

Research Article

A survey on hyperparasitoids of the poplar spiral gall aphid, *Pemphigus spyrothecae* Passerini (Hemiptera: Aphididae) in Northwest Iran

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Abstract: A survey was carried out on the hyperparasitoids of the poplar spiral gall aphid, *Pemphigus spyrothecae* Passerini, 1860 in Ardabil province from 2012 to 2013. Two pteromalid species, including *Pachyneuron solitarium* (Hartig, 1838) and *Asaphes suspensus* (Nees, 1834) were reared from the mummified aphids. Both species are hyperparasitoid of *P. spyrothecae* via *Monoctonia vesicarii* Tremblay, 1991 (Hymenoptera: Braconidae, Aphidiinae). *Pachyneuron solitarium* is newly recorded from Iran.

Keywords: *Pemphigus*, *Monoctonia*, *Pachyneuron*, *Asaphes*, new record

Introduction

Aphid hyperparasitoids are found mainly in five families of three superfamilies of Hymenoptera: (i) Figitidae of Cynipoidea; (ii) Encyrtidae, Pteromalidae and Eulophidae of Chalcidoidea; and (iii) Megaspilidae of Ceraphronoidea (Sullivan, 1988). They are all solitary parasitoids except for a few gregarious species, and either endoparasitic or ectoparasitic depending on the family (Sullivan and Völkl, 1999). The family Pteromalidae Dalman, 1820 (Hymenoptera: Chalcidoidea) with more than 3,500 described species ordered in 390 genera (Noyes, 2013) is one of the largest families among parasitic Hymenoptera of the superfamily Chalcidoidea. To date about 145 species of Pteromalidae are recorded from Iran

(Lotfalizadeh and Gharali, 2008; Mitroiu *et al.*, 2011; Hasani *et al.*, 2011; Hasani and Madjdzadeh, 2012; Mahdavi and Madjdzadeh, 2013; Dehdar and Madjdzadeh, 2013). It includes important natural enemies of numerous pest insects, widely distributed in major insect orders such as Coleoptera, Diptera, Lepidoptera, Hymenoptera and Hemiptera (Dzhanokmen, 1989).

Species of the family Pemphigidae are gall forming aphids on different host plants (Blackman and Eastop, 1994), among them species of the genus *Pemphigus* Hartig, 1839 (Pemphiginae) have a specific affinity to poplars (*Populus*-species, Salicaceae) (Whitham, 1980). Over 70 *Pemphigus* species have been described until now, of which 46 are known to form galls on leaves or twigs of *Populus* species (Blackman and Eastop, 1994). Seven species of the family Pemphigidae have been known in Iran in association with poplars as gall makers (Rezwani, 2001). *Pemphigus spyrothecae* Passerini, 1860 is a holocyclic species that develops exclusively on its primary host (Urban, 2002). It is known from

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Poland (Heie, 1980), Hungary, Bulgaria, Romania, Serbia, Croatia (Čamprag *et al.*, 2003), Greece (Ioannidis, 1996), Ukraine and Russia (Pisnya and Fedorenko, 1988). In addition to Europe, there are records from Asian countries including Georgia, Armenia, Kazakhstan (Čamprag *et al.*, 2003) and Iran (Derakhshan-Shadmehri *et al.*, 2001). The specific environment of the closed galls is a habitat inviting specific natural enemies (Rakhshani *et al.*, 2007; Urban, 2002). Ghafouri-Moghaddam *et al.* (2012) previously recorded the aphidiine parasitoid, *Monoctonia vesicarii* Tremblay, 1991 in association with *P. spyrothecae* on *P. nigra* in Iran. Takada *et al.* (2010) reported three chalcidoid species consisting of *Aprostocetus* (A.) *doronokianus* (Kamijo), *Pachyneuron* sp. and *Eupelmus* sp. as hyperparasitoids of *Pemphigus matsumurai* (Monzen) on *Populus maximowiczii* from Japan. The primary parasitoid has also been recorded as *M. vesicarii*. Kurdjumov (1913) reported *Aprostocetus* (A.) *populi* (Kurdjumov) as hyperparasitoid of *P. populinigrae* (Schrank) in Ukraine. In General, the aphid hyperparasitoids are considered to be detrimental for biological control efforts since, they reduce the efficiency of primary parasitoids (Starý, 1970). However, under certain circumstances they may even have a regulatory effect to maintain the balance between population of primary parasitoid and its host aphid (Bennet, 1981; Sullivan, 1988). The objective of the present study was to identify the hyperparasitoid species attacking *Monoctonia vesicarii* in Ardabil province.

Materials and Methods

In order to investigate the occurrence of the aphid hyperparasitoids associated with *Pemphigus* aphids, a survey was carried out during 2012-2013 in Ardabil province, where the poplars are naturally or artificially growing. First author collected leaves with unopened galls from the branches at a height of 2.5 meter from these trees in mid-November 2012 and mid-September 2013 and on the fallen leaves with unopened galls beneath the same trees in late October 2013. The plant material with aphid galls from

Populus nigra was sampled, and it was dissected *in situ* in order to inspect the presence of mummified aphid (Fig. 1). If present, the galls were collected and placed inside small plastic boxes covered with muslin for ventilation. All the materials were subsequently transferred to the nearest location with natural conditions similar to collecting area and monitored until the next year. The emerged parasitoids and hyperparasitoids were carefully collected using an aspirator and placed into 75% ethanol for further examination. External morphology was illustrated using an Olympus™ SZH, equipped with a Canon™ A720 digital camera. The specimens were identified according to the reliable keys and descriptions (Graham, 1969; Doğanlar, 1986) by the second author. Terminology and morphology follow Bouček (1988) and Gibson (2001). The specimens were deposited in the insect collection of the Department of Plant Protection, East-Azerbaijan Research Center for Agriculture and Natural Resources, Tabriz, Iran. General data regarding geographical distribution, biology as well as brief taxonomic comments are given for each species.

Results

Two following pteromalid species were reared from the mummified aphids. Both species were hyperparasitoids of *P. spyrothecae* via *M. vesicarii*.

Asaphes suspensus (Nees, 1834)

Material examined: IRAN, Ardabil province, Ardabil, 38°19'32"N, 48°25'28"E, 1315m, 21.xi.2012; leg.: M. Ghafouri-Moghaddam, 6♀ & 3♂.

Distribution in Iran: It has already been recorded from Iran by Lotfalizadeh and Gharali (2008) from East Azarbaijan province in Northwest Iran and by Mitroiu *et al.* (2011) from Kerman province (Southeast Iran), as well as by Dehdar and Madjdzadeh (2013) from Kurdistan province (Western Iran). There is only one species from this genus in Iran.



Figure 1 The leaf galls of *Pemphigus spyrothecae* on *Populus nigra* (A) and the mummified aphids with emergence hole of the primary and secondary parasitoids (B).

province in Northwest Iran and by Mitroiu *et al.* (2011) from Kerman province (Southeast Iran), as well as by Dehdar and Madjdzadeh (2013) from Kurdistan province (Western Iran). There is only one species from this genus in Iran.

General distribution: *Asaphes suspensus* is widely distributed as a secondary parasitoid of Braconidae (Aphidiinae) in the Holarctic region (Noyes, 2013). Its distribution in the Neotropical region is regarded as doubtful by Gibson and Vikberg (1998) who considered that these records belong to the *P. californicus* complex.

Diagnosis. Head transverse in frontal view (width 1.25 times of height); first funicular segment transverses, second funicular segment ring-like, the rest slightly transverse; metapleuron bare, frenulum of scutellum smooth and shiny; petiole slightly longer than wide, strongly carinate; basal cell of fore wing with two rows of setae, speculum poorly developed, submarginal vein with several setae.

Coloration: Head and mesosoma dark with metallic green luster, legs (except coxae) yellow.

Remark: *Asaphes suspensus* was considered as a synonym of *A. vulgaris* until Graham (1969) revived the species and thus the records published prior to 1969 should be regarded with caution.

***Pachyneuron solitarium* (Hartig, 1838) (Fig. 2)**

Material examined: IRAN, Ardabil province, Ardabil, 38°19'32"N, 48°25'28"E, 1315m,

19.ix.2013; Leg.: M. Ghafouri-Moghaddam, 4♀, 3♂.

Distribution in Iran: New record for Iran.

General distribution: Cosmopolitan.

Diagnosis. This species can be distinguished from the closely related species, *P. muscarum* by the combination of following characters: In *P. solitarium* the anterior margin of the clypeus is slightly produced, the produced part weakly emarginated or subtruncate, and the surface of clypeus only weakly convex, whereas in *P. muscarum* the anterior margin of the clypeus, which is more strongly convex, has a blunt, rounded median projection.

Brief description: Female. (Fig. 2A) Median produced portion of clypeus narrow, with anterior margin slightly emarginate or truncate and its surface virtually flat (Fig. 2D); head in dorsal view with temples rounded posteriorly; scape reaching upper edge of median ocellus, first funicular segment as long as the second, slightly longer than wide, following four segments a little longer than wide, and the sixth segment quadrate or slightly longer than wide; middle lobe of mesoscutum coarsely reticulated, propodeum sloping at a less steep angle, about 45° relative to the tangential plain of the mesoscutum and scutellum, narrowed posteriorly and remarkably produced beyond bases of hind coxae, median area of propodeum longitudinally and broadly elevated, plicae indicated by elevation between basal fovea and spiracular sulcus, so that a V-shaped depression is formed between the median

and lateral elevations, surface of propodeum densely reticulate and without carinae, nucha finely reticulate, with front edge not distinctly defined; fore wing with marginal vein as long as stigmal vein, basal cell with 3–11 setae, speculum closed below; petiole slender; gaster about 1.5 times as long as wide.

Coloration: Head and mesosoma and metasoma metallic green (Fig. 2A); scape yellowish brown or dark brown, pedicel and flagellum dark brown (Fig. 2C); coxae concolorous with thorax; femora dark brown, hind coxae usually with metallic reflections,

the rest of legs yellowish brown, with tibiae sometimes infusate.

Body length 1.4–2.1 mm.

Male. Differs from the female in the antennae, gaster and darker coloration (Fig. 2B); flagellum as long as width of head, with longer setae; first funicular segment as long as or sometimes slightly longer than the second, 1.7–1.9 times as long as wide; sixth funicular segment shorter than preceding segments, 1.2 times as long as wide; gaster shorter and depressed.

Body length 1.2–1.9 mm.



Figure 2 *Pachyneuron solitarium*: (A): female in lateral view, (B): male in lateral view, (C): female antenna, (D): clypeus in frontal view (E): Head in lateral view.

Discussion

Species of the genus *Asaphes* occur in the Palaearctic, Oriental, Nearctic, and Neotropical regions. *Asaphes suspensus* is a generalist hyperparasitoid of four to five genera of Aphidiinae and Aphelinidae (Hymenoptera) primary parasitoids (Chow and Mackauer, 1999). It has also been regarded as a tertiary parasitoid of other aphid hyperparasitoids (Carew and Sullivan, 1993). Many aphid genera are recorded in association with *A. suspensus* (Noyes, 2013). Many species of the genus *Pachyneuron* are hyperparasitoids of Aphididae (Hemiptera) or of other plant sucking Hemiptera (Coccoidea, Psylloidea) through their Braconidae (Ichneumonidae) or Aphelinidae and Encyrtidae (Chalcidoidea) primary parasitoids, and some are recorded as pupal parasitoids of mining or gall forming Diptera or as egg parasitoids of several families of Lepidoptera (apparently as hyperparasitoids) (Gibson, 2001; Noyes, 2013).

A wide range patterns of host association have already been recorded for *P. solitarium* including hyperparasitoids of aphids, coccids and also eggs of *Dendrolimus* spp. (Lep.: Lasiocampidae). It has been recorded as parasitoid or hyperparasitoid of Lepidoptera (Lasiocampidae, Lymantriidae), Hymenoptera (Aphelinidae, Braconidae, Encyrtidae, Scelionidae and Trichogrammatidae) and Hemiptera (Aphididae) as well as Coleoptera (Coccinellidae) (Noyes, 2013). According to Orlov (1962), this species parasitizes *Ooencyrtus* (Hym.: Encyrtidae), *Trichogramma* (Hym.: Trichogrammatidae) and *Telenomus* (Hym.: Scelionidae) which are the main egg parasitoids of *Dendrolimus sibiricus* Tschetverikov, 1908. Hirose (1969) also reported that it is a hyperparasitoid of the eggs of *D. spectabilis* (Butler, 1877) through *Trichogramma dendrolimi* Matsumura, 1926 and/or *Telenomus dendrolimi* (Matsumura). Bouček (1965) considered that *P. solitarium* is synonymous with *P. concolor* and the host range is surprisingly wide. On the contrary, Graham (1969) stated that these two species are distinct

from each other based on morphological characters and on the host range. He also stated that the host range of *P. solitarium* is restricted to the eggs of *Dendrolimus* spp., whereas *P. muscarum* is parasitic on the coccids. Our findings have indicated that *P. solitarium* is not restricted to *Dendrolimus*, but it is also represented as an aphid hyperparasitoid. An unknown species of *Pachyneuron* has already been recorded from Italy as a hyperparasitoid of *Pemphigus vesicarius* on *P. nigra* through *M. vesicarii* (Tremblay, 1991). *Pachyneuron* nr *leucopiscida* Mani was also recorded as hyperparasitoid of Pistachio gall making aphid, *Smynturoides betae* (Westwood, 1849) through *Monoctonia pistaciaecola* Sary, 1962 (Wool and Burstein, 1991).

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بررسی هیپرپارازیتوئیدهای شته گال مارپیچی صنوبر *Pemphigus spyrothecae* Passerini (Hem.: Aphididae) در ایران

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چکیده: این مطالعه به منظور شناسایی هیپرپارازیتوئیدهای شته گال مارپیچی دمبرگ صنوبر، *Pemphigus spyrothecae* Passerini, 1860 طی سال‌های ۹۱-۱۳۹۰ در اردبیل انجام گرفت. دو گونه زنبور از خانواده Pteromalidae شامل *Pachyneuron solitarium* (Hartig, 1838) و *Asaphes suspensus* (Nees, 1834) از شته‌های مومیایی شده پرورش یافتند. هر دو گونه هیپرپارازیتوئید شته *P. spyrothecae* هستند که توسط زنبور پارازیتوئید اولیه، *Monoctonia vesicarii* Tremblay, 1991 برای اولین بار از ایران (Hym., Braconidae, Aphidiinae) پارازیت شده بودند. گونه *P. solitarium* گزارش می‌شود.

واژگان کلیدی: *Pemphigus*, *Pachyneuron*, *Asaphes*, *Monoctonia*، گزارش جدید