

**REVIEW OF INVASIVE GRAPEVINE APHID, *APHIS ILLINOISENSIS* SHIMER, AND NATIVE PARASITOIDS IN THE MEDITERRANEAN (HEMIPTERA, APHIDIDAE; HYMENOPTERA, BRACONIDAE, APHIDIINAE)**

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**Abstract** — A summary of the study of *Aphis illinoisensis* Shimer on grapes, *Vitis vinifera* in the Mediterranean area brings references and new findings on its distribution in Crete/Greece, Turkey, Northern Cyprus, Malta, Israel, Montenegro, Tunisia, Algeria and Libya. Parasitoids of *A. illinoisensis* were only occasionally found (*Aphidius matricariae* Hal. – Cyprus, Turkey, Greece; *Aphidius colemani* Viereck – Libya; *Lysiphlebus testaceipes* Cress. – Algeria). Of the native species, i.e. *A. colemani*, and others similar to the native species, *L. testaceipes* seem to be a promising biocontrol agent within the framework of an ecologically friendly management in the area. Given the evidence of its expansion, *A. illinoisensis* is expected to expand further in several directions from the recently documented invaded area to all the grape-growing areas of the Mediterranean and even those of South-Eastern and Central Europe.

**Key words:** Invasions, *Aphis illinoisensis*, grapevine, parasitoids, Mediterranean, Libya

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## INTRODUCTION

As is generally known, the attack by pest aphids on grapevines in Europe was restricted for a long time to the occurrence of the Phylloxerid aphid *Viteus vitifolii* (Fitch). Originally an American species which was introduced into Europe between 1851-1862, the *Viteus vitifolii* was a key pest of grapes in many grape-growing countries until the introduction of resistant American varieties (Bournier, 1977).

However, apart from the occasional occurrence of some polyphagous aphid species such as *Aphis*

*gossypii* Glov. and a few others, a new potential pest species of grapes has been detected and has gradually become widespread in the Mediterranean. *Aphis illinoisensis* Shimer, the grape or grapevine aphid, was originally distribution in North, Central and South America (Blackman and Eastop, 2006). In North America, it is a holocyclic dioecious species, with *Viburnum prunifolium* as its primary host and several species of Vitaceae, including *Vitis vinifera*. However, like many other aphids, it manifests an anholocyclic cycle in warmer areas (Blackman and Eastop, 2006; Petrović-Obradović et al., 2010). In some cases, it is reported as a virus vector (Webb et al., 1994 -Water-

melon mosaic virus-2); other references sound adversely for transmission of the virus to grapes (Kuniuki et al., 1995 in Brazil).

## MATERIAL AND METHODS

This study integrates the references as well as our original and/or verified sample records of the grape aphid and its parasitoids in the Mediterranean area, with some background on overseas areas. Samplings from Libya and Greece were carried out during the period of 2008 - 2010. A list of other available published records of the grape aphid and parasitoids from Mediterranean has been created, with a critical review of references. Aphid colonies were inspected on *Vitis vinifera*. Together with plant materials the parasitized aphids were collected and transferred to a laboratory, where they were subsequently maintained until parasitoid emergence. Live aphids were preserved in 90% ethanol and 75% lactic acid at a ratio of 2:1 (Eastop and van Emden, 1972) for identification at a later date (Kavallieratos et al., 2001).

## RESULTS

### *History of invasion*

Remaudiere et al. (2003) reported the occurrence of *A. illinoisensis* for the first time in the Mediterranean in southern Turkey in 2002, and identified it as a new possible threat to the respective grape-growing areas. Further evidence for Turkey includes: Görür (2004a, b), Eser et al. (2008) and Remaudiere et al. (2006).

Thereafter, the grape aphid was detected on the island of Crete, Greece in 2005. At first, it was detected in several localities of the Heraklion Prefecture but within one growing season it was found throughout the island (Tsitsipis et al., 2005; Anagnou-Veroniki et al., 2008; Aggellakis et al., 2005; Kavallieratos et al., 2007). In the aphidofauna of Greece, the grape aphid is exceptional in its North American origin but otherwise shows no special characteristics and consists of species already known from other European countries (Tsitsipis et al., 2007).

A general historical set of invasive grape aphid detection is as follows: 2002 southern Turkey (Remaudiere et al., 2003), 2005 Crete - Greece (Tsitsipis et al., 2005), 2004-2005 Northern Cyprus (Kocadal and Ulusoy, 2006), 2007 Israel (Barjadze and Ben-Dov, 2010 - so far regarded as a minor pest in Israel, besides the occasional occurrence of *A. gossypii*, *A. spiraecola* and *Viteus vitifolii*), 2007 Montenegro (Petrović-Obradović et al., 2010), 2009 Tunisia (Ben Halima Kamel and Mdellel, 2010), 2009 Algeria (Laamari and Coeur d'acier, 2010 - more regions of viticulture). During 2010, grape aphids were sampled frequently at several localities in Libya and Greece and it was reported that viticulture was heavily attacked in targeted areas. Original records in Libya and Greece are as follows: Libya - Zliten, 14.04.2010, Libya - Derna, 07.08.2010, Libya - Misurata1, 08.10.2010, Libya - Misurata2, 11.10.2010, Libya - Misurata3, 13.10.2010, Greece - Kifissia-Attica, 25.09.2008, Greece - Varympompi-Attica, 27.09.2008, Greece - Zeugolatio-Korinthia, 28.09.2008, Greece - Vrahati-Korinthia, 28.09.2008, Greece - Nerantza-Korinthia, 07.08.2010, Greece - Dilessi-Attica- 14.08.2010, Greece-Thessaloniki, 06.09.2010, Greece - Ksylokastron - Korinthia, 14.09.2010.

### *Biology*

The biology of the aphid, including its life cycle occurrence on the infested plants, was generally mentioned in several papers, but useful information has been presented by Sforza, 2008; Petrović-Obradović et al., 2010; Ben Halima Kamel et al., 2010. Barjadze and Ben-Dov (2010) and Petrović-Obradović (2010) also presented a taxonomic treatment and key to the identification of *A. illinoisensis* and similar aphids, which is useful for the whole Mediterranean area.

### *Damage*

The grape aphid could be the only recent serious pest aphid on grapes, causing damage by feeding on leaves, shoots and stems. No virus transmission has been detected to date (see above).

However, another possible though indirect adverse feature of the grape aphid should be mentioned. Sforza (2008) also emphasized the possible role of *Harmonia axyridis*, an exotic coccinellid immigrant to Europe and the Mediterranean, as contributing to the damage on grapes by aggregations in the vineyards. In our opinion, possible interaction between this coccinellid (Berkvens et al., 2010) and *A. illinoisensis* might support their occurrence in the vineyards. Rod (2010) has also classified the presence of this coccinellid as a future problem for grape growers as the smell of the adverse coccinellid penetrates the grapes and thereby decreases their quality.

#### *Parasitoids*

As is usual in such cases, evidence of the parasitoids of the grape aphid in the target area started with no information, developing first through occasional samples followed by targeted research centered either on the aphid itself or, more broadly, on aphid parasitoids and their associations in the individual countries of the Mediterranean. Our evidence is as follows:

*Aphidius colemani* Viereck - Libya - Zliten, 14.04.2010, *Vitis vinifera*, 3 females 1 male (A. H. Shukshuk and M. E. Ghaliow), Libya - Misurata, 11.08.2010, *Vitis vinifera*, 2 females (A. H. Shukshuk and M. E. Ghaliow), new records.

*Aphidius matricariae* Haliday - Northern Cyprus (Kocadal and Ulusoy, in 2004-5, unpublished), Turkey (Barjadze et al. 2011) found a rare parasitization of *A. illinoisensis* by *Aphidius matricariae* in Isparta province. There were big colonies of aphids on the shoots and leaves of the grape but only a single specimen was obtained by rearing - Greece: Attica, 14.08. 2010, *Vitis vinifera*, 3 females (N. Kavallieratos), new record.

*Lysiphlebus testaceipes* (Cress.) - Algeria (Laamari et al. 2010, 2011): a large number of specimens were reared from the sample.

The above listing does not indicate a very intensive and effective adaptation of the local parasitoids to the new exotic immigrant, whereas, in general terms, the *Aphis* aphid hosts are known to support large parasitoid diversity and a rather extensive parasitoid complex (Starý and Rejmanek, 1981) even in the Mediterranean (Starý, 1976; Kavallieratos et al., 2004). *L. testaceipes* was, however, obtained in relatively high numbers in a grape aphid colony in Algeria (Laamari et al. 2010, 2011).

Given the host range of *L. testaceipes* in Cuba, the area of origin of its introduced population (Starý 1968b), and its original area of distribution (North-Central-South America), the positive adaptation to parasitism on grapevine aphid could be expected (Starý 1968a). So far, the abovementioned reference by Laamari et al. (2010, 2011) is the only one, but because of the extensive distribution of *L. testaceipes* in the Mediterranean, similar evidence might be expected also for the other grape-growing countries in the area. In every case, *L. testaceipes* can be classified as a preventative (though unintentional) biocontrol agent in the Mediterranean. Incidentally, this situation also further supports the positive role of *L. testaceipes* in the ecosystems of the Mediterranean, but opposes the classification of this species by EPPO; its removal from the positive list (EPPO/IOBC 2008) should be considered.

## DISCUSSION

### *Further invasion forecast*

The forecast may be elaborated on the grounds of two key background sources: firstly, the up-dated distribution of the grape aphid in North-Central-South America, which manifests a wide range of available climatic conditions; and secondly, the prevailing specificity of the grape aphid for grapes, which, moreover, have been on American rootstocks since the well-known crisis by *Viteus* in the Old World.

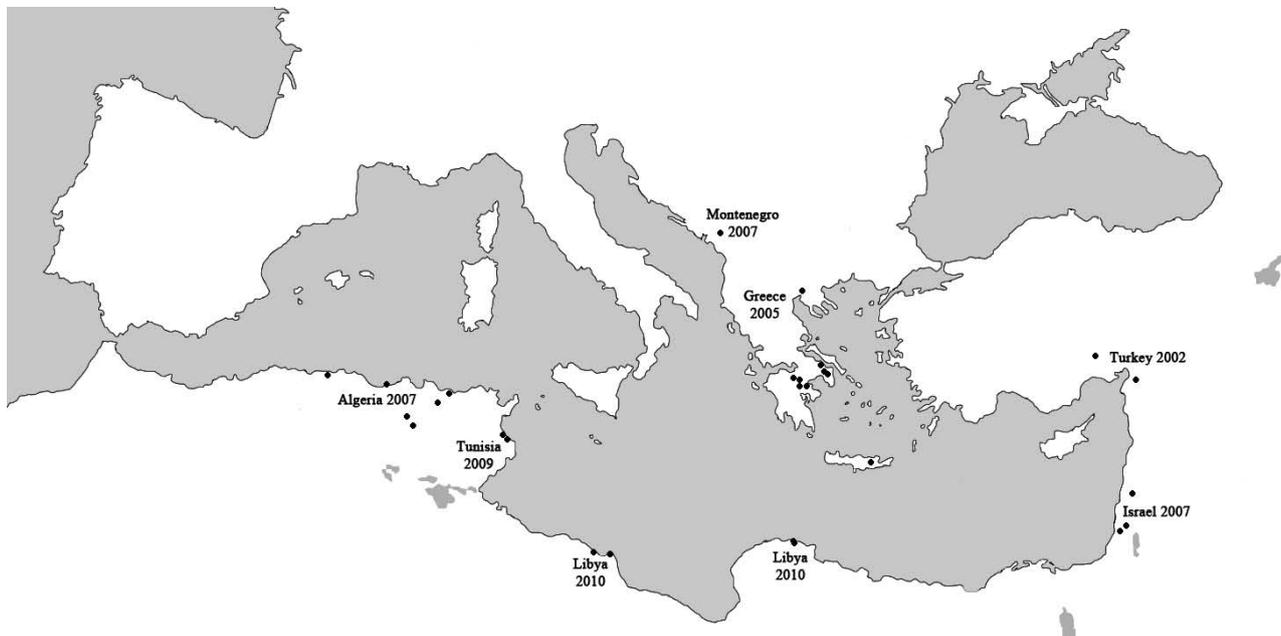


Fig. 1. Present distribution of the grape aphid *Aphis illinoisensis* in the Mediterranean and nearby areas.

An over-all classification of the invasion history, including references to a rather fast expansion in the invaded areas of the grape aphid in the Mediterranean (Tsitsipis et al., 2005; Aggelakis et al., 2005; Laamari et al., 2010; Ben Halima Kamel, 2010; Petrović-Obradović et al., 2010; Coeur d'acier et al., 2010), indicated its on-going further expansion in several directions concerning the grape-growing districts not only in the ancient Mediterranean but also up to Central-Eastern and Central Europe. In our opinion, the next grape-growing areas to be invaded by the grape aphid are as follows (the grape aphid positive countries are free, those predicted are in brackets) (Fig. 1).

1) Turkey – Greece - (Albania) - Montenegro - (Serbia) - (Romania) – (Hungary) - (Slovakia)- (Austria) – (Czech Republic) - (Germany) - (with an adventive branch to northern Italy).

2) Turkey – (Bulgaria) - (Moldova) – (south Ukraine) - (Transcaucasia) - (Iran)

3) Turkey – (Transcaucasia) - (Iran) – (Iraq)

4) Turkey – Cyprus – Israel – (Syria) – (Iraq) – (Iran)

5) Turkey – Crete /Greece – (Malta) - Libya - Tunisia - Algeria - (Morocco) - (Spain, Portugal, southern France, northern Italy). Published evidence suggests the successive/simultaneous detection in Tunisia and later in Algeria, but new detection in Libya favors North Africa, probably via Malta, as the primary source of the aphid invasion.

6) Turkey – Crete/Greece – (Malta) – (Sicily) – (southern Italy).

The hypothetical invasion will probably occur through the winged alatae in both closer and long distances, on the mainland and overseas. The occurrence of the grape aphid on the islands of Crete, Malta and Cyprus supports the long-distance air-borne dispersal over the sea.

To some extent, we might expect similar up-dated expansion patterns like those in the arboricolous Monterey pine aphid, *Essigella californica* (Essig)

(Barbagallo et al., 2006 - Italy; Ben Halima Kamel, 2009 - Tunisia; Aguiar and Ilharco 2001, - Madeira; Fernández and Durante, 1992 - Spain; Turpeau and Remaudiere, 1990 - France) or the Greenideine fig aphid, *Greenidea ficicola* (Tak.) (Starý et al., 2010 - with references for Italy, Malta, Tunisia).

#### *Ecologically friendly management of the grape aphid*

The grape aphid is agreed to be the only recent pest aphid of grapes in the Mediterranean; its host plant range is also restricted to grapes. In this respect, there are no alternate hosts of parasitoids in vineyards. The only opportunity seems to be near to, or within the vineyard environment: weed plants in the vineyards as well as in the nearby ecosystems (roadsides, crops) might have a role. Some similar approaches were proposed by Kavallieratos et al. (2002, 2008) and Starý et al. (2011). *L. testaceipes* might also play a significant role in these associations.

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