

# Chalcidoidea of Turkey (Insecta: Hymenoptera)



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By

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This book is dedicated to valuable researchers who have conducted, and will continue to conduct, studies on Chalcidoidea in Turkey.



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# INTRODUCTION

## CHALCIDOIDEA OF TURKEY (INSECTA: HYMENOPTERA)

Turkey has been a small continent in terms of biological diversity because of the change in climatic and geographical characteristics at short intervals. It has three biogeographic regions: Europe-Siberia, Mediterranean and Iran-Turan, and along with their transition zones. Moreover, Turkey serves as a vital bridge connecting Asia and Europe. This unique position grants Turkey access to many resources of vital importance in terms of food security. Turkey also carries the responsibility of conserving and utilizing them wisely for the well-being of future generations. In this regard, Turkey can be classified as one of the most fortunate countries in the world (Republic of Turkey Ministry of Forestry and Agriculture, Biodiversity database, 2021).

Turkey is the home to many living species thanks to its geographical diversity. One of them is the Chalcidoidea superfamily, which is in the Hymenoptera order and has an important place in biological control. In this regard, there are faunistic and systematic studies about the Chalcidoidea superfamily in Turkey (Avcı, 2000; 2003; 2009; Çalışkan et al., 2016; Çalışkan et al., 2018; Çam, 2011; 2012; Çıkman and Doğanlar 2006; Çıkman, 2012; Dzhaposhvili, 2005; Doğanlar, 1984; 1985a; 1985b; 1987; 1990; 1993a; 1993b; 2003; 2006; 2007; 2011; 2011a; 2011b; 2012; 2013; 2014; 2015; 2016; 2016a; 2016b; 2016c; 2016d; 2016f; 2006g; 2017a; 2017b; 2017c; 2017d; 2018a, 2018b, 2018c, 2019; 2020; Doğanlar and Çam, 1991; Doğanlar and Mendel, 2007; Doğanlar and Triapitsyn, 2007; Doğanlar and Doğanlar, 2008a; 2008b; 2009; 2010; Doğanlar et al. 2009a; 2009b; Doğanlar and Hassan, 2010; Doğanlar et al., 2010; Doğanlar and Yiğit, 2011; Doğanlar et al., 2011a; 2011b; Doğanlar and Doğanlar, 2012; 2013; 2013a; 2013b; 2014a; 2014b; Doğanlar et al., 2013; Doğanlar and Aslan, 2018; Doğanlar and Zengin, 2018; Doğanlar et al., 2018a; Doğanlar and Yiğit, 2019; Doğanlar et al., 2020; Doğanlar and Laz, 2022; 2023; Gençer and Doğanlar 1995; Gençer, 2004; 2009a; 2009b;

Güler and Kodon 2010; İpekdal et al., 2014; Japoshvili et al., 2002; Japoshvili and Karaca, 2002; Japoshvili and Khan, 2004; Japoshvili, 2007; Japoshvili and Çelik, 2010; Japoshvili, 2012; Japoshvili and Noyes, 2005; Kaçar and Doğanlar, 2020; Karaca and Uygun, 1990; Karaca et al., 2003; Kaydan and Japoshvili, 2010; Mete and Mergen, 2017; Öncüler, 1991; Özbek et al., 1999; Özbek and Çoruh, 2010; Özgen et al., 2018; Polat and Tozlu, 2010; Sakaltaş and Gençer, 2005; Sakaltaş Arıyak and Tüzün, 2014; 2016; Stojanova et al., 2012; Ulgenturk and Toros, 2001; Yıldırım and Çalmaşur, 2002; Comrade, 1995; Zerova and Seryogina, 2003).

There are more than 26,000 identified species of Chalcidoidea worldwide, and with unidentified species, this number is estimated at more than 100,000. Current studies suggested that there may be more than 500,000 species (Noyes, 2019; Ghahari et al., 2021). Many species of Chalcidoidea have bright, metallic, and eye-catching colors. Their body length ranges between 0.3-17 mm. Their small size can make them extremely difficult to collect and investigate. Therefore, they have received comparatively little attention from taxonomists. If it is not for their importance as parasitoids of insect pests, the group would receive even less attention. Although their general morphology is in the form of the features described in Hymenoptera, they can be easily distinguished from other Hymenoptera groups with some of their distinct features. These features are usually seen in the antenna, wing and lateral region of the mesosome. Elbowed antennae and the presence of multiporous plate sensilla (longitudinal sensilla) with free apical ends in the antennae of both sexes (Gibson, 1986; Başıbüyük and Quicke, 1999) make them easily distinguished from other small Hymenoptera. Another common feature that distinguishes Chalcids from other Hymenoptera is the presence of a triangular scleritis, the prepectus, lateral to the mesosoma between the tegula and the pronotum. However, in most Chalcids the prepectus is very small, so it would be difficult to distinguish by considering the prepectus. In Chalcidoids, the wing is well developed, its veins are reduced, it is reduced to a single longitudinal vein anteriorly, and the cellular structure in the wing branches only at the end of the longitudinal vein to form the postmarginal and stigmal vein. Most of the time there is no postmarginal vein. Sometimes, the stigmal vein may also become smaller. The first abdominal segment in the metasoma is described as the propodeum. The second abdominal and the next 7 or 8 abdominal segments are called the gasters. The majority of Chalcidoids have a pair of sensory cerci in the 8<sup>th</sup> metasomal tergum.

Chalcidoids are crucial both as biological control agents of agricultural pests and as pests themselves as well. Therefore, more than 800 different

species have been associated with biocontrol programs in one way or another and many Chalcidoid families have been utilized successfully in this regard. However, two families, namely Aphelinidae and Encyrtidae, have been proven extremely successful in the biological control of insect pests. Generally, the beneficial effects of Chalcidoids emerge only when the injudicious use of pesticides leads to their eradication and a consequent explosion of the pest population. Among the Aphelinidae, the genus *Encarsia* is one of the most important parasitoid groups exploited for biological control. Besides, many species have proven their importance in the biological control of whiteflies (Aleyrodidae) and armored-scale insects (Diaspididae). Despite these beneficial effects, more than 80 species are also known to be pests of agriculture, and most of these species belong to the families Eurytomidae and Torymidae (Noyes, 2019).

The economic importance, interesting biological features, and host relationships of Chalcidoids have made Chalcidoid biosystematics a valuable and important field of study. Most species are parasitoid, and their hosts are plant pests. Some of these are Coleoptera, Lepidoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Neuroptera, Odonata, Orthoptera, Psocoptera, Siphonaptera, Strepsiptera, Thysonoptera, as well as spiders' egg sacs, ticks, mites, and nematodes (Boucek, 1988; LaSalle, 1999; Noyes, 2019).

Prof. Dr. Mikdat Doğanlar, who conducted the most comprehensive studies on Chalcidoidea in Turkey, donated his collection consisting of over 12.000 Chalcidoidea specimens to Ankara-Plant Protection Central Research Institute Agricultural Fauna and Microflora department. This collection is an indispensable comparison resource for researchers working on Chalcidoidea systematics, plant protection and biological diversity.

The Chalcidoidea superfamily has been recently divided into 19 separate families with more than 90 subfamilies recognized. Currently, the largest family is the Eulophidae with nearly 4,500 included species and followed closely by the Encyrtidae and Pteromalidae (Noyes, 2019). In this study, the families, genera, and species belonging to the Chalcidoidea fauna of Turkey were based on the Universal Chalcidoidea Database and the studies conducted in Turkey. Some information about the tours (publications with Turkey records, hosts, associates, parasitoids, and general distributions) is also presented in this book. Accordingly, it was determined that 19 families, 51 subfamilies, 269 genus and 1024 species (see Table 1) of Chalcidoidea were distributed in Turkey. The highest

number of species belonged to the families such as Eulophidae, Pteromalidae, and Encyrtidae (Noyes, 2019). In addition, the species names of Chalcidoidea found in Turkey are presented in the appendix section of the book. The aim of this study is to reveal the place of Chalcidoidea, an agriculturally important parasitoid group, in the fauna of Turkey and to help researchers with similar purposes.

**Table 1:** Number of families, subfamilies, genus, and species of Chalcidoidea identified and registered in Turkey according to Universal Chalcidoidea Database (Noyes, 2019)

| Family              | Genus     | Species    |
|---------------------|-----------|------------|
| <b>Agaonidae</b>    |           |            |
| Agaoninae           | 1         | 1          |
| Blastophaginae      | 1         | 1          |
| <b>Total</b>        | <b>2</b>  | <b>2</b>   |
| <b>Aphelinidae</b>  |           |            |
| Aphelininae         | 3         | 21         |
| Calesinae           | 1         | 1          |
| Coccophaginae       | 5         | 24         |
| Eretmocerinae       | 1         | 3          |
| <b>Total</b>        | <b>10</b> | <b>49</b>  |
| <b>Azotidae</b>     | <b>1</b>  | <b>3</b>   |
| Chalcididae         |           |            |
| Chalcidinae         | 1         | 10         |
| Dirhininae          | 1         | 1          |
| Haltichellinae      | 11        | 28         |
| <b>Total</b>        | <b>13</b> | <b>39</b>  |
| <b>Encyrtidae</b>   |           |            |
| Encyrtinae          | 45        | 118        |
| Tetracneminae       | 14        | 46         |
| <b>Total</b>        | <b>59</b> | <b>164</b> |
| <b>Eucharitidae</b> |           |            |
| Eucharitinae        | 2         | 6          |
| <b>Total</b>        | <b>2</b>  | <b>6</b>   |
| <b>Eulophidae</b>   |           |            |
| Entedoninae         | 6         | 81         |
| Entiinae            | 2         | 4          |
| Eulophinae          | 22        | 76         |
| Opheliminae         | 1         | 1          |
| Tetrastichinae      | 17        | 83         |
| <b>Total</b>        | <b>48</b> | <b>245</b> |
| <b>Eupelmidae</b>   |           |            |
| Calosotinae         | 2         | 3          |

|                             |           |            |
|-----------------------------|-----------|------------|
| Eupelminae                  | 2         | 14         |
| <b>Total</b>                | <b>4</b>  | <b>17</b>  |
| <b>Eurytomidae</b>          |           |            |
| Eurytominae                 | 8         | 96         |
| Rileyinae                   | 1         | 2          |
| <b>Total</b>                | <b>9</b>  | <b>98</b>  |
| <b>Leucospidae</b>          | <b>1</b>  | <b>6</b>   |
| <b>Megastigmidae</b>        | <b>3</b>  | <b>20</b>  |
| <b>Mymaridae</b>            | <b>9</b>  | <b>19</b>  |
| <b>Ormyridae</b>            | <b>1</b>  | <b>12</b>  |
| <b>Perilampidae</b>         |           |            |
| Chrysolampinae              | 4         | 17         |
| Perilampinae                | 1         | 2          |
| <b>Total</b>                | <b>5</b>  | <b>19</b>  |
| <b>Pteromalidae</b>         |           |            |
| Asaphinae                   | 1         | 2          |
| Ceinae                      | 1         | 1          |
| Cerocephalinae              | 1         | 1          |
| Cleonyminae                 | 1         | 1          |
| Colotrechninae              | 1         | 9          |
| Diparinae                   | 1         | 1          |
| Epichrysomallinae           | 1         | 1          |
| Eunotinae                   | 2         | 2          |
| Miscogastrinae              | 5         | 21         |
| Ormocerinae                 | 2         | 2          |
| Otitesellinae               | 1         | 1          |
| Pireninae                   | 2         | 6          |
| Pteromalinae                | 46        | 124        |
| Spalangiinae                | 1         | 4          |
| Sycoryctinae                | 1         | 3          |
| <b>Total</b>                | <b>67</b> | <b>179</b> |
| <b>Signiphoridae</b>        | <b>2</b>  | <b>3</b>   |
| <b>Tetracampidae</b>        |           |            |
| Mongolocampinae             | 1         | 1          |
| Platynocheilinae            | 1         | 2          |
| Tetracampinae               | 2         | 5          |
| <b>Total</b>                | <b>4</b>  | <b>8</b>   |
| <b>Torymidae</b>            |           |            |
| Chalcimerinae               | 1         | 1          |
| Erimerinae                  | 7         | 49         |
| Glyphomerinae               | 1         | 2          |
| Monodontomerinae            | 2         | 6          |
| Podagrioninae: Podagrionini | 2         | 3          |
| Toryminae: Torymini         | 2         | 22         |
| Toryminae: Torymoidini      | 4         | 28         |
| <b>Total</b>                | <b>19</b> | <b>111</b> |

|                                     |                  |                     |
|-------------------------------------|------------------|---------------------|
| Trichogrammatidae                   |                  |                     |
| Oligositinae: Chaetostichini        | 6                | 8                   |
| Oligositinae: Oligositini           | 2                | 5                   |
| Trichogrammatinae: Trichogrammatini | 2                | 11                  |
| <b>Total</b>                        | <b>10</b>        | <b>24</b>           |
| <b>CHALCIDOIDEA TOTAL</b>           | <b>269 Genus</b> | <b>1024 species</b> |

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## CHAPTER ONE

### FAMILY: AGAONIDAE WALKER, 1846

The Agaonidae is a medium-sized family found in both tropical and subtropical regions. They are generally only collected on figs. The family is characterized by the head lacking a horseshoe-shaped occipital carina (which is typical of Torymidae), and their bodies are generally smooth or have only very faint sculpturing. They also have at least one of the following characteristics: mid-femur being distinctly thinner than either fore or hind legs, mandibles in females are modified into rasp-like structures, and female metasoma is turned into terminal 'tail' composed of either ovipositor alone or ovipositor and terminal tergites. In addition, the stigmal vein of the forewing is often thin and at a right angle to the wing margin. Species in this family are often strongly sexually dimorphic with males being wingless and having reduced appendages, making them hardly recognizable as wasps.

All agaonids are associated with figs (*Ficus*), with some acting as pollinators (Agaoninae) and others as phytophagous or possibly parasitoids. All species are associated with the fig inflorescences (syconia). The relationship between figs and their Agaonine pollinators is an obligate mutualism because *Ficus* species can only be pollinated by the right species of fig wasps, and fig wasps are unable to produce progeny outside a narrow spectrum of fig species. The biology of non-pollinator species of Agaonidae is poorly known; however, it is believed that most of these species, which have generally been considered as parasitoids, are phytophagous. The larvae feed on the fig ovaries or may be seed-eaters or gall-formers within the fig syconia (Stringer et al., 2012).

While there are currently 76 genera and 757 species in six subfamilies in the world, there are two species belonging to two subfamilies in Turkey (Noyes, 2019).

**Subfamily Agaoninae** (Walker, 1846)

**Genus *Eupristina*** (Saunders, 1882)

***Eupristina verticillata*** (Waterston, 1921)

**Publications with Turkey records:** Doğanlar (2012), Noyes (2019).

**Associates:** *Odontofroggattia sp.*, *Walkerella kurandensis* (Pteromalidae), *Ficus macrocarpa*, *Ficus microcarpa*, *Ficus retusa*, *Ficus aurea* (Moraceae) (Noyes, 2019).

**Hosts:** *Ficus aurea*, *Ficus microcarpa* (Moraceae) (Noyes, 2019).

**Parasitoids:** *Odontofroggattia galili*, *Philotrypesis okinavensis*, *Philotrypesis taiwanensis*, *Sycoryctes moneres*, *Sycoscapter gajimaru* (Hymenoptera; Agaonidae) (Noyes, 2019).

**Distribution:** Afrotropical, Australia, Bermuda, Brazil (Sao Paulo), Canary Islands, El Salvador, Hawaii, Honduras, India, Indonesia, Italy, Japan, Madeira, Malaysia, Mexico, People's Republic of China, Hong Kong, Philippines, Puerto Rico, Solomon Islands, Taiwan, Tunisia, Turkiye, United States of America (Noyes, 2019).

**Subfamily Blastophaginae** (Kirchner, 1867)

**Genus *Blastophaga*** (Gravenhorst, 1829)

***Blastophaga psenes*** (Linnaeus, 1758)

**Publications with Turkey records:** Doğanlar (2012), Noyes (2019).

**Associates:** *Philotrypesis caricae* (Hymenoptera: Agaonidae), *Fusarium sp.*, *Fusarium moniliforme*, *Fusarium verticillioides* (Fungus), *Crematogaster scutllaris* (Formicidae), *Schistonchus caprifici* (Nematoda: Aphelenchoididae) (Noyes, 2019).

**Hosts:** *Ficus carica*, *Ficus palmata* (Moraceae), *Philotrypesis caricae* (Hymenoptera: Agaonidae) (Noyes, 2019).

**Parasitoids:** *Philotrypesis caricae* (Hymenoptera: Agaonidae) (Noyes, 2019).

**Distribution:** Afghanistan, Algeria, Armenia, Australia (New South Wales), Canary Islands, Caucasus, Croatia, Eritrea, Ethiopia, Europe, France, India, Iran, Israel, Italy, Nearctic, Nepal, North Africa, Pakistan, South Africa, Turkey, Ukraine, United States of America (Arizona, California, Texas), USSR, Central Asia, Yemen (Noyes, 2019).

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## CHAPTER TWO

### FAMILY: APHELINIDAE THOMSON, 1876

The Aphelinidae are a medium-sized family of Chalcids that are often overlooked due to their extremely small size (0.5–1.5 mm). They are characterised by the antenna having four or less funicular segments, the tarsi having 4–5 segments, the fore tibial spur being large, curved and bifid, the metasoma being broadly joined to the thorax (not the petiolate), and the notauli being complete, straight, deep, and widely separated posteriorly (generally by more than the length of the scutellum).

Aphelinids are commonly reared from a large variety of homopteran hosts. Most are primary ecto- or endoparasitoids of Hemiptera: Sternorrhyncha (especially Coccoidea, Aleyrodoidea, and Aphidoidea). However, others attack the eggs of these groups or of Orthoptera (grasshoppers and crickets), and still others are obligatory or facultative hyperparasitoids. Several of these species are of particular interest because males and females of the same species may develop in very different ways. In well-studied species, the females are always primary endoparasitoids. However, the males may develop as primary ectoparasitoids on the same host, as hyperparasitoids on their own species, as facultative hyperparasitoids on their own or other species, or as obligate hyperparasitoids on other species. There are numerous examples of aphelinids being used successfully in classical biological control, and this family boasts more such successes than any other group of entomophagous insects. The majority of aphelinids belong to the subfamilies Aphelininae (antenna with six or less segments and lineae calvae present) and Coccophaginae (antenna with 7–9 segments and lineae calvae absent) (Stringer et al., 2012).

The family currently includes 33 genera and 1168 species classified in seven subfamilies. There are 49 species in four subfamilies in Turkey (Noyes, 2019).

**Subfamily Aphelininae** (Thomson, 1876)**Genus *Aphelinus*** (Dalman, 1820)***Aphelinus asychis*** (Walker, 1839)**Publications with Turkey records:** Noyes (2019), Öncüer (1991).

**Associates:** *Paecilomyces fumosoroseus* (Fungus), *Aphidius ervi* (Braconidae), *Aphidencyrus annulipes*, *Aphidencyrus aphidivorus* (Encyrtidae), *Asaphes suspensus*, *Pachyneuron aphidis* (Pteromalidae), *Helianthus* sp., *Helianthus annuus*, *Sonchus* sp., *Sonchus oleraceus* (Asteraceae), *Heliotropium europaeum* (Boraginaceae), *Brassica napus*, *Brassica oleracea*, *Raphanus sativus* (Brassicaceae), *Cucumis sativus* (Cucurbitaceae), *Medicago sativa*, *Phaseolus radiatus*, *Trifolium pratense*, *Vicia faba*, *Wisteria* sp. (Fabaceae), *Paecilomyces fumosoroseus* (Fungus), *Ocimum* sp. (Lamiaceae), *Gossypium hirsutum* (Malvaceae), *Picea pungens* (Pinaceae), *Hordeum vulgare*, *Saccharum officinarum*, *Sorghum* sp., *Triticum aestivum* (Poaceae), *Emex australia*, *Rumex obtusifolius* (Polygonaceae), *Digitalis* sp. (Scrophulariaceae), *Capsicum annuum*, *Lycopersicon esculentum*, *Solanum tuberosum* (Solanaceae) (Noyes, 2019).

**Hosts:** *Phytomyza atricornis* (Agromyzidae), *Acyrtosiphon* sp., *Acyrtosiphon kondoi*, *Acyrtosiphon pisum*, *Aphis* sp., *Aphis chloris*, *Aphis citricola*, *Aphis craccivora*, *Aphis gossypii*, *Aphis helianthi*, *Aphis nerii*, *Aulacorthum solani*, *Brachycaudus persicae*, *Brachycolus korotniewi*, *Brachycolus noxius*, *Brevicoryne* sp., *Brevicoryne brassicae*, *Chaetosiphon fragaefolii*, *Dactynotus helianthicola*, *Diuraphis* sp., *Diuraphis noxia*, *Diuraphis tritici*, *Elatobium abietinum*, *Holcaphis tritici*, *Hyperomyzus lactucae*, *Lipaphis* sp., *Lipaphis erysimi*, *Macrosiphoniella* sp., *Macrosiphum* sp., *Macrosiphum avenae*, *Macrosiphum convolvuli*, *Macrosiphum euphorbiae*, *Megoura viciae*, *Metopolophium dirhodum*, *Metopolophium festucae*, *Myzaphis* sp., *Myzaphis rosarum*, *Myzodes persicae*, *Myzus* sp., *Myzus convolvuli*, *Myzus ornatus*, *Myzus persicae*, *Nasonovia ribisnigri*, *Neomyzus* sp., *Rhopalosiphum maidis*, *Rhopalosiphum padi*, *Rungia maydis*, *Schizaphis* sp., *Schizaphis graminum*, *Sipha flava*, *Sipha glyceriae*, *Sitobion avenae*, *Therioaphis maculata*, *Therioaphis trifolii*, *Toxoptera citricidus* (Hemiptera: Aphididae) (Noyes, 2019).

**Distribution:** Afghanistan, Angola, Argentina, Australia, Azerbaijan, Belgium, Brazil, Canada, Canary Islands, Chile, Colombia, Croatia, Czech Republic, Egypt, Europe, Finland, France, Georgia, Germany, Greece, Hawaii, Hungary, India, Iran, Iraq, Israel, Italy, Japan, Kazakhstan, Mexico, Morocco, Nearctic, Nepal, Netherlands, Norway, Pakistan, Palaearctic, People's Republic of China, Portugal, Russia, Slovakia, South Africa, Spain, Sweden, Transcaucasus, Tselinograd Obl., Türkiye, Ukraine, United Kingdom, United States of America, USSR, Central Asia (Noyes, 2019).