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Parasitoid Wasps (Hymenoptera: Chalcidoidea) Associated with *Bruchophagus astragali* Fedoseeva (Hymenoptera: Eurytomidae) and *Bruchidius marginalis* (Fabricius) (Coleoptera: Chrysomelidae) on *Astragalus glycyphyllos* L. (Fabaceae) in Bulgaria

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Abstract: The seed-eater wasp *Bruchophagus astragali* Fedoseeva, 1954, seed beetle *Bruchidius marginalis* (Fabricius, 1775) and a great diversity of associated parasitoid wasps were reared from fruits of liquorice milkvetch *Astragalus glycyphyllos* L. (Fabaceae) in Bulgaria. The following species of Chalcidoidea were identified: *Baryscapus endemus* (Walker) and *Pediobius bruchicida* (Rondani) (Eulophidae); *Anastatus* sp., *Eupelmus confusus* Al khatib, *E. barai* Fusu, *E. messene* Walker and *E. vesicularis* (Retzius) (Eupelmidae) and *Dinarmus acutus* (Thomson), *Pteromalus sequester* Walker and *Pteromalus* sp. cf *semotus* (Walker) (Pteromalidae). New associations with both seed-feeding species and also with liquorice milkvetch were found for many of the reared parasitoids.

Key words: liquorice milkvetch, chalcidoid parasitoids, seed wasp, seed beetle, new hosts, new associations.

Introduction

The genus *Bruchophagus* Ashmead, 1888 (Hymenoptera: Chalcidoidea: Eurytomidae) is represented in the world fauna with more than 165 species. Among them, 90 species have a Palaearctic distribution (Noyes 2019). All species are phytophagous (Bouček 1988, La Salle 2005) and develop mainly as seed-feeders of legume plants of the family Fabaceae (Zerova et al. 2021), with a few species known as gall inducers on citrus trees (La Salle 2005).

Bruchophagus astragali Fedoseeva, 1954 is a species whose larvae feed inside seeds of different species of *Astragalus* L. (Fabaceae) (Popescu 2009). It is reported in Bulgaria, Georgia, Germany, Hungary, Iran, Kazakhstan, Mongolia, Romania, Russia, Sweden, Turkey, Turkmenistan and the former USSR (Zerova et al. 2021). This seed-eater wasp is associated with five chalcidoid parasitoids belonging to the families Eulophidae, Eurytomidae and Pteromalidae (Mitroiu & Andriescu 2003, Perju 2005, Haghighian & Sadeghi 2010, Zerova et al. 2021).

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The genus *Bruchidius* Schilsky, 1905 (Coleoptera: Chrysomelidae: Bruchinae) includes about 300 species of seed beetles and is widely distributed in the Old World. Some of them have been introduced to territories outside their native area (Kingsolver 2004, Stojanova 2010). These beetles attack and damage seeds and pods of some edible, medicinal, and ornamental legumes and wild forest plants (Arora 1980). Their larvae develop mainly in leguminous plant seeds and less often feed on representatives of the plant families Apiaceae and Asteraceae (Borowiec 1987). Other species of the genus are used as biological control agents against some invasive plant species (Derbel et al. 2007, López-Núñez et al. 2020).

Bruchidius marginalis (Fabricius, 1775) is found in various countries, from Spain and Latvia to the Caucasus (Delobel & Delobel 2007). Recently, this beetle was also recorded from the territory of the Republic of Khakassia (Lopatina & Lukyantsev 2023). It belongs to the *Bruchidius astragali* species group whose larvae live and feed on the seeds of various *Astragalus* spp. (Borowiec 1985). The imago is anthophagous (Alekseev & Bukejs 2011) and flies from April to September (Schott 2004). To date, *B. marginalis* has been recorded as a host of nine hymenopterous parasitoids belonging to the families Eupelmidae and Pteromalidae (De Luca 1965, Vidal 1997, Dzhanokmen 2017, Pérez-Benavides et al. 2019).

The genus *Astragalus* L. is the most diverse in the family Fabaceae and comprises 2300 to 2900 described species (Castillón et al. 2023). They are annual and perennial plants with a wide range of applications (fodder, food, medicine, ornamental plants, etc.) (Amiri et al. 2020). The liquorice milkvetch, *Astragalus glycyphyllos* L., is a perennial herbaceous plant widely distributed throughout Europe and the temperate regions of Asia (Gnat et al. 2014). In Bulgaria, it grows mainly in dry grassy places, forests and scrub up to 1800 m a.s.l. in mountainous regions (Valev 1976, Stoyanov et al. 2021).

The aim of this study is to present a list of parasitoids associated with *B. astragali* and *B. marginalis* in Bulgaria.

Materials and Methods

This study was undertaken in 2019. Over 850 clusters of dry fruits of *A. glycyphyllos* were collected from two localities in the Kyustendil region [W of Lelintsi vill. (42.22797°N / 22.72602°E, 800 m) and Eremia vill. (42°12′53.8″N / 22°50′11.3″E,

Table 1. Parasitoid wasps reared from the fruits of *Astragalus glycyphyllos* L. in Bulgaria.

		Number of individuals				
Family	**Parasitoid species**	**W of Lelintsi vill. 18.VIII.2019**		**Eremia vill. 22.VIII.2019**		**Percentage of total**
		♀♀	♂♂	♀♀	♂♂	♀♂
Eulophidae	*Baryscapus endemus* (Walker, 1839)	110	36	-	-	5.47
	Pediobius bruchicida (Rondani, 1872)	16	1	-	-	0.63
Eupelmidae	*Anastatus* sp.	2	1	-	-	0.11
	Eupelmus confusus Al khatib, 2015	33	11	-	-	1.64
	Eupelmus barai Fusu, 2017	246	48	-	-	11.01
	Eupelmus messene Walker, 1839	3	-	-	-	0.11
	Eupelmus vesicularis (Retzius, 1783)	17	-	-	-	0.63
Pteromalidae	*Dinarmus acutus* (Thomson, 1878)	41	8	9	1	2.21
	Pteromalus sequester Walker, 1835	312	130	1	-	16.59
	Pteromalus sp. cf *semotus* (Walker, 1834)	1048	591	3	1	61.55

600 m)]. The plant material containing host insects and their parasitoids was placed in plastic bottles covered with fine white cheesecloth and stored under laboratory conditions at a temperature of 26-27° C until all emergences had ceased. The emerged insects were aspirated with a exhaustor, fixed in ethyl alcohol and later examined under a stereo microscope.

The species were identified using the keys of Bouček (1965), Graham (1969, 1991), Kalina (1981), Borowiec (1985, 1987), Decelle (1989), Rasplus (1989), Bouček & Rasplus (1991), Zerova & Seryogina (1994), Zerova (1995), Gibson & Fusu (2016) and Fusu (2017).

The examined material is deposited in the authors' collections (University of Plovdiv and Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences).

The photos of the pteromalids were taken using a Canon EOS 200D digital camera attached to a Zeiss Stemi 508 doc stereo microscope. The remaining insects were photographed using a Leica EZ4 W stereo microscope with an integrated 5.0 megapixel CMOS WiFi Camera. The images were processed through Zerene Stacker and Helicon Focus 8.0 software and subsequently edited in Adobe Photoshop to enhance clarity.

Results

During this study, 1198 specimens of *B. astragali* (Fig. 1) and 111 specimens of *B. marginalis* (Fig. 2) were reared, along with 2669 specimens of parasitoid wasps belonging to ten species of three Chalcidoidea families (Eulophidae, Eupelmidae and Pteromalidae) (Table 1, Figs 3-12).

With the exception of *P. sequester*, all parasitoids are newly associated with *B. astragali*. New associations with *B. marginalis* were established for all parasitoids except *E. vesicularis*, *D. acutus,* and *P. sequester*. The plant associations with *A. glycyphyllos* are newly recorded here for *B. endemus*, *P. bruchicida*, *Anastatus* sp., *E. confusus* and *Pteromalus* sp. cf *semotus*.

Discussion

The review of the literature sources shows that five chalcidoid parasitoids in Eulophidae, Eurytomidae and Pteromalidae have been recorded as associated with *B. astragali*, and nine in Eupelmidae and Pteromalidae with *B. marginalis* (Tables 2, 3).

All recorded parasitoids, except *D. acutus*, are polyphagous and have a wide range of hosts.

Baryscapus endemus (Fig. 3) attacks many species of Coleoptera (Curculionidae), Hemiptera (Coccidae and Kermesidae), Hymenoptera (Eurytomidae), Lepidoptera (Coleophoridae, Geometridae, Gracillariidae, Heterogynidae, Noctuidae, Notodontidae, Oecophoridae, Tortricidae and Yponomeutidae). Moreover, it can develop as a hyperparasitoid of some Hymenoptera species belonging to Braconidae, Encyrtidae, Eulophidae, Ichneumonidae and Pteromalidae) (Graham 1991, Noyes 2019). In the order Coleoptera, it has been associated only with hosts in the family Curculionidae (Noyes 2019). In Eurytomidae, its known hosts are *Bruchophagus gibbus* (Boheman), *Bruchophagus platypterus* (Walker), *Bruchophagus roddi* Gussakovskiy and *Eurytoma onobrychidis* Nikolskaya (Graham 1991, Perju 2005).

Pediobius bruchicida (Fig. 4) has been recorded as a primary parasitoid of numerous phytophagous insects belonging to Coleoptera (Chrysomelidae and Curculionidae), Diptera (Cecidomyiidae), Hymenoptera (Cynipidae) and Lepidoptera (Arctiidae, Gelechiidae, Geometridae, Lymantriidae, Noctuidae, Notodontidae, Pieridae, Pyralidae, Tortricidae and Yponomeutidae), but also is known to acts as a secondary parasitoid of Diptera (Tachinidae) and Hymenoptera (Braconidae, Encyrtidae, Eulophidae and Ichneumonidae) (Noyes 2019). The only known seed beetle host of *P. bruchicida* is *Bruchus* sp. (Bouček & Askew 1968). The species is reported as a parasitoid of *Bruchophagus robiniae* Zerova in seed pods of *Robinia pseudoacacia* L. (Fabaceae) in Romania (Lakatos et al. 2018).

Anastatus Motschulsky, 1859 is a large and speciose genus in the subfamily Eupelminae (Eupelmidae) consisting of about 150 species with cosmopolitan distribution (Chen et al. 2019, Peng et al. 2020). The species are mostly primary egg parasitoids of a wide diversity of insect orders, and a few are known to be secondary parasitoids. Some have been reared from Coleoptera larvae and Diptera puparia (Gibson 1995). In our study, we reared two females (Fig. 5) and one male of an *Anastatus* species. Its appearance in our material is probably due to the presence of eggs of some other insects that have been laid on the liquorice milkvetch pods and collected together with them. The small number of reared specimens, combined with the fact that *Anastatus* are mostly endoparasitoids of insect eggs, suggests that its association with *Bruchophagus* or *Bruchidius* is accidental.

Eupelmus confusus (Fig. 6) is known to be associated with a wide spectrum of hosts belonging to Coleoptera (Chrysomelidae: Bruchinae) (Pin-

Figs 1-12. Seed-feeding and parasitoid species reared from fruits of *A. glycyphyllos* in Bulgaria: 1 – *Bruchophagus astragali*; 2 – *Bruchidius marginalis*; 3 – *Baryscapus endemus*; 4 – *Pediobius bruchicida*; 5 – *Anastatus* sp.; 6 – *Eupelmus confusus*; 7 – *E. barai*; 8 – *E. messene*; 9 – *E. vesicularis*; 10 – *Dinarmus acutus*; 11 – *Pteromalus sequester*; 12 – *Pteromalus* sp. cf *semotus*. Scale bar = 0.5 mm.

Table 2. List of known parasitoids associated with *B. astragali*.

Family	Parasitoid species	References
Eulophidae	*Elasmus nudus* (Nees, 1834)	Perju (2005)
	Tetrastichus sp.	Haghighian & Sadeghi (2010); Zerova et al. (2021)
Eurytomidae	*Eurytoma aspila* (Walker, 1836)	Perju (2005)
Pteromalidae	*Pteromalus sequester* Walker, 1835	Perju (2005)
	Spintherus dubius (Nees, 1834)	Mitroiu & Andriescu (2003)

Table 3. List of known parasitoids associated with *B. marginalis*.

Family	Parasitoid species	References
Eupelmidae	*Anastatus bifasciatus* (Geoffroy, 1785) as *Eupelmus bifasciatus* Förster	De Luca (1965)
	Eupelmus urozonus Dalman, 1820	Vidal (1997); Pérez-Benavides et al. (2019)
	Eupelmus vesicularis (Retzius, 1783) as *Eupelmella vesicularis* Retzius	De Luca (1965)
Pteromalidae	*Cyrtogaster vulgaris* Walker, 1833	De Luca (1965); Dzhanokmen (2017)
	Dinarmus acutus (Thomson, 1878)	Dzhanokmen (2017); Pérez-Benavides et al. (2019)
	Pteromalus sequester Walker, 1835 as *Pteromalus varius* Walker (in De Luca 1965)	De Luca (1965); Vidal (1997); Dzhanokmen (2017); Pérez-Benavides et al. (2019)
	Stenomalina micans (Olivier, 1813) as *Pteromalus micans* Nees	De Luca (1965)
	Trichomalus inscitus (Walker, 1835) as ?*Pteromalus affinis* Walker	De Luca (1965)
	Trichomalus statutus (Förster, 1841) as *Pteromalus statutus* Förster	De Luca (1965)

tilioaie et al. 2018, Rădac et al. 2021), Diptera (Cecidomyiidae, Periscelidae and Tephritidae), Hymenoptera (Braconidae, Cynipidae, Eulophidae and Eurytomidae) and Lepidoptera (Gelechiidae, Periscelidae, Pyralidae and Tineidae) (Al Khatib et al. 2014, Gibson & Fusu 2016). It was reared from the seeds of *Albizia julibrissin* Durazz. and *Cercis siliquastrum* L. (Fabaceae) infested with *Bruchidius terrenus* (Sharp) and *Bruchidius siliquastri* Delobel larvae in Romania (Pintilioaie et al. 2018). In Romania, this parasitoid was also obtained from the seed pods of *Gleditsia triacanthos* L. (Fabaceae) infested with *Amblycerus robiniae* (Fabricius), *Megabruchidius dorsalis* (Fåhraeus) and *Megabruchidius tonkineus* (Pic) larvae (Rădac et al. 2021). In Spain, the species has been reared from fruits of *Asphodelus ramosus* L. (Asphodelaceae) with a *Bruchophagus* sp. (Askew & Nieves-Aldrey 2017).

Eupelmus barai (Fig. 7) has been recorded as a parasitoid of many species belonging to ten families (Fusu 2017). There are no data regarding the association of this parasitoid with Bruchinae species. Fusu (2017) examined a specimen of this species reared from *B. roddi* in *Medicago sativa* L. (Fabaceae) seed from France.

Eupelmus messene (Fig. 8) hosts are mainly endophytes developing in plant stems or galls (Fusu 2017, Askew et al. 2021). Among those listed by Fusu (2017), there is no data about the association of this species with seed beetles and seed-eating wasps.

Eupelmus vesicularis (Fig. 9) attacks a wide variety of holometabolous insects that usually are concealed within protected habitats such as galls, grass stems, seeds or cocoons (Bouček 1977, Fusu 2017). It has been reared from *B. marginalis* larvae in fruits of *A. glycyphyllos* (Ruschka 1921). This eupelmid

is associated with the following *Bruchophagus* species: *B. gibbus* (Nikolskaya 1952), *B. platypterus* (Peterson et al. 1991) and *B. roddi* (Perju 2005). In addition to these, Noyes (2019) lists *Bruchophagus caraganae* (Nikolskaya) and *B. kolobovae* Fedoseeva (synonyms of *Eurytoma caraganae* Nikolskaya and *Bruchophagus platypterus* (Walker)). Some of the hosts listed for *E. vesicularis* possibly refer to *E. barai* or *E. messene*, species prior to Fusu (2017) being included under *E. vesicularis*.

Dinarmus acutus (Fig. 10) is a primary parasitoid of a wide range of seed beetles in pods of Fabaceae (Bouček 1977) belonging to the following genera: *Acanthoscelides* Schilsky, *Bruchidius* Schilsky, *Bruchus* L., *Callosobruchus* Pic and *Paleoacanthoscelides* Borowiec (Chrysomelidae) (Dzhanokmen 2017, Pérez-Benavides et al. 2019). It is also known to be a secondary parasitoid of other *Dinarmus* spp. (Tselikh & Kostjukov 2017).

Pteromalus sequester (Fig. 11) is a primary parasitoid of various insect hosts belonging to Coleoptera (Apionidae, Chrysomelidae (Bruchinae) and Curculionidae), Diptera (Cecidomyiidae and Tephritidae), Hymenoptera (Eurytomidae) and Lepidoptera (Pyralidae) (Tselikh 2020). It has been reported as a secondary parasitoid of *Dinarmus italicus* (Masi) [= *Oedaule italica* Masi] in pods of *Calicotome spinosa* (L.) Link (Fabaceae) (Graham 1969).

The following set of morphological characters of females of *Pteromalus* sp. cf *semotus* (Fig. 12) suggests that they may be specifically distinct from those of *Pteromalus semotus* (Walker): Antennae and legs with paler colouration – scape pale testaceous, flagellum brown above and pale testaceous below (in *semotus* the scape is infuscated and the flagellum entirely brown); legs stout, with the femur, infuscate, tibiae slightly infuscate with pale testaceous distal half (in *semotus* the legs are more slender, with tibiae dark proximally but whitish or yellowish in distal third); head in dorsal view 2.3x as broad as long (2.1x in *semotus*); malar space distinctly longer, about 0.6x length of the eye (in *semotus* only 0.45-0.48x length of the eye); pronotal collar in profile forming more or less obtuse angle with the neck (in *semotus* the pronotal collar has a slightly abrupt front edge and forms a right angle with the neck); thorax in dorsal view more squat, at most 1.5x as long as broad (in *semotus* 1.7x). Based on these differences, we assume that this *Pteromalus* sp. is probably undescribed. In our study, it is the most numerous parasitoid (1643 specimens or 61.55%) and will be subject of a future research.

Conclusion

This study reveals a diverse insect community based upon two phytophagous species using the same food source and their ten chalcidoid parasitoids. Considering the host ranges of these parasitoids, they are most likely primary parasitoids of the seed-eating wasp and/or seed beetle, but secondary parasitism cannot be excluded.

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References

Alekseev V.I. & Bukejs A. 2011. Contributions to the knowledge of beetles (Insecta: Coleoptera) in the Kaliningrad region. 2. Baltic Journal of Coleopterology 11(2): 209-231.

Al khatib F., Fusu L., Cruaud A., Gibson G., Borowiec N., Rasplus J.-Y., Ris N. & Delvare G. 2014. An integrative approach to species discrimination in the *Eupelmus urozonus* complex (Hymenoptera, Eupelmidae), with the description of 11 new species from the Western Palaearctic. Systematic Entomology 39: 806-862.

Amiri M.S., Joharchi M.R., Nadaf M. & Nasseh Y. 2020. Ethnobotanical knowledge of *Astragalus* spp.: The world's largest genus of vascular plants. Avicenna Journal of Phytomedicine 10(2): 128-142.

Arora G.L. 1980. A study of the biology and taxonomy of genus *Bruchidius* (Coleoptera: Bruchidae) from India. Final technical report (1974-1979). Chandigarh: Panjab University. 96 pp.

Askew R.R. & Nieves-Aldrey J.L. 2017. Eupelmidae (Hymenoptera, Chalcidoidea) of Iberia and the Canary islands: an annotated checklist with descriptions of some previously unrecognised males and a new species of *Calosota* Curtis, 1836. Graellsia 73(2): 1-17.

Askew R.R., Rey del Castillo C., Rodríguez Rojo M.P. & Nieves-Aldrey J.L. 2021. A review of the Iberobalearic and Macaronesian species of *Eupelmus* (*Macroneura*)

Walker, 1837 (Hymenoptera, Chalcidoidea, Eupelmidae). Graellsia 77(1): 1-7.

Borowiec L. 1985. The status of *Bruchus tragacanthae* Olivier (Coleoptera, Bruchidae). Polskie Pismo Entomologiczne 55: 245-249.

Borowiec L. 1987. The genera of seed-beetles (Coleoptera, Bruchidae). Polskie Pismo Entomologiczne 57: 3-207.

Bouček Z. 1965. Studies of European Eulophidae, IV: *Pediobius* Walk. and two allied genera (Hymenoptera). Acta Entomologica Musei Nationalis Pragae 36: 5-90.

Bouček Z. 1977. A faunistic review of the Yugoslavian Chalcidoidea (Parasitic Hymenoptera). Acta Entomologica Jugoslavica, Supplement 13: 1-145.

Bouček Z. 1988. Australasian Chalcidoidea (Hymenoptera): A biosystematic revision of genera of fourteen families, with a reclassification of species. Wallingford: CAB International. 832 pp.

Bouček Z. & Askew R.R. 1968. Hym. Chalcidoidea. Palearctic Eulophidae (excl. Tetrastichinae). In: Delucchi V. & Remaudière G. (Eds): Index of Entomophagous Insects, Volume 3. Paris: Le François, 1-254.

Bouček Z. & Rasplus J.-Y. 1991. Illustrated key to West-Palearctic genera of Pteromalidae (Hymenoptera: Chalcidoidea). Paris: Institut National de la Recherche Agronomique. 140 pp.

Castillón E.E., Quintanilla J.Á.V., Delgado-Salinas A. & Rebman J.P. 2023. The genus *Astragalus* (Leguminosae: Papilionoideae: Galegeae) in Mexico. Phytotaxa 586(1): 1-162.

Chen Y.-M., Gibson G.A.P., Peng L.-F., Iqbal A. & Zang L.-S. 2019. *Anastatus* Motschulsky (Hymenoptera, Eupelmidae): egg parasitoids of *Caligula japonica* Moore (Lepidoptera, Saturniidae) in China. ZooKeys 881: 109-134.

Decelle J.E. 1989. Les Bruchidae (Coleoptera) de Belgique. In: Wouters K. & Baert L. (Eds): Invertebraten van België / Invertébrés de Belgique. Comptes rendus du Symposium "Invertébrés de Belgique", 25-26 November 1988. Bruxelles: Institut royal des Sciences naturelles de Belgique, pp. 345-350.

Delobel A. & Delobel B. 2007. Contribution to the knowledge of Bulgarian seed beetles (Coleoptera: Bruchidae). Russian Entomological Journal 16(2): 213-218.

De Luca Y. 1965. Catalogue des metazoaires parasites et prédateurs de bruchides (Coleoptera). Journal of Stored Products Research 1: 51-98.

Derbel S., Noumi Z., Anton K.W. & Chaieb M. 2007. Life cycle of the coleopter *Bruchidius raddianae* and the seed predation of the *Acacia tortilis* subsp. *raddiana* in Tunisia. Comptes Rendus Biologies 330(1): 49-54.

Dzhanokmen K.A. 2017. Pteromalids (Hymenoptera, Chalcidoidea: Pteromalidae) of the Karatau ridge and adjacent territories of the Talas Alatau ridge in Western Tien Shan. Entomological Review 97(6): 794-817.

Fusu L. 2017. An integrative taxonomic study of European *Eupelmus* (*Macroneura*) (Hymenoptera: Chalcidoidea: Eupelmidae), with a molecular and cytogenetic analysis of *Eupelmus* (*Macroneura*) *vesicularis*: several species hiding under one name for 240 years. Zoological Journal of the Linnean Society 181(3): 519-603.

Gibson G.A.P. 1995. Parasitic wasps of the subfamily Eupelminae: classification and revision of world genera (Hymenoptera: Chalcidoidea: Eupelmidae). Memoirs on Entomology, International, Volume 5. Gainesville, Florida: Associated Publishers. 421 pp.

Gibson G.A.P. & Fusu L. 2016. Revision of the Palaearctic species of *Eupelmus* (*Eupelmus*) Dalman (Hymenoptera: Chalcidoidea: Eupelmidae). Zootaxa 4081(1): 1-331.

Gnat S., Wójcik M., Wdowiak-Wróbel S., Kalita M., Ptaszyńska A. & Małek W. 2014. Phenotypic characterization of *Astragalus glycyphyllos* symbionts and their phylogeny based on the 16S rDNA sequences and RFLP of 16S rRNA gene. Antonie van Leeuwenhoek 105: 1033-1048.

Graham M.W.R. de V. 1969. The Pteromalidae of Northwestern Europe (Hymenoptera: Chalcidoidea). Bulletin of the British Museum (Natural History). Entomology, Supplement 16: 1-908.

Graham M.W.R. de V. 1991. A reclassification of the European Tetrastichinae (Hymenoptera: Eulophidae): revision of the remaining genera. Memoirs of the American Entomological Institute 49: 1-322.

Haghighian F. & Sadeghi S.E. 2010. Some biological aspects of a seed pest wasp, *Bruchophagus astragali* (Hym.: Eurytomidae), in rangelands of Chaharmahal & Bakhtiary province of Iran. In: Melika G. (Ed.): Proceedings of the Seventh International Congress of Hymenopterists, 20-26 June 2010. Köszeg, Hungary, p. 85.

Kalina V. 1981. The Palearctic species of the genus *Anastatus* Motschulsky, 1860 (Hymenoptera, Chalcidoidea, Eupelmidae), with descriptions of new species. Silvaecultura Tropica et Subtropica 8: 3-25.

Kingsolver J.M. 2004. Handbook of the Bruchidae of the United States and Canada (Insecta, Coleoptera). Volume I. Washington: United States Department of Agriculture, Agricultural Research Service. Technical Bulletin Number 1912. 324 pp.

Lakatos K.T., László z. & Tóthmérész B. 2018. Disturbance induced dynamics of a tritrophic novel ecosystem. Bulletin of Entomological Research 108(2): 158-165.

La Salle J. 2005. Biology of gall inducers and evolution of gall induction in Chalcidoidea (Hymenoptera: Eulophidae, Eurytomidae, Pteromalidae, Tanaostigmatidae, Torymidae). In: Raman A., Schaefer C.W. & Withers T.M. (Eds): Biology, ecology, and evolution of gall-inducing arthropods. Enfield: Science Publishers, 507-537.

Lopatina S.V. & Lukyantsev S.V. 2023. *Bruchidius marginalis* (Fabricius, 1776) (Coleoptera: Chrysomelidae: Bruchinae) - a species new to the Republic of Khakassia (Russia). Acta Biologica Sibirica 9: 597-603.

López-Núñez F.A., Neto Duarte L., Yus Ramos R., Marchante E. & Marchante H. 2020. Expanding the European distribution limits of *Bruchidius raddianae*. First record in Portugal from Vachellia karroo's infested seeds (Coleoptera: Bruchidae; Fabales: Fabaceae). Fragmenta Entomologica 52(1): 53-55.

Mitroiu M.D. & Andriescu I. 2003. Contributions to the knowledge of the pteromalids (Hymenoptera, Chalcidoidea, Pteromalidae) from David's Valley hay fields nature reserve, Iași (III). Analele Ştiinţifice ale Universităţii „Al. I. Cuza" Iaşi. s. Biologie animală XLIX: 63-70.

Nikolskaya M.N. 1952. Chalcids of the fauna of the USSR (Chalcidoidea). Keys to the fauna of the USSR, published by the Zoological Institute of the Academy of Sciences of the USSR. Volume 44. Moscow-Leningrad: Publishing House of the Academy of Sciences of the USSR. 574 pp. (In Russian).

Noyes J.S. 2019. Universal Chalcidoidea Database. World Wide

Web electronic publication. Available from http://www.nhm.ac.uk/chalcidoids [accessed 2 November 2023].

Peng L., Gibson G.A.P., Tang L. & Xiang J. 2020. Review of the species of *Anastatus* (Hymenoptera: Eupelmidae) known from China, with description of two new species with brachypterous females. Zootaxa 4767(3): 351-401.

Pérez-Benavides A.L., Hernández-Baz F., González J.M. & Riverón A. Z. 2019. Updated taxonomic checklist of Chalcidoidea (Hymenoptera) associated with Bruchinae (Coleoptera: Chrysomelidae). Zootaxa 4638(3): 301-343.

Perju T. 2005. Parasitoids reared from insect pests of different agroecosystems. In: Mustaţă G. (Ed.): Lucrările simpozionului "Entomofagii şi rolul lor în păstrarea echilibrului natural" Universitatea "Al. I. Cuza". Iaşi: Editura Universităţii "Al. I. Cuza", 47-54.

Peterson S.S., Wedberg J.L. & Hogg D.B. 1991. Postdiapause development and phenology of the trefoil seed chalcid (Hymenoptera: Eurytomidae) and its parasitoids. Environmental Entomology 20 (6): 1606-1611.

Pintilioaie A.-M., Manci C.-O., Fusu L., Mitroiu M.-D. & Rădac A.-I. 2018. New invasive bruchine species (Chrysomelidae: Bruchinae) in the fauna of Romania, with a review on their distribution and biology. Annales de la Société entomologique de France (N.S.) 54(5): 401-409.

Popescu I.E. 2009. Torymidae and Eurytomidae (Hymenoptera: Chalcidoidea) from Bucureşti city and the surrounding area. Travaux du Muséum National d'Histoire Naturelle «Grigore Antipa» 52: 457-477.

Rădac I.-A., Manci C.O. & Pintilioaie A.-M. 2021. *Amblycerus robiniae* (Fabricius, 1781) (Chrysomelidae: Bruchinae), analien species established in Europe. BioInvasions Records 10(1): 57-64.

Rasplus J.-Y. 1989. Révision des espèces afrotropicales du genre *Dinarmus* Thomson (Hymenoptera: Pteromalidae). Annales de la Société entomologique de France (N.S.) 25 (2): 135-162.

Ruschka F. 1921. Chalcididenstudien I. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien 70: 234-315.

Schott C. 2004. Catalogue et atlas des Coleopteres d'Alsace. Tome 14 Bruchidae, Urodonidae, Anthribidae. Strasbourg: Société Alsacienne d'Entomologie. 71 pp.

Stojanova A. 2010. Seed beetle *Bruchidius terrenus* (Sharp) (Coleoptera: Chrysomelidae: Bruchinae) – new invasive species to the Bulgarian fauna. Biotechnology & Biotechnological Equipment 24 (suppl. 1): 646-647.

Stoyanov K., Raycheva Ts. & Cheschmedzhiev I. 2021. Key to the native and foreign vascular plants in Bulgaria. Plovdiv: Agricultural University Plovdiv Academic Press. 678 pp.

Tselikh E.V. 2020. New data on the pteromalid wasps (Hymenoptera, Chalcidoidea: Pteromalidae) of Eastern Siberia with description of a new genus. Entomological Review 100(5): 714-726.

Tselikh E.V. & Kostjukov V.V. 2017. New data on the pteromalid wasps (Hymenoptera, Chalcidoidea: Pteromalidae) of Krasnodar territory (Russia). Entomological Review 97(1): 44-56.

Valev S. 1976. *Astragalus* L. In: Yordanov D. (Ed.): Flora Republicae Popularis Bulgaricae, Volume 6. Sofia: Aedibus Academiae Scientiarum Bulgaricae, 147-148. (In Bulgarian).

Vidal S. 1997. Determination list of entomophagous insects. Nr. (13) Bulletin. Section Regionale Ouest Palaearctique, Organisation Internationale de Lutte Biologique 20(2): 1-53.

Zerova M.D. 1995. The parasitic Hymenoptera – subfamilies Eurytominae and Eudecatominae (Chalcidoidea, Eurytomidae) of the Palaearctics. Kiev: Naukova Dumka Publishers. 457 pp. (In Russian).

Zerova M.D. & Seryogina L. Ya. 1994. The seed-feeding Chalcidoidea of Palaearctics. Kiev: Naukova Dumka Publishers. 237 pp. (In Russian).

Zerova M.D., Ghahari H., Fursov V.N., Gibson G.A.P. & Doğanlar M. 2021. Chapter 10. Family Eurytomidae Walker, 1832. In: Ghahari H., Gibson G. A. P. & Viggiani G. (Eds): Chalcidoidea of Iran (Insecta: Hymenoptera). Wallingford, Oxfordshire: CABI Publishing, 225-253.