

## Parasitoids of *Heterogynis* Rambur (Lepidoptera: Zygaenoidea, Heterogynidae)

Vladimir Žikić<sup>1</sup>, Saša S. Stanković<sup>1,\*</sup>, Hans-Peter Tschorsnig<sup>2</sup>, Yeray Monasterio León<sup>3</sup> and Josef J. De Freina<sup>4</sup>

<sup>1</sup> Faculty of Sciences, Department of Biology and Ecology, University of Niš, Višegradska 33, 18000 Niš, Serbia

<sup>2</sup> Staatliches Museum für Naturkunde, Rosenstein 1, 70191 Stuttgart, Germany

<sup>3</sup> Asociación Española para la Protección de las Mariposas y su Medio (ZERYNTHIA) Madre de Dios, 14-7D. 26004. Logroño, La Rioja, Spain

<sup>4</sup> Museum Witt, Tengstraße 33, 81541 München, Germany

\*Corresponding author: sasasta@gmail.com

Received: July 9, 2018; Revised: August 28, 2018; Accepted: August 31, 2018; Published online: September 26, 2018

**Abstract:** Nine parasitoids of the moth genus *Heterogynis* are presented: six species of Hymenoptera from the families Chalcididae, Eulophidae and Ichneumonidae (*Agrothereutes hospes* (Tschek), *Baryscapus endemus* (Walker), *Brachymeria inermis* (Fonscolombe), *Diplazon laetatorius* (F.), *Itopectis maculator* (F.) and *Trichomalopsis heterogynidis* Graham), and three Diptera, family Tachinidae (*Compsilura concinnata* (Meigen), *Exorista segregata* (Rondani) and *Phryxe hirta* (Bigot)). Two of these species, *Trichomalopsis heterogynidis* and *Phryxe hirta*, are oligophagous parasitoids specialized on the genus *Heterogynis*. We also identified two newly recorded parasitoids of *Heterogynis*: *Brachymeria inermis* (Chalcididae) and *Diplazon laetatorius* (Ichneumonidae).

**Key words:** *Heterogynis*, parasitoids, Chalcidoidea, Ichneumonidae, Tachinidae.

### INTRODUCTION

*Heterogynis* Rambur is the only genus within the family Heterogynidae Hampson and it comprises about 15 species [1-3], distributed in Europe and the Maghreb region of North Africa. The best known and well-investigated species is certainly *H. penella* (Hubner), which is nowadays considered a species complex with geographically isolated populations in spatially narrowly-defined habitats [4]. Data on the parasitoids of *Heterogynis* have been published in a few papers [5-7], while some sporadic information can be found in Herting [8], Ford and Shaw [9], and Ford et al. [10].

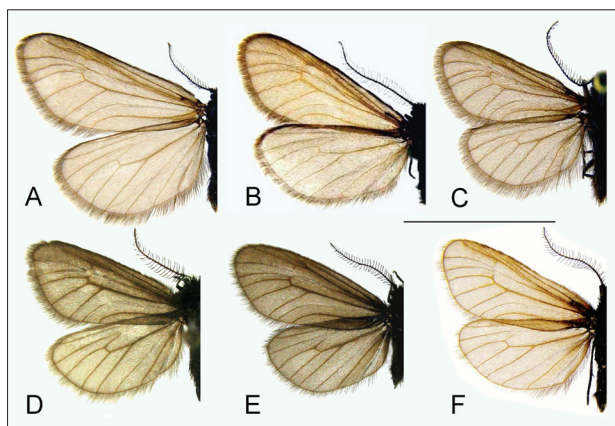
*Heterogynis* species are usually not considered as agricultural or forest pests, apart from the newly described *H. zikici* de Freina, which was observed to defoliate almost completely *Chamaecytisus heuffelii* on the Vlasina Plateau, Serbia, in 2016. In a previous work, Žikić et al. [7] cited the *Heterogynis* species found in Serbia as *H. sondereggeri* de Freina, but it was subsequently identified as spec. nov. *H. zikici* [11].

However, most *Heterogynis* parasitoid communities have not been studied yet in detail.

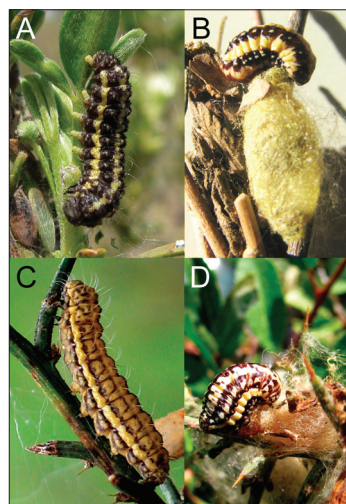
Herein we present all known parasitoids that have been reared from *Heterogynis* species, revealing relevant information on their biology, other hosts and distribution.

### MATERIALS AND METHODS

Of about 15 *Heterogynis* species recorded in the Western Palearctic, we observed six of them where parasitoids were registered: *H. paradoxa* Rambur, (Fig. 1 A), *H. canalensis* Chapman, (Fig. 1 B, Figs 2 C, D), *H. penella* (Hubner) (Fig. 1 C), *H. chapmani* de Freina (Fig. 1 E), *H. zikici* de Freina (Fig. 1 D, Fig. 2 A) and *H. eremita* Zilli, Cianchi, Racheli and Bullini (Fig. 1 F). To present the parasitoid community of *Heterogynis* we combined literature and original data. Parasitoids were reared in laboratory conditions from previously caught *Heterogynis* larvae. The larvae were put into plastic containers covered with muslin cloth to allow



**Fig. 1.** Six *Heterogynis* species registered as hosts for nine parasitoids: *H. paradoxa*, Central Spain (A), *H. canalensis*, northeast Spain (B), *H. penella*, France, Hautes Alpes (C), *H. zikici*, Serbia (D), *H. chapmani*, Central Spain (E), *H. eremita*, Southern Italy, Abruzzo (F). Scale bar represents a length of 10 mm.



**Fig. 2.** *H. zikici*, 3<sup>rd</sup> instar (A), *Heterogynis* sp. cf. *zikici*, female with cocoon, Romania (B), *H. canalensis*, adult instar, Northern Spain (C) (photo E. Murria Beltran), *H. canalensis*, female on her cocoon (left), beside that the white cocoon (right), parasitized by Pteromalidae, Northern Spain (D).

ventilation. Ecloded parasitoids were subsequently collected and conserved in 98% ethanol. The information used from the articles is cited in the Introduction. The compiled results are presented in Table 1. Original data are marked with an asterisk (\*).

## RESULTS

In total, we list nine parasitoids from the orders Hymenoptera and Diptera. From the order Hymenoptera, there were six parasitoid species from four families: Chalcididae: *Brachymeria inermis* (Fonscolombe) (Fig. 3A); Eulophidae: *Baryscapus endemus* (Walker) (Fig. 3B); Ichneumonidae: *Agrothereutes hospes* (Tschek) (Fig. 3D); *Diplazon laetatorius* (F.) (Fig. 3F), *Itopectis maculator* (F.) (Fig. 3E), and Pteromalidae: *Trichomalopsis heterogynidis* Graham (Fig. 3C). Species from the family Tachinidae (Diptera) are *Compsil-*

*ura concinnata* (Meigen) (Fig. 3G), *Exorista segregata* (Rondani) (Fig. 3H) and *Phryxe hirta* (Bigot) (Fig. 3I).

The trophic associations established between parasitoids and *Heterogynis* species are given in Table 1.

## Short notes on biology and distribution of parasitoids

### Chalcididae

#### \**Brachymeria inermis* (Fonscolombe) (Fig. 3A)

This is a primary koinobiont parasitoid of larvae from the following taxa: Coleoptera, Chrysomelidae: *Cassida nebulosa* (L.), *C. nobilis* (L.), *C. rubiginosa* Müller, *C. viridis* L., *Metriona thais* Spaeth; Lepidoptera, Coleophoridae: *Zagulajevia tadhikiella* Danilevsky; Geometridae: *Apocheima cinerarius* Erschoff; Nymphalidae: *Vanessa* spp. F.; Tortricidae: *Apotomis lutosana* Kennel, *Spilonota ocellana* (Denis and Schiffermüller)

**Table 1.** List of parasitoids of *Heterogynis* species found in Europe.

Parasitoid	<i>Heterogynis</i> species [Country where found]
<i>Brachymeria inermis</i> (Chalcididae)*	<i>H. zikici</i> [Serbia]
<i>Baryscapus endemus</i> (Eulophidae)	<i>H. penella</i> [?]
<i>Agrothereutes hospes</i> (Ichneumonidae)	<i>H. zikici</i> [Serbia]
<i>Itopectis maculator</i> (Ichneumonidae)*	<i>H. penella</i> [Italy]
<i>Diplazon laetatorius</i> (Ichneumonidae)*	<i>H. zikici</i> [Serbia]
<i>Trichomalopsis heterogynidis</i> (Pteromalidae)	<i>H. penella</i> cf. [France, Romania]; <i>H. zikici</i> [Serbia]
<i>Compsilura concinnata</i> (Tachinidae)	<i>H. canalensis</i> [Spain]; <i>H. penella</i> [France]
<i>Exorista segregata</i> (Tachinidae)	<i>H. chapmani</i> , <i>H. paradoxa</i> [Spain]
<i>Phryxe hirta</i> (Tachinidae)	<i>H. canalensis</i> [Spain]; <i>H. chapmani</i> , [Spain]; <i>H. paradoxa</i> [Spain]; <i>H. penella</i> [Italy, France, Spain]; <i>H. ?penella</i> [Italy]; <i>H. ?penella</i> [Germany]; <i>H. zikici</i> [Serbia]

[12,13]. Also, this species behaves as a hyperparasitoid attacking primary parasitoids from the family Braconidae (Hymenoptera): *Bracon telengai* (Muljarskaya), *Aleiodes bicolor* (Spinola) and *A. rossicus* (Kokujev).

Distribution: Austria, Croatia, Czech Republic, France, Hungary, Italy, Former Yugoslav Republic of Macedonia, Romania, Serbia, Slovakia, Spain (mainland and Balearic Islands) and also Turkey, the Near East and the Oriental region [12,14,15].

New material collected: ♀2, Serbia, Vlasinsko Jezero (lake), 1200 m, 22.06.2017, on *Chamaecytisus heuffelii*. This is a newly recorded parasitoid for the genus *Heterogynis* emerged from the pupae of *H. zikici*.

## Eulophidae

### *Baryscapus endemus* Walker (Fig. 3B)

This is a broad oligophagous parasitoid attacking various insects belonging to numerous genera and families from different orders. From Coleoptera, Curculionidae: *Cionus hortulanus* (Geoffroy), *C. scrophulariae* (L.), *Hypera postica* Gyllenhal, *Orchestes fagi* (L.), *O. quercus* (L.), *Stereonychus fraxini* (De Geer); Hemiptera, Coccidae: *Sphaerolecanium prunastri* (Boyer de Fonscolombe), Kermesidae: *Kermes quercus* L.; Lepidoptera, Coleophoridae: *Coleophora alticolella* Zeller, *C. deauratella* Lienig and Zeller, Geometridae: *Peribatodes rhomboidaria* (Denis and Schiffermüller), Gracillariidae: *Phyllonorycter corylifoliella* (Hubner), *Ph. pyrifoliella* (Gerasimov), *Parornix petiolella* Frey, *Phyllocnistis citrella* Stainton, Noctuidae: *Apterogenum ypsilon* (Denis and Schiffermüller), Notodontidae: *Thaumetopoea pityocampa* (Denis and Schiffermüller), Oecophoridae: *Agonopterix alpigena* (Frey), Tortricidae: *Clavigesta purdeyi* (Durrant), *Rhyacionia buoliana* (Denis and Schiffermüller), Yponomeutidae: *Argyresthia conjugella* Zeller, *Scythropia crataegella* (L.) [13].

This species also parasitizes primary parasitoids from several other hymenopteran families: Eurytomidae: *Bruchophagus gibbus* (Boheman), *B. platypterus* (Walker), *Eurytoma onobrychidis* Nikol'skaya, Braconidae: *Apanteles lacteus* (Nees), *Diolcogaster alvearia* (F.), *Eubazus minutus* (Ratzeburg), *Pholetesor circumscriptus* (Nees), *Triaspis fagi* (Ratzeburg), Encyrtidae: *Holcothorax testaceipes* (Ratzeburg), *Litomastix kriebbaumeri* Mayr, Eulophidae: *Elachertus olivaceus* Thomson, Ichneumonidae: *Diadegma* sp., Pteromalidae: *Mesopolobus subfumatus* (Ratzeburg), *Pteromalus* sp., *Trichomalus* sp.

Distribution: Austria, Bulgaria, Czech Republic, England, Denmark, France, Germany, Hungary, Iran, Ireland, Moldova, Netherlands, North Ireland, Norway, Poland, Russia (Ulyanovsk Oblast), Serbia, Spain (mainland), Sweden, Switzerland, Turkey, Ukraine.

## Ichneumonidae

### *Agrothereutes hospes* (Tschek) (Fig. 3D)

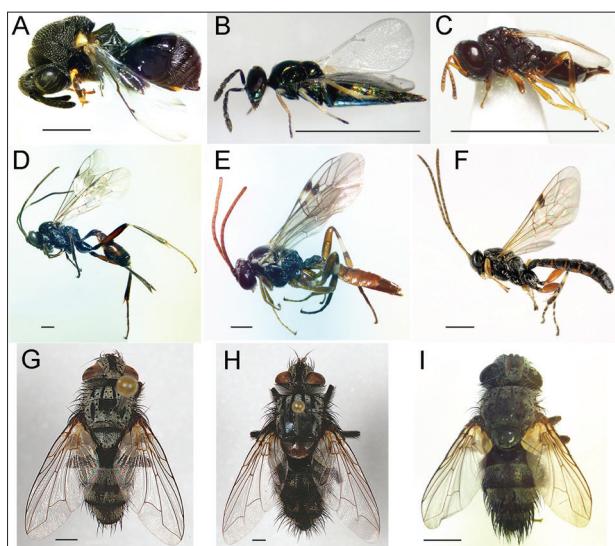
This is the primary solitary larval/pupal ectoparasitoid of *Heterogynis zikici* de Freina (in Žikić et al. [7] cited as *H. sondereggeri*) where females oviposit in mature larvae or prepupae and adults emerge from pupae. *Agrothereutes hospes* is an oligophagous parasitoid attacking several hosts, mostly from the family Zygaenidae [16,17]. The other known lepidopteran hosts are Notodontidae: *Drymonia ruficornis* (Hufnagel) [18], Lasiocampidae: *Eriogaster lanestris* (L.), Psychidae: *Canephora hirsuta* (Poda) [19], Pyralidae: *Galleria mellonella* (L.), [20], Erebidae: *Lymantria dispar* (L.) [21], Saturniidae: *Saturnia spini* (Denis and Schiffermüller), [22], Tortricidae: *Sparganothis pilleriana* (Denis and Schiffermüller) [23] and Lycaenidae: *Lycaena dispar* (Haworth). This parasitoid has been recorded only from *H. zikici*.

Distribution: Austria, Belgium, Bulgaria, Corsica, Czech Republic, Finland, France, Germany, Gibraltar, Hungary, Iran, Italy, Latvia, Moldova, Norway, Poland, Romania, Serbia, Spain (mainland), Sweden, Switzerland, Turkey, United Kingdom.

### \**Diplazon laetatorius* (Fabricius) (Fig. 3F)

This is a cosmopolitan solitary larval/pupal parasitoid that is the best known from aphidophagous syrphids, but also from many other dipterous hosts, and sporadically from Coleoptera and Lepidoptera [24-30]. Females oviposit in early larval instars, while adults emerge from the host's pupae; parthenogenesis is the main kind of reproduction [26]. According to literature data, males have been found rarely in North America and India [31]. In the host list of *D. laetatorius* there are about 80 species, mainly from Syrphidae (53 species), the rest are from Diptera families: Anthomyiidae (1), Muscidae (2), lepidopterans: Depressariidae (1), Gelechiidae (1), Lymantridae (1), Noctuidae (2), Plutellidae (1), Pyralidae (4), Tortricidae (5), coleopterans: Curculionidae (1) Chrysomelidae (2), even Diprionidae (1) and Pamphiliidae (1) from the order Hymenoptera. For detailed information see Yu et al. [17].





**Fig. 3.** Parasitoids of six *Heterogynis* species found in Europe: *Brachymeria inermis* (A), *Baryscapus endemus* (B), *Trichomalopsis heterogynidis* (C), *Agrothereutes hospes* (D), *Itopectis maculator* (E), *Diplazon laetatorius* (F), *Compsilura concinnata* (G), *Exorista segregata* (H), *Phryxe hirta* (I). Scale bars below each species image represent a length of 1 mm.

Distribution: present on all continents except Antarctica [17].

New material collected: ♀1, Serbia, Vlasinsko Jezero (lake), 1200 m a.s.l., 22.06.2017, on *Chamaecytisus heuffelii*.

#### ***Itopectis maculator* (Fabricius) (Fig. 3E)**

*Itopectis maculator* is a typical pupal solitary endoparasitoid in which eggs are laid in host pupae where larvae finish the development and metamorphosis, and afterwards the adults eventually emerge. The first record of *I. maculator* was recorded from *Heterogynis penella* in Italy [5]. This polyphagous species has already been recorded from about 120 lepidopterans, attacking more than 50 species from the family Tortricidae: e.g. *Pandemis heparana* (Denis and Schiffermüller) and *Tortrix viridana* L., Yponomeutidae: e.g. *Yponomeuta evonymella* (L.), Pieridae: *Pieris brassicae* L., several Erebididae: *Lymantria dispar* and *Orgyia antiquoides* (Hubner), also Zygaenidae species such as *Zygaena laeta* (Hubner), *Z. filipendulae* (L.), *Z. lonicerae* (Scheven), species from Lepidoptera families Geometridae, Noctuidae, Coleophoridae and several others [5,17]. *Itopectis maculator* has also been reported from some coleopterans, Chrysomelidae, Curculionidae and from hymenopterans, Diprionidae:

*Diprion pini* (L.). This parasitoid species is known to be a facultative hyperparasitoid of Braconidae: e.g. *Aleiodes pallidator* (Thunberg) and *Macrocentrus linearis* (Nees) and about a dozen Ichneumonidae, such as *Phytodietus polyzonias* (Förster) and *Hyposoter tricolor* (Ratzeburg) [17].

Distribution: Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, Canary Islands, Corsica, Croatia, Czech Republic, Denmark, Estonia, Finland, France, FYR of Macedonia, Georgia, Germany, Greece, Hungary, Iran, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Mongolia, Montenegro, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Spain (mainland), Sweden, Switzerland, Tunisia, Turkey, Ukraine, United Kingdom [17].

#### **Pteromalidae**

##### ***Trichomalopsis heterogynidis* Graham (Fig. 3C)**

*Trichomalopsis heterogynidis* has been recorded as a primary parasitoid of two species of *Heterogynis*, *H. penella* [32] from France and Romania (de Freina; personal observation) and from *H. zikici* (in Žikić et al. [7] as *H. sondereggeri*). *Trichomalopsis heterogynidis* is also a hyperparasitoid of the tachinid species *Phryxe hirta* [7,13,32].

Distribution: France, Romania and Serbia.

New material collected: Serbia, Vlasinsko Jezero (lake), 1200 m a.s.l., [30.6.2016, ♂30, ♀63]; [22.06.2017, ♂22, ♀33], leg. V. Žikić and S. S. Stanković.

#### **Tachinidae**

##### ***Compsilura concinnata* (Meigen) (Fig. 3G)**

This polyphagous larval parasitoid is native to Europe and introduced in the USA. It attacks more than 200 host species, mainly from Lepidoptera, Erebididae: e.g. *Euproctis chrysorrhoea* (L.), *Leucoma salicis* (L.), *Lymantria dispar*, Pieridae: *Pieris brassicae* (L.), *P. rapae* (L.) Lasiocampidae: *Malacosoma neustria* Hubner, Nymphalidae: *Aglais milberti* (Godart), *Nymphalis antiopa* (L.), *N. vaualbum* (Denis and Schiffermüller) and also some Noctuidae, Geometridae, Papilionidae, Saturniidae, etc., and from Coleoptera, Curculionidae: *Pissodes* Germar and sawflies families such are Cimbicidae, Diprionidae, Pamphiliidae, Tenthredinidae [33].

Distribution: *Compsilura concinnata* is recorded throughout Europe, except for Belarus, Estonia, Fin-

land, Iceland, Latvia, Lithuania and Norway. It is also widespread in Russia and Asia: China, Georgia, India, Indonesia, Iran, Israel, Japan, Korea, Lebanon, Pakistan and Turkey. In Africa, it is only recorded from Morocco, in America from Barbados, Canada and USA, and also in Australia [34-37].

### ***Exorista segregata* (Rondani) (Fig. 3H)**

This fly is only recorded from two species of *Heterogynis*, *H. canalensis* and *H. paradoxa* from Spain. The species is recorded from over 50 lepidopteran species such as: Pieridae: *Aporia crataegi* (L.), *Pieris brassicae*, [38]; Erebididae: *Leucoma salicis*, *Euproctis chryssorrhoea* (L.), Noctuidae: *Acronicta rumicis* (L.), *Sesamia nonagrioides* (Lefebvre), *Spodoptera exigua* (Hubner), Erebididae: *Lymantria dispar* (L.), *Utetheisa pulchella* (L.), Lasiocampidae: *Malacosoma neustria* (L.), *Dendrolimus pini* (L.), *Psilogaster loti* (Ochsenheimer), Notodontidae: *Thaumetopoea pityocampa* (Denis and Schiffermüller), *T. solitaria* (Freyer), *T. wilkinsoni* Tams, *Phalera bucephala* (L.) [35-37].

Distribution: Egypt, France, Hungary, Italy, Lebanon, Luxembourg, Morocco, Russia, Sardinia, Serbia, Spain (mainland), Turkey, Tunisia, USA [15,35,36].

### ***Phryxe hirta* (Bigot) (Fig. 3I)**

This species is a specialized parasitoid of the genus *Heterogynis* [6]. It has already been collected from several *Heterogynis* species: *H. penella* recorded in France, ex *H. eremita*, *H. penella* and *H. ?penella*, from Italy; ex *H. chapmani* and *H. paradoxa* from Spain [6,36] and ex *H. zikici* from Serbia [7,39]. Distribution: There are only a few records of this European species: Czech Republic, France, Italy, Serbia and Spain (mainland). [7,15,35,36, 39].

## **DISCUSSION**

This contribution to parasitoids of the largely under-investigated genus *Heterogynis* represents the first comprehensive compilation of data and new, original records. Of nine parasitoids listed in Table 1, seven have already been reported in several countries. The two newly recorded parasitoids are *Brachymeria inermis* and *Diplazon laetatorius*, both emerging from pupae of *H. zikici*. The finding of *D. laetatorius* as a parasitoid of *H. zikici* could be an erroneous record,

because some experts emphasize that this parasitoid is specialized to parasitize only hover flies [30]. On the other hand, *D. laetatorius* has also been sporadically reported from some Coleoptera and Lepidoptera [26-28]; see the list of other host families in the results.

According to our results it seems that *Phryxe hirta* is a generalist with regard to *Heterogynis* species, since it was found on seven taxa, considering *H. penella* as a different taxon.

From the nine species we report as parasitoids of *Heterogynis* species, seven are more or less common parasitoids of many other lepidopteran host. However, two species, *Trichomalopsis heterogynidis* and *Phryxe hirta*, specialize in only parasitizing *Heterogynis* species. Nevertheless, *T. heterogynidis* can hyperparasitize *P. hirta* when they find themselves in the same host individual.

We can say with some certainty that the specimen of *Diplazon laetatorius* emerged from one of the collected pupae of *H. zikici* since we collected the caterpillars and pupae by hand. However, there exists a small possibility that a syrphid larva came in the rearing box with the branches of the host plant. Considering that the sampling site for this species is accessible to authors of this article, we can investigate if the host range of *D. laetatorius* also includes other insect groups, except Syrphidae.

**Funding:** This research was supported by Grant III43001 of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

**Acknowledgments:** We are grateful to Dr. Lydia Mitits from the Democritus University of Thrace, Komotini, Greece and Antonis Mylonopoulos, Komotini, Greece for the English language proof-reading. We also thank Enrique Murria Beltrán, Aineto (Huesca, Spain), who provided us with photo material.

**Author contributions:** All the authors participated in the research and article preparation. Vladimir Žikić wrote the manuscript, Hans-Peter Tschorsnig identified tachinid flies, Josef J. De Freina identified *Heterogynis* species. Vladimir Žikić and Saša S. Stanković identified wasp species. Yeray Monasterio León provided material from Spain and the photographs of *Heterogynis*.

**Conflict of interest disclosure:** The authors declare that they have no conflict of interest.

## REFERENCES

- de Freina JJ. Zur Kenntnis der Biologie und Taxonomie von *Heterogynis andalusica* Daniel, 1966 sowie ergänzende Bemerkungen zum Status von *Heterogynis thomas* Zilli, 1987 stat. rev. *Atalanta*. 2003a;34(1/2):179-92. German.
- de Freina JJ. *Heterogynis jellaba* sp. n. und *Heterogynis rifen-sis* sp. n., zwei neue nordafrikanische *Heterogynis*-Arten aus Marokko mit ergänzenden Bemerkungen zum Verbreitungsbild und Artenspektrum der Gattung *Heterogynis* Rambur, 1837. *Atalanta*. 2003b;34(1/2):193-208. German.
- de Freina JJ. Heterogynidae auf dem Balkan, mit Beschreibung von *Heterogynis sondereggeri* sp. n. aus den Hochlagen des Peloponnes (Lepidoptera: Zygaenoidea, Heterogynidae). *Nachr Entomol Ver Apollo*. 2012;33(2/3):129-38. German.
- de Freina JJ. Die Artengruppe von *Heterogynis penella* (Hubner, 1819) auf der Iberischen Halbinsel, mit Beschreibung der zentralspanischen *Heterogynis chapmani* sp. n. (Lepidoptera: Zygaenoidea, Heterogynidae). *Nachr Entomol Ver Apollo*. 2014;34(4):185-94. German.
- de Freina JJ. Erstnachweis von *Itopectis maculator* (F.) als parasitoide Ichneumonidae (Pimplinae) von *Heterogynis penella* (Hubner, 1819) (Lepidoptera, Zygaenoidea, Heterogynidae; Hymenoptera, Ichneumonidae). *Atalanta*. 2004;35:117-8. German.
- de Freina JJ, Tschorsnig HP. Raupenfliegen (Diptera: Tachinidae) aus *Heterogynis* spp. (Lepidoptera: Heterogynidae). *Nachr Bl Bayer Entomol*. 2005;54(3/4):95-100. German.
- Žikić V, Stanković SS, Hric B, Mitroiu MD, Schwartz M, Tschorsnig HP. First records of parasitoids of the orders Hymenoptera (Ichneumonidae and Pteromalidae) and Diptera (Tachinidae) from *Heterogynis sondereggeri* de Freina, 2012 (Lepidoptera: Heterogynidae). *Acta Zool Bulg*. 2015;67(3):385-88.
- Herting B. Biologie der westpaläarktischen Raupenfliegen (Diptera: Tachinidae). *Monogr Angew Entomol*. 1960;16:1-188. German.
- Ford TH, Shaw MR. Host records of some west palaeartic Tachinidae (Diptera). *Entomol Rec J Var*. 1991;103:23-38.
- Ford TH, Shaw MR, Robertson DM. Further host records of some west Palaeartic Tachinidae (Diptera). *Entomol Rec J Var*. 2000;112:25-36.
- de Freina JJ. Faunistische Studie zur *Heterogynis penella* (Hubner, 1818-1819) Artengruppe auf der Balkanhalbinsel mit der Beschreibung von *Heterogynis zikici* nov. sp. (Lepidoptera: Zygaenoidea, Heterogynidae). *Entomofauna*. 2018;39(1):59-71.
- Madl M. Zur Kenntnis der Familie Chalcididae (Hymenoptera: Chalcidoidea) in Österreich. *Entomofauna*. 2008;29(4):69-80.
- Universal Chalcidoidea Database [Internet]. London: Natural History Museum. [modified 2018 Mar; cited 2018 Jan 20] Available from: <http://www.nhm.ac.uk/chalcidoids/>.
- Doğanlar M. Notes on Chalcidoidea of Turkey, I. Chalcididae, Eurytomidae, Torymidae, Ormyridae, Perilampidae, Eucharitidae. *Turk Entomol Derg*. 1984;8(3):151-8.
- Fauna Europaea, all European animal species on the web [Internet]. Berlin: Museum für Naturkunde, Biodiversity Data Journal 2, e4034. 2000- [cited 2017 Dec 25]. Available from: <http://www.faunaeur.org/>.
- Schwarz M, Shaw MR. Western Palaearctic Cryptinae (Hymenoptera: Ichneumonidae) in the National Museums of Scotland, with nomenclatural changes, taxonomic notes, rearing records and special reference to the British check list. Part 1. Tribe Cryptini. *Entomol Gaz*. 1998;49:101-27.
- Yu DS, van Achterberg C, Horstmann K. *Taxapad 2012, Ichneumonoidea 2011* [DVD]. Ottawa, Ontario, Canada Dicky Sick Ki Yu; 2012.
- Constantineanu MI, Pirvescu D, Mihalache G. Contribution to the study of Ichneumonidae, parasites of *Drymonia ruficornis* Hufnagel, a dangerous defoliator of oak trees from forestry plantation in Perisor, Segarcea and Craiova (Dolj region). *Studii si Cercetari de Biologie Seria Zoologie*. 1979;31(2):127-30. Romanian
- Šedivý J. Príspevek k poznani hostitelu lumku I. Zprávy Československé Společnosti Entomologické pri CSAV. 1965;1:6-13.
- Gurbuz MF, Kolarov J, Aksoylar MY, Akdura N. A survey of the *Agrothereutes hospes*, an ectoparasitoid on wax moth *Galleria mellonella*. *J Pest Sci*. 2006;79(1):31-4.
- Russo G. I principali parassiti dei lepidotteri defogliatori forestali in Italia. *Boll Lab Entomol Agrar Portici*. 1959;17:172-88.
- Mocsáry A. Hymenoptera parasitica educata in collectione Musaei nationalis Hungarici. *Természetrájsi Füzetek*. 1895;18:67-72.
- Vidal S. Determination list of entomophagous insects. Nr. 13. IOBC-WPRS Bulletin. 1997;20(2):1-8.
- Rotheray GE. Emergence from the host puparium by *Diplazon pectoratorius* (Gravenhorst) (Hymenoptera: Ichneumonidae), a parasitoid of aphidophagous syrphid larvae. *Entomol Gaz*. 1981a;32(1):39-41.
- Rotheray GE. Host searching and oviposition behaviour of some parasitoids of aphidophagous Syrphidae. *Ecol Entomol*. 1981b;6(1):79-87.
- Fitton MG, Rotheray GE. A key to the European genera of diplazontine ichneumon-flies, with notes on the British fauna. *Syst Entomol*. 1982;7(3):311-20.
- Rotheray GE. Host relations, life cycles and multiparasitism in some parasitoids of aphidophagous Syrphidae (Diptera). *Ecol Entomol*. 1984;9(3):303-10.
- Greco CF. Specificity and instar preference of *Diplazon laetatorius* (Hymenoptera: Ichneumonidae) parasitizing aphidophagous syrphids (Diptera: Syrphidae). *Entomophaga*. 1997;42(3):315-8.
- Lingu-Constantineanu CŞ. Parasitoid ichneumonids (Hymenoptera) of some defoliator Tortricidae moths in Bârnova forest massif, Iași county. *Buletin de informare Societatea Lepidopterologică Română*. 2009;20:39-42.
- Klopfstein S. Revision of the Western Palaearctic Diplazontinae (Hymenoptera: Ichneumonidae). *Zootaxa*. 2014;3801(1):1-143.
- Gauld ID, Wahl DB, Bradshaw K, Hanson P, Ward SL. The Ichneumonidae of Costa Rica: Introduction and Keys to Species of the Smaller Subfamilies, Anomaloninae, Ctenopelmatinae, Diplazontinae, Lycorininae, Phrudinae, Tryphoninae (excluding *Netelia*) and Xoridinae, with an Appendix on the Rhysinae. *Mem Am Entomol Inst*. 1997;57:1-485.

32. de V Graham MWR. New Chalcidoidea (Insecta: Hymenoptera) mainly from France, including several species of *Eurytoma* and *Pteromalus* associated with *Euphorbia*. *J Nat Hist*. 1984;18(4):495-520.
33. Arnaud PH. Host Parasite Catalog of North American Tachinidae (Diptera). Washington: United States Department of Agriculture; 1978. 860 p. (Miscellaneous publication; no. 1319).
34. Greathead DJ, Greathead AH. Biological control of insect pests by insect parasitoids and predators: the BIOCAT database. *Biocontrol*. 1992;13(4):61-8.
35. Tschorsnig HP. Tachinidae (Diptera) recorded from the Swiss National Park and adjacent areas, collected by Fred Keiser. *Mitt Schweiz Entomol Ges*. 1997;70(1/2):101-16.
36. Tschorsnig HP. Preliminary host catalogue of Palaearctic Tachinidae (Diptera). *First version*. [Internet]. North American Dipterists Society; 2017 [cited 2017 Dec 20]. 480 p. Available from: [http://www.nadsdiptera.org/Tach/World-Tachs/CatPalHosts/Cat\\_Pal\\_tach\\_hosts\\_Ver1.pdf](http://www.nadsdiptera.org/Tach/World-Tachs/CatPalHosts/Cat_Pal_tach_hosts_Ver1.pdf).
37. CABI: Invasive Species Compendium [Internet]. Wallingford: CAB International. [cited 2017 Dec 25]. Available from: <http://www.cabi.org/isc/>.
38. Razmi M, Karimpour Y, Safaralizadeh MH, Safavi SA. Parasitoid complex of cabbage large white butterfly *Pieris brassicae* (L.) (Lepidoptera, Pieridae) in Urmia with new records from Iran. *J Plant Prot Res*. 2011;51(3):248-51.
39. Stanković SS, Žikić V, Hric B, Tschorsnig HP. Several records of Tachinidae (Diptera) reared from their hosts in Serbia and Montenegro. *Biologica Nyssana*. 2014;5(1):71-3.