

## New records for the association between eulophid parasitoids (Hymenoptera: Chalcidoidea: Eulophidae) and gall wasps (Hymenoptera: Cynipoidea: Cynipidae and Diplolepididae)

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**Abstract:** To expand knowledge on gall communities, we identified 10 species from 6 genera within the family Eulophidae (Hymenoptera: Chalcidoidea) found in oak and rose galls (formed by Cynipidae and Diplolepididae) collected in northeastern Anatolia. The eulophid parasitoids identified in this study represent new associate records for the gall wasp species examined. Additionally, *Euderus albitarsis* (Zetterstedt, 1838), *Stepanovia rosae* Boyadzhiev and Todorov, 2013, and *Aprostocetus levadiensis* Graham, 1987 are recorded for the first time in the fauna of Türkiye.

**Keywords:** Parasitoid wasps, Chalcidoidea, Eulophidae, Oak galls, Rose galls, New records

## Eulophid parazitoitler (Hymenoptera: Chalcidoidea: Eulophidae) ve gal arıları (Hymenoptera: Cynipoidea: Cynipidae ve Diplolepididae) arasındaki ilişkiye dair yeni kayıtlar

**Öz:** Gal komüniteleri hakkındaki bilgilere katkı sağlamak amacıyla, Kuzeydoğu Anadolu'da Cynipidae ve Diplolepididae tarafından oluşturulan meşe ve gül galleri toplanmış ve bu gallerde Eulophidae (Hymenoptera: Chalcidoidea) familyasından 6 cinse ait 10 tür tespit edilmiştir. Bu çalışmada tespit edilen eulophid parazitoitler, incelenen gal arısı türleri ile ilişkili olmaları bakımından yeni kayıtlardır. Ayrıca, *Euderus albitarsis* (Zetterstedt, 1838), *Stepanovia rosae* Boyadzhiev and Todorov, 2013 ve *Aprostocetus levadiensis* Graham, 1987 Türkiye faunasında ilk kez kaydedilmiştir.

**Anahtar kelimeler:** Parazitoit yaban arıları, Chalcidoidea, Eulophidae, Meşe galleri, Gül galleri, Yeni kayıtlar

### 1. Introduction

Galls formed by gall wasps (Hymenoptera: Cynipidae and Diplolepididae) host diverse communities, including primary and secondary parasitoids, phytophagous inquilines, various predators, and the gall maker itself. Most parasitoids associated with cynipid galls belong to the superfamily Chalcidoidea (Hymenoptera). This superfamily includes several families with species that attack inhabitants of cynipid galls (such as gall wasps, inquilines, and other parasitoids), including Eurytomidae, Torymidae, Eulophidae, Eupelmidae, Pteromalidae, and Ormyridae. Within Chalcidoidea, the family Eulophidae alone contains over 5.000 described species worldwide, distributed among 328 genera (Noyes, 2019). Among them, 221 species have been recorded in Türkiye (Doğanlar, 1982; 1985; 1993a; 1993b; 1993c; Graham, 1987; Öncüler, 1991; Yaşarakıncı and Hıncal, 1997; 2000; Bulut and Göçmen, 2000; Ülgentürk, 2001; Gençer, 2003a; 2003b; 2004a; 2004b; 2005; Civelek and Lasalle, 2005; Elekcioğlu and Uygün, 2006; Doğanlar and Triapitsyn, 2007; Doğanlar et al., 2009; Yefremova et al.,

2010; Cebeci et al., 2011; Karaca et al., 2015; Sakaltaş Arıyak and Tüzün, 2016; Boyadzhiev et al., 2017; Doğanlar et al., 2020).

Eulophids are small-bodied insects and are predominantly parasitoids, although secondary phytophagy is occasionally observed (Graham, 1987; Yefremova et al., 2010; Talebi et al., 2011; Gadallah et al., 2015). In the Western Palearctic region, 42 eulophid species across 9 genera (*Aulogymnus* Foerster, 1851, *Cirrospilus* Westwood, 1832, *Aprostocetus* Westwood, 1833, *Baryscapus* Foerster, 1856, *Minotetrastichus* Kostjukov, 1977, *Pediobius* Walker, 1846, *Dichatomus* Foerster, 1878, *Stepanovia* Kostjukov, 2004, and *Sigmophora* Rondani, 1867) have been reported in association with gall wasps (Askew et al., 2006; Lotfalizadeh et al., 2006; Hesami et al., 2010; Askew et al., 2013; Boyadzhiev and Todorov, 2013; Boyadzhiev et al., 2017).

The primary aim of this study is to expand knowledge on eulophid species within gall wasp communities. A deeper understanding of these species will help clarify their ecological roles, host relationships, and distribution patterns. Additionally, this knowledge may offer valuable insights for

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biological control applications and contribute to future studies on gall wasp-associated ecosystems.

## 2. Materials and method

Field studies were conducted in northeastern Anatolia (in other words the Eastern Black Sea Region of Türkiye) from 2017 to 2019, during which gall samples from oak and rose gall wasps were collected. Each sample was meticulously inspected to remove any insects, spiders, or other organisms not associated with the gall community but incidentally present in the collected plant material. Gall samples were then individually stored in jars and kept at room temperature until the parasitoid wasps emerged. Adult parasitoids were preserved in 96% ethanol. Eulophid specimens reared from the samples were identified using the following taxonomic references: Graham (1959; 1987), Askew (1959), Bouček (1963; 1965), Boyadzhiev and Todorov (2013), and Li et al. (2017). All specimens are deposited in the insect collection of the Zoology Section, Department of Biology, Faculty of Science, Hacettepe University, Ankara, Türkiye. New records for the Turkish eulophid fauna are marked with an asterisk (\*).

## 3. Results and discussion

Here, 10 eulophid species from 6 genera were identified.

### 3.1. Genus *Aulogymnus* Foerster, 1851

#### 3.1.1. *Aulogymnus gallarum* (Linnaeus, 1761)

Distribution: Widely distributed in the Western Palaearctic region (Noyes, 2019).

Material examined: Rize — Fındıklı, Sultandağı, 41°12' N, 41°16' E, 1300 m, 16 Nov. 2017, ex. gall of *Andricus mammadovi* Azmaz & Katılmış, 2021, 1♂; Fındıklı, Sultandağı, 41°12' N, 41°16' E, 1150 m, 17 May. 2018, ex. gall of *A. mammadovi*, 54♀♀, 63♂♂; Fındıklı, Sultandağı, 41°12' N, 41°16' E, 1150 m, 22 Jun. 2018, ex. gall of *A. mammadovi*, 16♀♀, 13♂♂.

Diagnosis: Female — Antennal formula 11232, first funicle segment about twice as long as pedicel; metathorax plus propodeum more than half as long as scutellum; scutellum with two longitudinal bluish-grey lines; forewings with two definite fuscous marks, one at proximal end of marginal vein, the other beneath stigma, speculum open beneath, marginal vein more than twice as long as stigmal vein; tibie pale yellow, with a fuscous streak on ventral aspect of front tibiae; length 1.5-1.8 mm. Male — Antenna with five undifferentiated funicle segments, last flagellar segment as long as penultimate segment, antennal hairs short and recumbent; wings hyaline, forewing stigma oblong, marginal vein less than 0.5 times as long as stigmal vein, speculum open beneath; tibiae pale yellow; length 1.2-1.7 mm.

Note: This species is a parasitoid of several oak gall wasps from the genera *Andricus* Hartig, 1840, *Biorhiza* Westwood, 1840, *Callirhytis* Förster 1869, *Cynips* Linnaeus, 1758, *Neuroterus* Hartig, 1840, and *Trigonaspis* Hartig, 1840 (Noyes, 2019). This study represents the first record of this parasitoid as an associate of *A. mammadovi*.

#### 3.1.2. *Aulogymnus trilineatus* (Mayr, 1877)

Distribution: Widely distributed in the Western Palaearctic region (Noyes, 2019).

Material examined: Giresun — Şebinkarahisar, Çamlıbel, 40°20' N, 38°31' E, 1170 m, 20 Feb. 2018, ex. gall of *Cynips quercus* (Fourcroy, 1785), 1♂; Gümüşhane — Kelkit, Çağlar, 40°05' N, 39°17' E, 1650 m, 21 Feb. 2018, ex. gall of *Cynips baskalei* Azmaz & Katılmış, 2020, 3♀♀; Kelkit, Çağlar, 40°05' N, 39°17' E, 1500 m, 24 Sep. 2019, ex. gall of *C. baskalei*, 15♀♀, 14♂♂; Şiran, Ardıçlı, 40°07' N, 39°12' E, 1620 m, 21 Feb. 2018, ex. gall of *C. baskalei*, 1♀; Ordu — Akkuş, Yolbaşı, 40°42' N, 36°59' E, 1050 m, 13 Mar. 2018, ex. gall of *Andricus mitratus* (Mayr, 1870), 1♂; Mesudiye, Mahmudiye, 40°35' N, 37°39' E, 1370 m, 13 Mar. 2018, ex. gall of *Andricus assarehi* Melika & Sadeghi, 2008, 1♀.

Diagnosis: Female — Antennal formula 11232, first funicle segment 2.2 times as long as pedicel, scape with a fuscous line above; metathorax plus propodeum more than half as long as scutellum; scutellum with two longitudinal bluish-green lines, and with a less defined median line in darker colour; forewings with a small fuscous mark at proximal end of marginal vein, and the stigma darkened, speculum open beneath, marginal vein more than twice as long as stigmal vein; gaster ovate, about as long as thorax, 1.5 times as long as wide; tibiae pale yellow, with a fuscous streak on ventral aspect of front tibiae; length 3.0-3.6 mm. Male — Funicle with short, recumbent, white hairs, fuscous above, paler below, first segment longer and larger than other segments, flagellum with last segment not longer than penultimate segment; speculum open beneath; wings hyaline but proximal end of marginal vein darkened; tibiae pale yellow; length 2.8-3.0 mm.

Note: This species is known to parasitize several oak gall wasp species from the genera *Andricus*, *Biorhiza*, *Cynips*, *Trigonaspis*, as well as some inquiline cynipid species (Noyes, 2019). This study provides the first record of this species as an associate of *A. assarehi* and *C. baskalei*.

#### 3.1.3. *Aulogymnus* sp.

Material examined: Gümüşhane — Karamustafa, Tersun, 40°19' N, 39°18' E, 1660 m, 24 Feb. 2018, ex. gall of *Biorhiza pallida* (Olivier, 1791), 1♀, 1♂; Torul, Zigana, 40°36' N, 39°20' E, 1115 m, 21 Oct. 2017, ex. gall of *B. pallida*, 1♀.

Note: Further examination is required due to the poor condition of the specimens.

### 3.2. Genus *Euderus* Haliday, 1844

#### 3.2.1. *Euderus albitarsis* (Zetterstedt, 1838)\*

Distribution: Widely distributed in the Palaearctic and Nearctic regions (Bouček, 1963; Noyes, 2019). This is a new record for Türkiye.

Material examined: Bayburt — Ortaçimağıl, 40°05' N, 40°35' E, 2190 m, 14 Nov. 2017, ex. gall of *Diplolepis fructuum* (Rübsaamen, 1895), 2♀♀.

Diagnosis: Female — Antennal formula 11143, funicle segments 1 to 3 obviously longer than broad; forewing hyaline, its distal part with some of the hairs arranged in 5 lines, 3 of which radiate from the stigma, submarginal vein with 5 dorsal bristles; gaster at least slightly longer than head

plus thorax; body dark metallic, blue and purple; legs dark brown except tarsi; length 2.3-2.5 mm.

Note: This species parasitizes various species across the orders Coleoptera, Lepidoptera (particularly Lepidoptera), Orthoptera, Homoptera, Diptera, Hemiptera, and Hymenoptera (Bouček, 1963; Noyes, 2019), as well as an unspecified cynipid species (Bouček and Askew, 1968). This study represents the first record of this parasitoid as an associate of *D. fructuum*.

### 3.3. Genus *Pnigalio* Schrank, 1802

#### 3.3.1. *Pnigalio agraulis* (Walker, 1839)

Distribution: Widely distributed in Palaearctic (Noyes, 2019).

Material examined: Bayburt — Bayburt-Erzurum 10. km, 40°10' N, 40°20' E, 1680 m, 18 Sep. 2018, ex. gall of *Cynips divisa* Hartig, 1840, 1♀.

Diagnosis: Female — Antennal formula 11242, antenna inserted near of lower edge of eyes, scape almost reaching the vertex; anterior margin of clypeus entire; notaulices present in front only; mesoscutum with conspicuous bristles; scutellum without sublateral longitudinal grooves; median carina of propodeum complete, plicae complete, costula present and reaching median carina; gaster 1.8 times as long as broad; hind tarsus with three basal segments whitish; inner face of midcoxa without setae; length 2.0 mm.

Note: This species is a parasitoid of several species within the orders Coleoptera, Lepidoptera, Diptera, and Hymenoptera (Noyes, 2019). It has been reported to attack the sexual form of the oak gall wasp *Neuroterus numismalis* (Geoffroy in Fourcroy, 1785) (Bouček and Askew, 1968; Askew and Shaw, 1974). This study provides the first record of this parasitoid as an associate of *C. divisa*.

### 3.4. Genus *Stepanovia* Kostjukov, 2004

#### 3.4.1. *Stepanovia rosae* Boyadzhiev & Todorov, 2013\*

Distribution: Bulgaria (Boyadzhiev and Todorov, 2013). This is a new record for Türkiye.

Material examined: Artvin — Ardanuç, Yolüstü, 41°10' N, 42°03' E, 1250 m, 13 Mar. 2019, ex. gall of *Diplolepis rosae* (Linnaeus, 1758), 8♀♀; Bayburt — Bayburt-Uluçayır 4. km, 40°14' N, 40°16' E, 1645 m, 21 Feb. 2018, ex. gall of *D. fructuum*, 3♀♀, 2♂♂; Çakırbağ, 40°23.645' N, 40°30.539' E, 1440 m, 23 Feb. 2018, ex. gall of *D. fructuum*, 8♀♀, 2♂♂; Ortaçimağıl, 40°05.322' N, 40°35.279' E, 2190 m, 14 Nov. 2017, ex. gall of *Diplolepis eglanteriae* (Hartig, 1840), 5♀♀; Gümüşhane — Olukdere, 40°22' N, 39°34' E, 1315 m, 18 Oct. 2017, ex. gall of *D. fructuum*, 1♀; Ordu — Akkuş, Yukarıdügencili, 40°44' N, 37°01' E, 1275 m, 17 Mar. 2018, ex. gall of *Diplolepis mayri* (Schlechtendal, 1876), 10♀♀, 2♂♂; Mesudiye, Güvenli, 40°25' N, 37°53' E, 1600 m, 17 Oct. 2018, ex. gall of *D. mayri*, 2♀♀, 1♂.

Diagnosis: Female — Antennal formula 11433; scape not quite reaching level of median ocellus; pedicellus 1.8 times as long as broad, 0.8 times as long as F1, clava 2.3-2.4 times as long as broad, POL about 1.2-1.3 OOL, OOL 2.0-2.2 OD; head brownish with U-shaped yellow stripe on lower face, and mouth edge pale, gaster entirely brownish, tibiae and distal parts of femora pale, femora broadly brownish proximally; scutellum 1.1-1.2 as long as broad; forewing 2.1-2.3 times as

long as broad; gaster 2.0-2.5 times as long as broad, acuminate; ovipositor sheaths plus postcercal 0.6 times as long as hind tibiae, sheaths 0.9-1.0 length of postcercal; length 2.2-2.5 mm. Male — Antenna with ventral plaque situated about in the middle third of scape; length 1.3-1.6 mm.

Note: This species is an associate of *D. rosae* (Boyadzhiev and Todorov, 2013). This study provides the first record of this parasitoid as an associate of *D. eglanteriae*, *D. fructuum*, and *D. mayri*.

#### 3.4.2. *Stepanovia* sp.

Material examined: Bayburt — Alapelit, 40°19' N, 40°30' E, 1585 m, 19 Oct. 2017, ex. gall of *D. fructuum*, 4♀♀, 1♂; Aydıntepe, Salmankuş, 40°28' N, 40°01' E, 1835 m, 20 Apr. 2018, ex. gall of *D. fructuum*, 6♀♀, 2♂♂; Giresun — Şebinkarahisar, Ocaktaşı, 40°12' N, 38°33' E, 1600 m, 18 Oct. 2018, ex. gall of *D. fructuum*, 1♂.

Note: Further identification was not possible because of the poor condition of the specimens.

### 3.5. Genus *Aprostocetus* Westwood, 1833

#### 3.5.1. *Aprostocetus levadiensis* Graham, 1987\*

Distribution: Greece (Graham, 1987). This is the first record of this species in Türkiye; however, the diagnosis requires confirmation with additional samples.

Material examined: Rize — Fındıklı, Sultandağı, 41°12' N, 41°16' E, 1330 m, 22 Jun. 2018, ex. gall of *A. mammadovi*, 3♀♀, 1♂.

Diagnosis: Female — Antennal funicle 3-segmented; head not broader than mesoscutum; apical margin of forewing ciliate throughout; thorax distinctly arched dorsally; body nonmetallic; midlobe of mesoscutum with a single row of adnotaular setae on each side; propodeum medially as long as dorsellum; gaster lanceolate, as long as head plus thorax, with the two longest setae of each cercus subequal in length; the midlobe of the mesoscutum have some trace of a median line; ovipositor sheaths plus postcercal less than length of hind tibia; ovipositor sheaths plus postcercal about 0.7 length of hind tibia; ovipositor sheaths at least 2.5 times as long as postcercal; body extensively yellow; propodeal callus with 2 setae; length 2.1-2.3 mm. Male — length 2.0 mm.

Note: Host unknown (Graham, 1987). This study provides the first record of this species as an associate of *A. mammadovi*; however, due to the poor condition of the specimens, additional samples are needed to verify the diagnosis.

#### 3.5.2. *Aprostocetus* sp.

Material examined: Artvin — Ormanlı, 41°16' N, 41°45' E, 575 m, 17 May. 2018, ex. gall of *B. pallida*, 1♀, 2♂♂; Bayburt — Dövmekaya-Alapelit 3. km, 40°17' N, 40°29' E, 2020 m, 19 Oct. 2017, ex. gall of *Cynips korsakovi* Belizin, 1961, 1♀; Gümüşhane — Kürtün, Demirciler, 40°38' N, 39°06' E, 640 m, 17 Apr. 2018, ex. gall of *B. pallida*, 1♀, 1♂; Rize — Fındıklı, Sultandağı, 41°12' N, 41°16' E, 1180 m, 22 Jun. 2018, ex. gall of *A. mammadovi*, 4♀♀, 2♂♂; Fındıklı, Sultandağı, 41°12' N, 41°16' E, 1150 m, 22 Jun. 2018, ex. gall of *A. mammadovi*, 3♂♂; Güneysu, 40°52' N, 40°39' E, 1875 m, 15 Nov. 2017, ex. gall of *A. mammadovi*, 1♀.

Note: Due to the poor condition of the specimens, further identification was not possible.

### 3.6. Genus *Pediobius* Walker, 1846

#### 3.6.1. *Pediobius rotundatus* (Fonscolombe, 1832)

Distribution: Southern Europe, North Africa (Noyes, 2019).

Material examined: Ordu — Akkuş, Gökçebayır, 40°42' N, 37°01' E, 940 m, 17 Mar. 2018, ex. gall of *Pseudoneuroterus macropterus* (Hartig, 1843), 8♀♀; Akkuş, Gökçebayır, 40°43' N, 37°01' E, 920 m, 14 Mar. 2019, ex. gall of *P. macropterus*, 3♀♀, 1♂.

Diagnosis: Female — Antennal formula 11223; F1 1.2-1.3 times as long as F2, F2 nearly as long as broad; scrobal grooves meeting just below the fork; scapus, femora and tibiae metallic; notauli shallow, their flat bottom reticulate; mesoscutum all over reticulate; scutellum reticulate; speculum in the forewing closed; postmarginal vein developed, about as long as stigmal vein; intercarinal stripe of propodeum fused into one anteriorly; length 1.9-2.0 mm. Male — length 1.8 mm.

Note: This species is known to associate with several oak gall wasp species from the genera *Andricus*, *Chilaspsis* Mayr, 1881, *Neuroterus*, *Plagiotrochus* Mayr, 1881, and *Pseudoneuroterus* Kinsey, 1923, as well as *Tortrix viridana* (Linnaeus, 1758) from the order Lepidoptera (Noyes, 2019). This is the first record of this parasitoid associating with *P. macropterus*.

During the study, oak and rose galls were collected from the northeastern part of Anatolia, and associated eulophid species were identified. There are no previous records of parasitoid species associated with oak galls belonging to *C. baskalei* (Azmaz and Katılmış, 2020), *A. assarehi* (Tavakoli et al., 2008), and *A. mammadovi* (Azmaz and Katılmış, 2021) in previous studies. Therefore, our discovery of species associated with these galls marks significant new additions to the gall community records. Furthermore, the inclusion of a new parasitoid species (*E. albitarsis*) enriches our understanding of the well-documented community dynamics involving *D. fructuum* galls (Diplolepididae). However, despite inspecting the gall samples to remove insects, spiders, and other organisms that were incidentally found in the collected plant material, further sampling is necessary to determine whether the occurrences of *P. agraulis* and *E. albitarsis* are incidental.

## 4. Conclusion

*Euderus albitarsis* and *S. rosae* are new records for the fauna of Türkiye, expanding the known distribution of these species. Additionally, *A. levadiensis* is recorded for the first time in this region; however, its identification needs further confirmation due to the poor condition of the examined material. These findings contribute to the understanding of gall-associated eulophid diversity, but more studies with additional specimens and molecular analyses would help to confirm species identities.

Moreover, none of the eulophid species found in this study were detected in both oak and rose galls, suggesting distinct ecological preferences among these communities. This result highlights the role of host plant specificity in shaping parasitoid assemblages and indicates that gall wasp

communities may host specialized eulophid species. Further research on host-parasitoid relationships and habitat preferences would be useful to better understand the ecological patterns of these species.

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