.*, 2009).

ACKNOWLEDGMENTS

The contribution by one of us (P. Starý) was conducted with an institutional support RVO:60077344. We also thank Thomas Cassar for donating material mentioned in the present study and Dr Nicolás Pérez Hidalgo (University of Leon, Spain) for the identification of the aphid samples.

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Received: June 30, 2013

Accepted: September 10, 2013