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Occurrence of *Pachycrepoideus vindemmiae* (Hymenoptera: Pteromalidae) as a parasitoid of *Ceratitis capitata* pupae (Diptera: Tiphritidae) in Syria

Ali YASEEN ALI & Matthias SCHÖLLER

Abstract: The Mediterranean fruit fly *Ceratitis capitata* is an economically important pest in citrus cultures. A survey of Hymenopteran parasitoids attacking *C. capitata* pupae was conducted during May and June 2014 in grapefruit and Valencia orange orchards in Tartous, Syria. Two species of parasitoid wasps emerged from host pupae, namely *Aganaspis daci* (Hymenoptera: Figitidae) and *Pachycrepoideus vindemmiae* (Hymenoptera: Pteromalidae). *P. vindemmiae* is recorded for the first time for Syria. Overall parasitism was 4% and 31% in Valencia orange and grapefruit, respectively. Further studies are now required to evaluate their potential for *C. capitata* population suppression and biological control.

Zusammenfassung: Die Mittelmeerfruchtfliege *Ceratitis capitata* ist ein wirtschaftlich bedeutender Schädling an Zitrusfrüchten. Eine Erfassung von Hymenopteren, die Puppen von *C. capitata* parasitieren wurde im Mai und Juni 2014 in Grapefruit- und Orangenhainen in Tartous, Syrien durchgeführt. Zwei Parasitoidenarten schlüpften aus den Fliegenpuppen, *Aganaspis daci* (Hymenoptera: Figitidae) and *Pachycrepoideus vindemmiae* (Hymenoptera: Pteromalidae). *P. vindemmiae* wird erstmals für Syrien nachgeweisen. Die gesamte Parasitierungsrate betrug 4% im Valencia Orangenhain und 31% im Grapefruit-Hain. Weitere Untersuchungen sind nötig, um das Potential der Nützlinge für die Populationsunterdrückung von *C. capitata* und die biologische Bekämpfung zu bestimmen.

Key words: Hymenoptera, Figitidae, Pteromalidae, Diptera, *Ceratitis capitata*, parasitism, Palaearctic region, Syria.

Introduction

The Mediterranean fruit fly *Ceratitis capitata* (Wiedemann, 1824) (Diptera: Tephritidae), is one of the most polyphagous and economically important pests of edible fruits worldwide (LANCE et al., 2014; OVRUSKI et al., 2003; LIQUIDO et al., 1991). In Syria specifically, *C. capitata* has several generations per year and attacks a large variety of economic fruits (AHMAD et al., 2001). The management of *C. capitata* in citrus orchards was followed by various control attempts including baitspray applications, cultural practices, and mass trapping. However, these do not generally keep the fly populations below economically damaging levels. As *C. capitata* causes economic damage in Syria, a survey for the presence of Hymenopteran parasitoids attacking *C. capitata* in loquat *Eriobotrya japonica* and guava *Psidium guajava* was recently conducted (ALI et al., 2015). In the present study, Hymenopteran parasitoids attacking pupae of *C. capitata* in citrus fruit orchards were surveyed in the coastal area of Tartous, Syria. The aim of this work is to document the species composition of naturally occurring pupal parasitoids of *C. capitata* in this area.

Materials and Methods

Insect samples were collected during May and June, 2014 in the coastal area of Tartous. Pupae of *C. capitata* were collected from soil samples taken in an orange (Valencia) *Citrus sinensis* (L.) Osbeck orchard and in a grapefruit *Citrus paradisi* Macfad. orchard (Fig. 1) (Table 1).

Table 1. Details of field sites and soil samples taken in 2014 to collect pupae of *C. capitata* and their parasitoids

Site name	Crop	Sampling period	No. soil samples	Long.	Lat.	Alt.
Al– Jemaseh	Grape-fruit	May	4	35°58' 39“.64	34°44' 0".74	30.9 m
Al- Sifsafeh	Valencia	June	10	36°02' 52".59	34°43' 58".10	178 m

These fruit crops were selected because they are economically important host plants of *C. capitata* in the Tartous area and had received no prior pest control treatments. Soil samples were all collected from beneath the tree canopy after 60-70% of the fruits had fallen onto the ground. Each soil sample was taken using a hand shovel to a depth of 5 cm from an area of 30 cm × 30 cm. The soil samples were placed in plastic bags, transferred to the laboratory and sieved through a 1 mm mesh to obtain *C. capitata* pupae. The total number of pupae were counted and transferred individually to glass tubes (length 20 cm, diameter 2.5 cm) and incubated at 25 ± 2°C for 60 days. The number of flies and parasitoids emerged, respectively, and the number of remaining non-emerged pupae were recorded daily. Parasitoids were preserved in 95% alcohol and deposited at the Center for Agricultural Research, Tartous.

Fig. 1: Grapefruit *Citrus paradisi* orchard in the coastal area of Tartous, Syria

Parasitoids belonging to the genus *Pachycrepoideus* sp. were identified by using the identification key by LEGNER et al. (1976) and confirmed by Dr. Lars KROGMANN. Specimens belonging to the genus

Aganaspis were compared with specimens deposited at the Agricultural Research Center, Tartous. The level of parasitism was calculated using the method of PETERSEN (1986):

(Total parasitoids that emerged from fly pupae) / total pupae that produced either a fly or a parasitoid) × 100.

Results and Discussion

A total of 255 *C. capitata* pupae were collected from the Valancia and grapefruit orchards, from which 176 *C. capitata* and 35 parasitoids emerged. Two hymenopteran parasitoids were recorded: *Aganaspis daci* (Weld, 1951) (Hymenoptera: Figitidae) and *Pachycrepoideus vindemmiae* (Rondani, 1875) (Hymenoptera: Pteromalidae) (Table 2).

The figitid wasp *A. daci* has been previously reported from Syria by ALI et al. (2015) as the predominant parasitoid of *C. capitata* pupae obtained from guava and loquat fruits. As known to date, *A. daci* has only one host species in Syria, therefore its occurrence is related to the presence of *C. capitata.*

The solitary ectoparasitoid *P. vindemmiae* is attacking pupae of large number of Diptera out of the families Anthomyiidae, Calliphoridae, Muscidae, Tachinidae and Tephritidae (MARCHIORI and BARBARESCO 2007; TORMOS et al., 2009; MARCHIORI et al., 2013; ZHAO et al., 2013). It was first introduced to the Americas from Hawaii in 1955 to control *C. capitata* (CLAUSEN, 1978; OVRUSKI et al., 2000). This species has also been found in Africa and it has been recently recorded from Brazil (MARCHIORI et al., 2003). The species can be readily distinguished by the short marginal vein which is not longer than the stigmal vein. The wing venation is incomplete. There are less than 14 antennomeres. The head and the disc of the pronotum are finely reticulate without noticeable punctures (LEGNER et al., 1976).

In the Valencia orchard, *P. vindemmiae* was the only parasitoid species emerging, i.e. three females and one male, corresponding to a parasitism rate of 2.35 % (Table 2).

In the grapefruit orchard, 25 *A. daci* and six *P. vindemmiae* individuals emerged from the *C. capitata* pupae collected, corresponding to a parasitism rate of 29.41% and 7.05%, respectively. Fifty-six % of emerging *A. daci* were females while the sex ratio in *P. vindemmiae* was 1:1.

Table 2. Number of *Ceratitis capitata* flies or parasitoid wasps emerging from *C. capitata* pupae collected in grapefruit and Valencia orchards during 2014 in Tartous, Syria

Crop	Total pupae	No. (%) flies	No. (%) parasitoids	No. (%) No emergence
Valencia	170	131 (77.05)	4 (2.35)	35 (20.58)
Grapefruit	85	45 (52.94)	31 (36.47)	9 (10.58)
Total	255	176 (69.01)	35 (13.72)	44 (17.25)

This study indicated *A. daci* to be the most abundant species, however, it was found only in Valencia orchard, while the Pteromalid wasp *P. vindemmiae* was recorded in two orchards. We suggest the broad host range of *P. vindemmiae* (HANSON & GAULD, 1995; MARCHIORI & BARBARESCO, 2007) to be advantageous for a wide distribution, as these wasp are able to attack in addition to *C. capitata* pupae many Diptera pupae of other species present in the studied area. However, *C. capitata* might not be an optimum host.

Although *P. vindemmiae* is known to attack pupae of many economically important fruit flies including *Bactrocera cucurbitae* (Coquillett, 1849) (WANG & MESSING, 2004; ZHAO et al., 2013), *B. dorsalis* and *C. capitata* (Wiedemann) (GUILLÉN et al., 2002; MARCHIORI et al., 2003) and it was most widely used for biological control of *Musca domestica* (L., 1758) and *Stomoxys calcitrans* (L., 1758) (MEYER et al., 1990; PETERSEN et al., 1992; TORMOS et al., 2009), concerns were raised against the use of *P. vindemmiae* in traditional biological control programs (WANG & MESSING, 2004). It was suggested to replace it with potential candidate species safer to non-target hosts (GUILLÉN et al., 2002). Its wide host range may lead to an expansion to non-tephritid, native flies (among them critical pollinators) (GUILLÉN et al., 2002) or to tephritid fruit fly parasitoids that are used in biocontrol programs (WANG & MESSING, 2004). In our study, it became not clear whether *P. vindemmiae* emerged from *A. daci*, or *C. capitata* pupae, as both parasitoid species were found together and caused a relative high field parasitism rate in *C. capitata* pupae obtained from infested grapefruit.

We suggest to obtain more information about alternative hosts available for *P. vindemmiae* in the studied area before any attempts to release it against *C. capitata* are undertaken.

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Authors

Dr. Ali Y. ALI
General Commission for Scientific Agricultural Research (GCSAR)
Tartous Research Center
Tartous, Syria
e-Mail:
aligeramny80@yahoo.de

Dr. Matthias SCHÖLLER
Humboldt-Universität zu Berlin
Faculty of Life Sciences
Berlin, Germany
e-Mail:
Matthias.Schoeller@hu-berlin.de