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# *Philaenus spumarius* (L.) (Homoptera: Aphrophoridae) and other potential insect vectors of *Xylella fastidiosa* in Western Crete (Greece) olive groves

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**Abstract:** Auchenorrhyncha and especially the xylem fluid-feeders belonging to the families Cicadellidae, Aphrophoridae and Cercopidae have received increasing attention in the last years, particularly in Europe, due to their potential ability to transmit the economically important bacterial pathogen *Xylella fastidiosa*. This is a xylem inhabiting bacterium that causes many diseases around the world, such as the Pierce's disease of grapevine, citrus variegated chlorosis, phony peach disease, alfalfa dwarf and a number of leaf scorch diseases in several plant species. The aim of this work was to identify the most abundant potential vectors of *X. fastidiosa* in olive groves of Western Crete (Chania) in southern Greece, and study their seasonal dynamics and abundance, focusing on *Philaenus spumarius*, considered the main vector of *X. fastidiosa* subspecies *pauca* in Southern Italy. Adult populations of Auchenorrhyncha species were monitored fortnightly from March 2017 to April 2018 using Malaise traps. Moreover, from November 2017 olive canopies, ground vegetation and adjacent natural habitat were swept using sweeping net and aspirator. Collected Auchenorrhyncha were identified and sampling results are herein presented and discussed. Moreover, we discuss differences among sampling methods used as well as habitat-dependent differences in population dynamics of potential vector species in the olive-grove environment. Our results provide new insights into the seasonal abundance of potential vectors of *X. fastidiosa* in olive groves of southern Greece, and are essential in planning an effective IPM strategy against them and prevent the establishment and spread of the pathogen in the area.

**Key words:** Auchenorrhyncha, spittlebug, olives, sampling, population dynamic

## Introduction

Insect-vectors belonging to the suborder Auchenorrhyncha are often the means of transmission of vector-borne bacteria. These species can be leafhoppers (Membracoidea), froghoppers/spittlebugs (Cercopoidea), and planthoppers (Fulgoroidea) (Perilla-Henao and Casteel, 2016). *Xylella fastidiosa*, a xylem inhabiting bacterium, with more than 350 host plant species (EFSA, 2016), has caused many diseases around the world such as the Pierce's disease of grapevine, citrus variegated chlorosis, phony peach disease, alfalfa dwarf and a

number of leaf scorch diseases (Saponari et al., 2014). Recently, *X. fastidiosa* ssp. *pauca*, the main agent causing the so called "Olive Quick Decline Syndrome" (OQDS), was detected in Europe in the province of Lecce Region in Apulia, Italy, affecting about 10000 ha of olive trees (Loconsole et al., 2014; Saponari et al., 2013; 2014). *Xylella fastidiosa* is transmitted by xylem fluid-feeding Auchenorrhyncha (Hemiptera), belonging to the families Cicadellidae, Aphrophoridae and Cercopidae (EFSA, 2015). In contrast to previous perception that only xylem feeding insects can vector *X. fastidiosa* (Purcell, 1989), individuals of the phloem feeder *Euscelis lineolatus* (Brullé) (Hemiptera: Cicadellidae), collected from the infested area of Southern Italy, were found to also be infected by the bacterium (Elbeaino et al., 2014; Ben Moussa et al., 2016). Because *X. fastidiosa* vectors are present throughout the Mediterranean basin and the bacterium colonizes several crop species, the threat of its introduction in Greece is significant. The aim of this work was to identify the most abundant potential vectors of the bacterium in Western Crete (Chania) olive groves and to study their seasonal dynamics focusing on the spittlebug *Philaenus spumarius* (L.) (Hemiptera: Aphrophoridae), considered the main vector of *X. fastidiosa* ssp. *pauca* in Southern Italy (Saponari et al., 2014).

## Material and methods

The samplings took place in 5 olive groves located in 5 different locations of Chania prefecture, a representative olive production region of Southern Greece. All the groves consisted of olive trees of the 'Koroneiki' variety, which is the most commonly cultivated variety in Greece, used for olive oil production also complying with organic standards according to EU legislation (Council Regulation (EC) 834/2007). During the study period, standard cultivating techniques were performed (weed destroying, pruning, irrigation), whereas insecticide spraying applications were not applied. Populations of Auchenorrhyncha species were monitored fortnightly from March 2017 to March 2018 using Malaise traps. Moreover, from November 2017 olive canopies, ground vegetation and adjacent natural habitat were swept using sweeping net and aspirator according to the proposed methodology of EFSA (2017). Captured insects were placed in vials containing 93% ethanol and transported to the laboratory for identification. All adults of Auchenorrhyncha species collected were identified at family and subfamily level. Some abundant leafhopper and spittlebug species were identified at genus or species level. The taxonomic classification of the captured Auchenorrhyncha was based on the keys of Ribaut (1936; 1952), Ossiannilsson (1978; 1981; 1983), Holzinger et al. (2003) and Gnezdilov et al. (2014).

## Results and discussion

A total of 1259 and 568 individuals of Auchenorrhyncha were captured in Malaise traps and sweeping net, respectively, belonging to 5 families (Cicadellidae, Delphacidae, Aphrophoridae, Issidae and Tettigometridae). The highest numbers of Auchenorrhyncha adults were captured in November and December. As illustrated in Figures 1 and 2, the most abundant family in all surveyed olive groves was Cicadellidae, followed by Issidae. Specifically, leafhoppers of the subfamilies Typhlocybinae and Deltocephalinae were the most abundant specimens. Because they primarily feed from the phloem and/or mesophyll tissues, these leafhoppers are not considered potential vectors of *X. fastidiosa*. However, the fact that *X. fastidiosa* was also detected in specimens of *E. lineolatus*, a phloem feeder (Elbeaino et al., 2014; Ben Moussa et al., 2016), leads to the hypothesis that Deltocephalinae leafhoppers can contact xylem vessels during feeding and become infected, too.

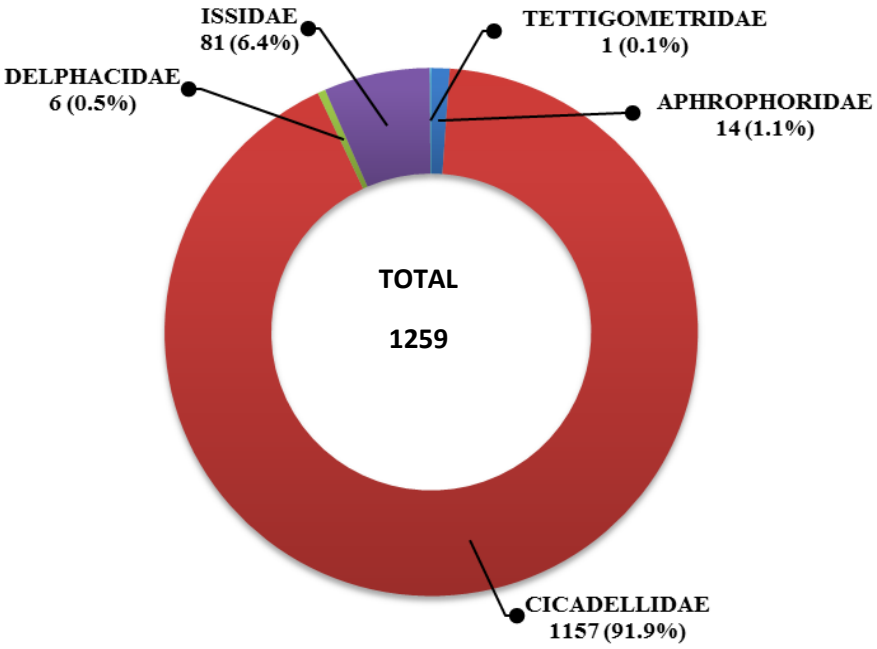


Figure 1. Total number and relevant percentage (in brackets) of captured Auchenorrhyncha individuals per family using Malaise traps from March 2017 to March 2018.

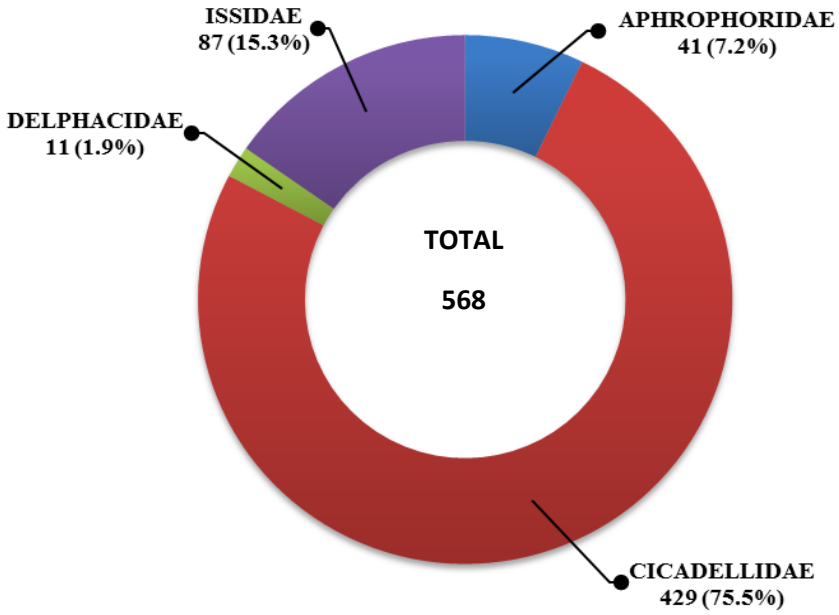


Figure 2. Total number and relevant percentage (in brackets) of captured Auchenorrhyncha individuals per family using sweeping net from November 2017 to March 2018.

According to our data, population density of *P. spumarius* was found to be relatively low, showing one slight peak in November and December. On the contrary, in the infested area of Apulia in Italy, *P. spumarius* was the most abundant Auchenorrhyncha species and

particularly abundant in summer (Ben Moussa et al., 2016). *Philaenus spumarius* was not as frequent in Crete as in Italy. An earlier study has considered *P. spumarius* to be bivoltine or partly bivoltine at elevations lower than 1000m in Greece (Drosopoulos and Asche, 1991). Our ongoing studies will cast light on important features (voltinism and phenology) of the biology, ecology and population dynamics of *P. spumarius* and will help in the establishment of an integrated management system of this pest, an important vector of *X. fastidiosa* in Southern Italy (Saponari et al., 2014).

Malaise traps have not been used in Auchenorrhyncha studies in other Mediterranean countries so far. However, the results of this study clearly suggest that they constitute a very effective tool for studying Auchenorrhyncha mainly of the Cicadellidae family and should be considered in future studies on species composition and abundance in olive groves. In addition, we found that during the study period the Auchenorrhyncha species are more abundant in the ground vegetation than on olive trees and adjacent natural vegetation.

Our results provide new insights into the species diversity, biology, ecology and population dynamics of Auchenorrhyncha potential vectors of *X. fastidiosa*, in olive grove environment of southern Greece, essential to plan an effective IPM strategy against them. Our ongoing studies will enhance the readiness of the country to control the pathogen when required.

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