ISRAEL JOURNAL OF ENTOMOLOGY, Vol. 48 (1), pp. 1–6 (30 January 2018)

Tamarixia bicolor Mercet (Hymenoptera: Eulophidae), a parasitoid of *Heterotrioza sahlbergi* (Šulc) (Hemiptera: Psylloidea: Triozidae) in Israel

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ABSTRACT

Tamarixia bicolor Mercet (Hymenoptera: Eulophidae: Tetrastichinae) was collected in Israel for the first time in 2015. *Heterotrioza sahlbergi* (Šulc) (Hemiptera: Triozidae) is now reported as a new host record for this parasitoid. This psyllid species was found in Israel in 1992, feeding on *Atriplex* spp. (Amaranthaceae). A study of *T. bicolor* on this host, including dissections of parasitized immatures of *H. sahlbergi*, has revealed it to be a solitary nymphal endoparasitoid.

KEYWORDS: Parasitic wasps, jumping plant lice, endoparasitoid, immatures, host-parasitoid relationships, Middle East.

INTRODUCTION

Tamarixia bicolor (Hymenoptera: Eulophidae: Tetrastichinae) was originally described from central Spain by Ricardo García Mercet (1924), who collected these parasitoids on the French tamarisk (*Tamarix gallica* Linnaeus, Tamaricaceae) in Seseña, the host insect being unknown at that time.

A redescription of the female and the first description of the male of *T. bicolor* were provided by Graham (1991), who examined the psyllid *Trioza chenopodii* Reuter, 1876 (Hemiptera: Psylloidea: Triozidae) collected in Pakistan on *Chenopodium album* Linnaeus (Chenopodiaceae). Other localities, where this parasitoid-psyllid-plant association has been recorded, include Bulgaria (Graham 1991) and China (Zhu & Huang 2002).

Tamarixia bicolor was first encountered in Israel together with another four congeners, *T. dorchinae* Yefremova & Yegorenkova, 2015, *T. flaviventris* (Kostjukov, 1978), *T. pronomus* (Walker, 1839), and *T. upis* (Walker, 1839) (Burckhardt *et al*. 2015). *Tamarixia bicolor* was collected by Malaise traps and therefore its host(s) in Israel remained unknown.

Here we report the psyllid *Heterotrioza sahlbergi* (Šulc, 1913) (Hemiptera: Triozidae) as a new host record for *T. bicolor*, which was reared at the Steinhardt Museum of Natural History, Tel Aviv University, Israel. The first record of *H. sahlbergi* in Israel was published by Burckhardt and Halperin (1992) as *Trioza sahlbergi*. This psyllid was collected on the halophilous saltbush shrubs *Atriplex halimus* Linnaeus and *A. leucoclada* Boissier (Amaranthaceae) in several regions

http://www.entomology.org.il/publications; ISSN (online) 2224-6304
urn:lsid:zoobank.org:pub:01DEA6F6-0F94-4E3B-A1C9-2D4C1DEF90DB

in Israel, including the Arava Valley, Coastal Plain, Jordan Valley, Dead Sea area, Judean Desert, lower Galilee and northern and central Negev Desert (Spodek *et al.* 2017). Other records of *H. sahlbergi* on *Atriplex* spp. are from Algeria, Italy and Tunisia (Conci & Tamanini 1986). Burckhardt and Halperin (1992) noted that this psyllid occasionally forms leaf galls on the plant host, but we did not observe those on plants collected in the Judean Desert.

MATERIALS AND METHODS

Branches of *Atriplex leucoclada* infested with *Heterotrioza sahlbergi* were collected in Ma'ale Qumeran [31°44'56"N 35°23'21"E, 120 m], Nahal Qumeran, Biq'at Hureqanya, Judean Desert, and placed in glass jars covered with organza fabric, where parasitoids emerged from. Several immature psyllids were photographed and dissected (Figs 1, 2). One leaf was infested by numerous psyllid immatures, several of which had a single emergence hole, indicating that adult parasitoids had already emerged (Fig. 3). In total, 79 females and 30 males of *Tamarixia bicolor* were reared from the 5th instar immatures of *H. sahlbergi* on *A. leucoclada* from 28 Feb. – 8 Mar. 2016. The parasitoids were mounted, measured and photographed with a Leica DFC295 digital camera mounted on a Leica M205C microscope, combining image stacks with Leica Application Suite 4.2.0 and Helicon Focus 5.3.

Fig. 1: Dorsal view of 5th instar immature of *Heterotrioza sahlbergi*.

The final images were edited with Adobe Photoshop CS5. The examined material is deposited in the insect collection of the Steinhardt Museum of Natural History, Tel Aviv University, Israel.

Fig. 2: Female of *Tamarixia bicolor* inside a parasitized 5th instar immature of *Heterotrioza sahlbergi* (dorsal view).

Fig. 3: Emergence hole on the dorsal surface of a 5th instar immature of *Heterotrioza sahlbergi*.

RESULTS AND DISCUSSION

Specimens of *T. bicolor* vary in their body size, with the body length ranging from 0.7–1.1 mm in females and 0.7–0.9 mm in males. Dissections suggest that the parasitoid wasp is a solitary nymphal endoparasitoid. Its body is positioned longitudinally inside the host with the head capsule of the parasitoid directly in line with the head capsule of the psyllid (Fig. 2). A single parasitoid occupies about 77% of the volume of *H. sahlbergi* mummy.

Other aspects of biology and development of *T. bicolor* are unknown. Out of 52 species in the genus *Tamarixia* Mercet, data on the insect or plant hosts of 34 species are lacking (Noyes 2017). Several genera of Psylloidea—*Caillardia* Bergevin (Aphalaridae), *Bactericera* Puton (Triozidae), *Diaphorina* Löw (Liviidae), *Trioza* Förster (Triozidae), and *Heteropsylla* Crawford (Psyllidae)—have been identified as hosts of some *Tamarixia* spp. (Bouček 1988; Graham 1991; Zuparko *et al*. 2011; Yefremova *et al.* 2014).

Most sources report the ectoparasitoid habit of *Tamarixia* spp. (Domenichini 1966*a*; Prinsloo 1984; Onagbola *et al*. 2009; Mann *et al*. 2010; Zuparko *et al.* 2011; Vankovsky & Hoddle 2017). Indeed, only *T. upis* develops as an endoparasitoid in immatures of *Trioza urticae* Linnaeus (Triozidae) (Domenichini 1966*a*, *b*; Kostjukov 1978; Yefremova *et al*. 2007).

Eggs of *Tamarixia* spp. are usually laid on the outside of the host nymph body, normally on its hind leg. Many authors have noted that the larva makes a small hole on the ventral side of the nymph and feeds as an ectoparasitoid (Aubert & Quilici 1984; Aubert 1987; Tang & Aubert 1990). It eventually pupates and, during emergence, it makes a large exit hole in the dorsal wall of the host's thorax (Aubert 1979, 1987; Aubert & Quilici 1984; Tang & Aubert 1990). Consequently we must ask why so many authors refer only to ectoparasitism in *Tamarixia* spp.?

We concur with Mark Hoddle (University of California, Riverside, USA; pers. comm., 24 Oct. 2016), who wrote us the following: "Everybody is calling it an ectoparasitoid but it is not entirely correct. It's really an ecto-endoparasitoid for the following reason. The egg of *Tamarixia* is laid underneath the host nymph, usually on the hind leg. Once the larva hatches, it makes a small hole on the ventral side of the nymph (which you never see afterward because it is underneath the mummy) and goes inside the nymph where it feeds as an endoparasitoid and eventually pupates, and then during emergence makes another, larger exit hole which is easy to see and photograph."

Our reared material and photographs document that *T. bicolor* develops inside the nymph of *H. sahlbergi* as an endoparasitoid. A mechanism of laying eggs on outside of the host or inside it cannot in itself determine the type of parasitism. What is more important is whether the preimaginal development of the parasitoid occurs, inside or outside the host.

ACKNOWLEDGEMENTS

We thank Dr D. Burckhardt (Naturhistorisches Museum, Basel, Switzerland) for helping with identification of the immature psyllids, Mr D. Zakay (Israel Nature and Park Authority) for his help with logistics in accessing the Nature Reserve, and Dr S. Zonstein (Tel Aviv University, Israel) for photographing the specimens featured in this note. Dr S. Triapitsyn (University of California, Riverside, USA) and an anonymous referee provided useful comments on an earlier draft of the manuscript.

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