http://dergipark.org.tr/trkjnat
Trakya University Journal of Natural Sciences, 23(Special Issue): S53-S64, 2022
ISSN 2528-9691
DOI: 10.23902/trkjnat.1115893

Research Article
Special Issue: Biodiversity of Insects

CONTRIBUTION TO THE KNOWLEDGE OF THE ZYGAENIDAE (LEPIDOPTERA) OF TÜRKİYE

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Cite this article as:

Can F., Ulaşlı B., Karaçetin E, & Akar S. 2022. Contribution to the knowledge of the Zygaenidae (Lepidoptera) of Türkiye. *Trakya Univ J Nat Sci*, 23(Special Issue): S53-S64, DOI: 10.23902/trkjnat.1115893

Received: 12 May 2022, Accepted: 08 July 2022, Published: 20 July 2022

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Key words:
Zygaeninae
Procridinae
Moth
Endemic
Fauna
Systematic

Abstract: The aim of this study is to contribute to the recent distribution and systematic classification of Zygaenidae (Lepidoptera) in 12 provinces in the Aegean, eastern Anatolia, and Thrace regions of Türkiye, with the records obtained from May 2020 to September 2021. Specimens were collected or photographed at 49 out of 132 localities. Twenty Zygaenidae species from five genera belonging to Procridinae and Zygaeninae subfamilies were recorded: *Theresimima* Strand, 1917 (1 species), *Rhagades* Wallengren, 1863 (1 species), *Adscita* Retzius, 1783 (1 species), *Jordanita* Verity, 1946 (5 species), and *Zygaena* Fabricius, 1775 (12 species). *Zygaena* (*Zygaena*) *ephialtes* (Linnaeus, 1767) was recorded again nearly 200 years later since after Herrich-Schäffer's first record in 1845. *Zygaena* (*Mesembrynus*) *lydia* Staudinger, 1887 endemic to Türkiye, was also recorded in this study. In addition, new localities of *Zygaena* (*Agrumenia*) *armena* Eversman, 1851, which is known only in Türkiye and Georgia, were also recorded from the Ardahan province in the eastern Anatolia region of Türkiye.

Özet: Bu makalenin amacı, Türkiye'nin Ege, Doğu Anadolu ve Trakya bölgelerindeki 12 ilde bulunan Zygaenidae (Lepidoptera)'nin yakın dönemdeki dağılımı ve sistematik sınıflandırmasına Mayıs 2020- Eylül 2021 tarihleri arasında elde edilen kayıtlarla katkı sağlamaktır. Ziyaret edilen 132 alandan 49'unda Zygaenid güveleri toplanmış ya da fotoğraflanmıştır. Procridinae ve Zygaeninae alt familyalarına ait, 5 cinse giren, 20 Zygaenidae türü belirlenmiştir: *Theresimima* Strand, 1917 (1 tür), *Rhagades* Wallengren, 1863 (1 tür), *Adscita* Retzius, 1783 (1 tür), *Jordanita* Verity, 1946 (5 tür), ve *Zygaena* Fabricius, 1775 (12 tür). *Zygaena* (*Zygaena*) *ephialtes* (Linnaeus, 1767) de yaklaşık 200 yıl önceki Herrich-Schäffer (1845)'in ilk kaydından sonra Türkiye'nin Trakya bölgesindeki yeniden kaydedilmiştir. Türkiye'ye endemik olan *Zygaena* (*Mesembrynus*) *lydia* Staudinger, 1887, bu çalışmada güncel olarak kaydedilmiştir Ayrıca, sadece Türkiye ve Gürcistan'da bilinen *Zygaena* (*Agrumenia*) *armena* Eversman, 1851'ya ait yeni lokaliteler Doğu Anadolu Bölgesinde, Ardahan ilinden iletilmiştir.

Introduction

Türkiye is located at the intersection of three different phytogeographic vegetation zones; The Euro-Siberian, Irano-Turanian and Mediterranean regions (FAO 2019). Each region has high level of endemism and contains a rich species diversity considering both flora and fauna (FAO 2019). Euro-Siberian Region extends from Bulgaria along most of north Anatolia to the west, and to Georgia in the north. The Irano-Turanian Region, the largest of the three regions, is confined to central and eastern Anatolia.The Mediterranean region reflects the communities of the East Mediterranean extending from eastern half of Italy to Lebanon (Davis 1965-1985, Takhtajan *et al.* 1986, FAO 2019).

Türkiye, acting as both a bridge and a barrier between Asia and Europe, is one of the most species-rich countries in the western Palaearctic Region in terms of flora and fauna (Çıplak 2003). Thrace is the region that covers the part on the European side of Türkiye, and includes the Edirne, Kırklareli and Tekirdağ provinces and the western sections of İstanbul and Çanakkale provinces. The surface area of Thrace region corresponds to 3% of Türkiye with 23,485 km^2. Asian side of Türkiye (Anatolia) is a biologically diverse region since its variable topography and climate provide many different macro or micro habitats; the region is a bridge between Asia and Europe in the south and to the Ethiopian region via the Arabian

Peninsula. It thus provides a natural pathway for the spread of species both via the north-south and east-west routes. Its tectonic evolution has continuously changed through Tertiary and Quaternary periods, providing an important refuge during the Quaternary ice ages receiving populations via the Balkans and/or the Caucasus (Çıplak 2003). Consequently, Anatolia has a distinctive zoogeography and habitat diversity. The European continent consists of approximately 15,000 plant species. The number of described taxa in Türkiye's flora is around 12,000 (11,707) of which 31.82% is endemic to the country (Güner 2014).

The loss of biological diversity in the Anthropocene era has been shown as one of the most intense environmental problems today (UN 2020). Biodiversity is rapidly declining at an unprecedented rate due to many threats, mainly loss of habitats by industrialization, urbanization, industrialization in agriculture, and climate change (Warren 2021). Considering all these threats, discovering the natural richness of Türkiye must be given more priority. Like all living organisms, the order Lepidoptera is adversely affected by all these factors (Karaçetin *et al.* 2011). To be able to protect species, scientific studies including producing distribution maps, and identifying relevant threats are required. This study concentrates on one of the most prominent families of Lepidoptera, Zygaenidae family. The Zygaenidae family contains several endemic species in Türkiye. Identification of endemic and other zygaenid species, determination of their biological characteristics and defining their current distribution are extremely crucial for future conservation practices in Türkiye.

Zygaenidae is a species rich family of predominantly diurnal moths with a worldwide distribution, being most diverse in tropical and subtropical Asia and Palearctic regions (Epstein 1996). The family, commonlyknown as burnet, forester, and smoky moths, contains more than 1,000 species distributed worldwide and the number of described species increases annually (Efetov *et al.* 2021). Zygaenid moths are distributed along a variety of natural and occasionally secondary habitats, from coastal dunes and cliffs and dry Mediterranean landscapes to various arboreal habitats and even high alpine and extreme boreal regions (Tarmann 2003). Based on the recent revisions, Zygaenidae includes five subfamilies: Chalcosiinae (Palearctic, Oriental), Callizygaeninae (Oriental), Inouelinae (Oriental), Procridinae (Holarctic, Afrotropical, Oriental, Australian, Neotropical) and Zygaeninae (Palearctic, Oriental, Afrotropical) (Alberti 1954, 1958, 1959, Tarmann 1984, 1994, 2004, Hofmann & Tremewan 1996, Efetov 1999, Yen 2003, Efetov & Tarmann 2012, 2014, 2016, 2017, Efetov *et al.* 2014, 2019, Ulaşlı & Can 2021).

The early studies of the family in Türkiye are based on the records from Anatolia by Zeller and Mann in 1847 and 1862 respectively. Subsequently Holik & Sheljuzhko (1953-1958), Reiss & Reiss (1969, 1972b, 1973) and Reiss & Schulte (1968) extended our knowledge on this group especially for western Anatolia, while Naumann & Naumann (1980) were the first to list and discuss the complete burnet moths (*Zygaena* Fabricius, 1775) fauna of northern and eastern Anatolia. They recorded 24 species including 3 new records (*Z. sedi* Fabricius, 1775, *Z. fraxini* Ménétriés, [recte *Z. peschmerga* Eckweiler & Görgner, 1982], *Z. cynarae* (Esper, 1789)) at that time. Later, *Z. turkmenica* Reiss, 1933 *Z. haematina* Kollar, [1849], *Z. mana* Kirby, 1892 and *Z. nevadensis* Rambur, 1858 were added (Görgner & Hofmann 1982, Reiss 1981, Lambert & Naumann 1992, Hofmann & Tremewan 2017). The complete inventory of burnet moths, their origin and ecological reference, refugia and endemics were currently listed by Hofmann & Tremewan (2017).

Currently, there are 56 Zygaenidae species recognized in Türkiye; 24 of which belong to Procridinae, and 32 species belong to Zygaeninae. Among these, five species are endemic to Türkiye: *Jordanita* (*Jordanita*) *chloronota* (Staudinger,1871), *Zygaena* (*Agrumenia*) *formosa* (Herrich-Schäffer, 1852), *Zygaena* (*Agrumenia*) *peschmerga* Eckweiler & Gorgner, 1981, *Zygaena* (*Mesembrynus*) *lydia* Staudinger, 1887, and *Zygaena* (*Zygaena*) *problematica* Naumann, 1966 (Efetov *et al.* 2010a, 2010b, 2019, Hofmann & Tremewan, 2017, Can Cengiz *et al.* 2018, Okyar *et al.* 2018, Can *et al.* 2019, Ulaşlı *et al.* 2021).

Identification of endemic and other zygaenid species, and the determination of their distribution are both crucial for the understanding, and the conservation of the Turkish fauna. This study aims to contribute to the knowledge Zygaenidae fauna in Türkiye which will provide a baseline for future conservation studies.

Materials and Methods

In recent years, some studies have been carried out to determine the Zygaenidae species of different regions of Türkiye. (Can Cengiz *et al.* 2012, 2018, 2019, Ulaşlı & Can 2021). In this study, both additional records were made from these regions and provincial records were given years after from the eastern Anatolia region. It is especially important to update the records of endemic species. In this study, most of the specimens were collected by the authors in different localities of Türkiye using sweep net at different altitudes with different climatic conditions, plant cover and surface features in Muğla, Denizli and Uşak in the Aegean region; in Ardahan, Erzincan, Kars and Erzurum provinces that are in the eastern Anatolia and İstanbul, Çanakkale, Kırklareli, Edirne and Tekirdağ from the Thrace region of Türkiye from May 2020 to September 2021. Some zygaenid species were observed and photographed in the field. The identification of the specimens, terminology, classification, and nomenclature of morphological structures are based on Hofmann & Tremewan (1996), Naumann *et al.* (1999), Hofmann & Tremewan (2017) and Hofmann & Tremewan (2020). Collected specimens were dissected in the laboratory, with the genitalia embedded in entellan on slides, following standard procedures. Genitalia slides were viewed using an

Olympus SZ40 microscope and photographs were taken with Canon EOS50D and the species identifications were confirmed by Prof. Dr. Konstantin Efetov (Crimea), Prof. Dr. Gerhard M. Tarmann (Austria) and Mr. Axel Hofmann (Germany). All specimens ae deposited in the Museum of Hatay Mustafa Kemal University, Hatay, Türkiye. Field observations were undertaken in 132 localities of 12 provinces of three different regions in Türkiye are coded as follows (See Fig.1 for the map):

A - Aegean Region

A1 Muğla, Dağdibi Vill., 37°10'28"N, 28°15'17"E, 579m.

A2 Muğla, Yeniköy-I, 37°08’31”N, 28°12’16”E, 700m.

A3 Muğla, Meke I, 37°08’23”N, 28°09’31”E, 707m.

A4 Muğla, Meke II, 37°06’51”N, 28°07’28”E, 1170m.

A5 Muğla, Pınaraltı, 37°04’41”N, 28°02’46”E, 530m.

A6 Muğla, Ören, 37°04’12”N, 27°59’42”E, 60m.

A7 Muğla, Ula, 37°06’47”N, 28°23’18”E, 610m.

A8 Muğla, Yukarımazı, 37°02’47”N, 27°42’03”E, 340m.

A9 Muğla, İncir, 37°06’26”N, 28°28’25”E, 560m.

A10 Muğla, Yeşilüzümlü-Ortaköy, 36°43’29”N, 29°15’50”E, 630m.

A11 Denizli, Citycenter (Eskihisarintersection), 37°49’33”N, 29°06’34”E, 293m.

A12 Denizli, Honaz National Park, 37°44’54”N, 29°16’31”E, 740m.

A13 Denizli, Mahmutgazi Değirmendere, 38°02’54”N, 29°26’25”E, 798m.

A14 Denizli, Selcen, 38°06’00”N, 29°19’04”E, 968m.

A15 Uşak, Güllü, 38°16’45”N, 29°07’37”E, 550m.

A16 Denizli, Kızılyer, 37°46’13”N, 29°19’58”E, 520m.

A17 Uşak, Kıranköy, 38°22’22”N, 29°11’19”E, 706m.

A18 Uşak, Ulubey, 38°27’01”N, 29°18’11”E, 785m.

A19 Uşak, Uşak University Campus, 38°40’24”N, 29°20’09”E, 920m.

A20 Uşak, Kaplıca, 38°38’19”N, 29°03’02”E, 583m.

A21 Uşak, Cemalçavuş, 38°34’22”N, 29°01’54”E, 750m.

A22 Uşak, Dumanlar, 38°28’56”N, 28°58’41”E, 932m.

A23 Uşak, Yeşilkavak, 38°19’41”N, 28°58’42”E, 690m.

A24 Denizli, Güney Yenikonak Vill., 38°12’14”N, 29°06’12”E, 736m.

A25 Denizli, Mecidiye, 37°54’34”N, 29°37’42”E, 1270m.

A26 Muğla, Algı, 37°08’26”N, 28°15’32”E, 718m.

A27 Muğla, Yeniköy-II, 37°08’01”N, 28°10’43”E, 540m.

A28 Muğla, Çırpı, 37°12’08”N, 28°08’24”E, 852m.

A29 Muğla, Çetibeli, 37°00’03”N, 28°18’13”E, 89m.

A30 Muğla, Muratlar, 37°10’52”N, 28°36’49”E, 895m.

A31 Denizli, Kale, Soğuksu, 37°26’04”N, 28°52’13”E, 1120m.

A32 Uşak, Sivaslı, Akarca, 38°34’13”N, 29°35’05”E, 875m.

A33 Denizli, Çivril, 38°20’11”N, 29°44’28”E, 1023m.

A34 Denizli, Citycenter, 37°38’41”N, 29°13’10”E, 1116m.

A35 Denizli, Tavas, 37°25’10”N, 28°50’25”E, 999m.

A36 Muğla, Ortaköy, 37°10’34”N, 28°25’28”E, 640m.

A37 Uşak, Banaz, Kızılcasöğüt, 38°37’17”N, 29°39’42”E, 980m.

A38 Uşak, Sivaslı, Erice, 38°34’25”N, 29°38’56”E, 865m.

A39 Uşak, Sivaslı, Yenierice, 38°32’31”N, 29°38’36”E, 858m.

A40 Uşak, Banaz, 38°41’11”N, 29°40’00”E, 997m.

A41 Uşak, Banaz, Yeşilyurt, 38°47’38”N, 29°43’55”E, 1025m.

A42 Uşak, Banaz, Küçükoturak, 38°49’46”N, 29°42’53”E, 1120m.

A43 Uşak, Banaz, Çamsu, 38°50’07”N, 29°37’52”E, 108m.

A44 Uşak, Merkez, Çamyuva, 38°49’16”N, 29°33’35”E, 1250m.

B - Eastern Anatolia Region

B1 Erzincan, Reşadiye, City Center, 39°53’00”N, 38°51’00”E, 1686m.

B2 Erzincan, Ahmetli, Gümüşhane road, 39°52’00”N, 39°20’00”E, 2045m.

B3 Erzincan, Bozçalı, 39°42’00”N, 38°36’00”E, 1400m.

B4 Erzurum, 39°16’17”N, 41°35’50”E, 2111m.

B5 Erzurum, 39°25’12”N, 41°35’53”E, 1807m.

B6 Erzurum, 39°53’7”N, 41°39’7”E, 1813m.

B7 Erzurum, 39°55’14”N, 40°29’26”E, 1963m.

B8 Erzurum, 40°9’4”N, 40°59’19”E, 2167m.

B9 Erzurum, 40°20’21”N, 41°37’6”E, 1989m.

B10 Kars, 40°26’47”N, 42°33’19”E, 2161m.

B11 Erzurum, 40°39’48”N, 41°1’51”E, 1739m.

B12 Ardahan, 41°29’0”N, 42°40’7”E, 1818m.

B13 Ardahan, 41°31’45”N, 42°36’4”E, 2178m.

B14 Ardahan, 41°14’20”N, 43°5’4”E, 1875m.

B15 Ardahan, 41°7’31”N, 42°46’53”E, 1818m.

B16 Ardahan, 41°1’7”N, 42°25’6”E, 2067m.

C - Thrace Region

C1 İstanbul, Çiftalan, 41°14’13”N, 28°54’25”E, 178m.

C2 İstanbul, Çatalca, Kadıköy, 41°09’41”N, 28°21’34”E, 185m.

C3 İstanbul, Yolçatı, 41°08’30”N, 28°08’57”E, 151m.

C4 Tekirdağ, Karamehmet, 41°17’13”N, 27°47’11”E, 180m.

C5 Tekirdağ, Kumbağ, 40°51’04”N, 27°27’07”E, 191m.

C6 Tekirdağ, Uçmakdere, 40°49’40”N, 27°23’46”E, 382m.

C7 Tekirdağ, Mürefte, 40°43’53”N, 27°19’35”E, 67m.

C8 Çanakkale, Gelibolu-Kilitbahir, 40°09’40”N, 26°22’22”E, 75m.

C9 Çanakkale, Eceabat, 40°13’09”N, 26°24’46”E, 55m.

C10 Çanakkale, Evreşe, 40°38’39”N, 26°50’58”E, 60m.

C11 Edirne, Karamahmut, 40°42’52”N, 26°45’17”E, 310m.

C12 Edirne, Keşan Barajı, 40°43’05”N, 26°25’50”E, 60m.

C13 Edirne, Enez, 40°43’36”N, 26°07’02”E, 78m.

C14 Edirne, Karapınar, Uzunköprü, 41°06’30”N, 26°38’26”E, 77m.

C15 Edirne, Kırcasalih, 41°17’50”N, 26°41’44”E, 86m.

C16 Edirne, Karaağaç, 41°39’28”N, 26°32’00”E, 99m.

C17 Kırklareli, Üsküp, 41°41’52”N, 27°20’19”E, 268m.

C18 Kırklareli, Hacıfakı-I, 41°43’41”N, 27°25’43”E, 360m.

C19 Kırklareli, Hacıfakı-II, 41°43’31”N, 27°27’04”E, 336m.

C20 Kırklareli, Kaynarca, 41°41’42”N, 27°28’54”E, 300m.

C21 Kırklareli, Hoyralı, 41°37’32”N, 27°35’05”E, 304m.

C22 Kırklareli, Yenice I, 41°44’54”N, 27°40’14”E, 761m.

C23 Kırklareli, Yenice II, 41°46’33”N, 27°41’58”E, 650m.

C24 Kırklareli, Demirköy, 41°51’40”N, 27°48’49”E, 421m.

C25 Kırklareli, İğneada, 41°52’31”N, 27°58’31”E, 72m.

C26 Edirne, Havsa, Necatiye, 41°30’40”N, 26°52’48”E, 175m.

C27 Kırklareli, Babaeski, Taşköprü, 41°27’17”N, 27°02’32”E, 103m.

C28 Kırklareli, Alpullu, 41°23’05”N, 27°09’16”E, 87m.

C29 Tekirdağ, Hayrabolu, 41°13’08”N, 27°07’01”E, 70m.

C30 Tekirdağ, Velimeşe, 41°14’22”N, 27°53’06”E, 181m.

C31 Kırklareli, Lüleburgaz, Sakızköy, 41°24’48”N, 27°30’21”E, 90m.

C32 Kırklareli, Pınarhisar, Ataköy, 41°36’16”N, 27°27’23”E, 150m.

C33 Kırklareli, Pınarhisar, 41°38’14”N, 27°29’51”E, 177m.

C34 Kırklareli, Pınarhisar, Kaynarca, 41°40’51”N, 27°27’14”E, 207m.

C35 Kırklareli, Karıncak, 41°39’54”N, 27°25’05”E, 225m.

C36 Kırklareli, Beypınar I, 41°46’44”N, 27°29’39”E, 580m.

C37 Kırklareli, Beypınar II, 41°47’45”N, 27°30’21”E, 565m.

C38 Kırklareli, Çukurpınar, 41°51’22”N, 27°28’31”E, 620m.

C39 Kırklareli, Demirhan, Armutveren, 41°54’25”N, 27°32’47”E, 408m.

C40 Kırklareli, Karadere, 41°55’28”N, 27°26’48”E, 466m.

C41 Kırklareli, Dereköy, 41°56’10”N, 27°21’18”E, 470m.

C42 Kırklareli, Geçitağı, 41°57’10”N, 27°17’47”E, 557m.

C43 Kırklareli, Kofçaz, Kula, 41°59’50”N, 27°17’44”E, 531m.

C44 Kırklareli, Kofçaz, Kocayazı, 41°58’12”N, 27°12’40”E, 670m.

C45 Kırklareli, Kofçaz, Kadıköy, 41°49’53”N, 27°10’57”E, 260m.

C46 Edirne, Trakya University Campus, 41°38’46”N, 26°37’20”E, 65m.

C47 Edirne, Kayapa, 41°46’50”N, 26°40’42”E, 120m.

C48 Edirne, Muratçalı, 41°48’10”N, 26°37’26”E, 148m.

C49 Edirne, Çömlek, 41°50’44”N, 26°36’44”E, 116m.

C50 Edirne, Saksağan, 41°53’12”N, 26°35’36”E, 134m.

C51 Edirne, Demirköy, 41°53’12”N, 26°39’50”E, 321m.

C52 Edirne, Hanlıyenice, 41°52’39”N, 26°41’06”E, 255m.

C53 Edirne, Lalapaşa, 41°51’49”N, 26°45’34”E, 252m.

C54 Edirne, Vaysal, 41°55’06”N, 26°50’25”E, 511m.

C55 Edirne, Süleymandanişment, 41°53’33”N, 26°53’24”E, 38m.

C56 Edirne, Ömeroba, 41°54’28”N, 26°57’22”E, 335m.

C57 Edirne, Çeşmeköy, 41°52’46”N, 26°59’28”E, 320m.

C58 Edirne, Karahamza, 41°50’13”N, 26°59’49”E, 247m.

C59 Edirne, Küküler, 41°43’44”N, 26°54’01”E, 134m.

C60 Edirne, Necatiye, 41°29’49”N, 26°55’32”E, 57m.

C61 Edirne, Yolageldi, 41°30’05”N, 27°00’45”E, 69m.

C62 Edirne, Demirkapı, 41°34’05”N, 27°00’45”E, 79m.

C63 Edirne, Dokuzhöyük, 41°38’54”N, 27°03’57”E, 95m.

C64 Edirne, Süloğlu, Büyükgerdelli, 41°44’21”N, 26°56’47”E, 153m.

C65 Kırklareli, İnece, 41°40’10”N, 27°03’55”E, 132m.

C66 Kırklareli, Kızılcıkdere, 41°41’52”N, 27°20’14”E, 210m.

C67 Kırklareli, Üsküp, 41°43’35”N, 27°25’56”E, 305m.

C68 Kırklareli, Pınarhisar, Hacıfaklı, 41°41’43”N, 27°28’59”E, 258m.

C69 Kırklareli, Pınarhisar, Poyralı, 41°37’29”N, 27°35’25”E, 247m.

C70 Kırklareli, Vize, Soğucak, 41°38’49”N, 27°39’23”E, 307m.

C71 Kırklareli, Vize, Sergen, 41°40’57”N, 27°41’03”E, 384m.

C72 Kırklareli, Vize, Soğucak, 41°37’28”N, 27°38’40”E, 271m.

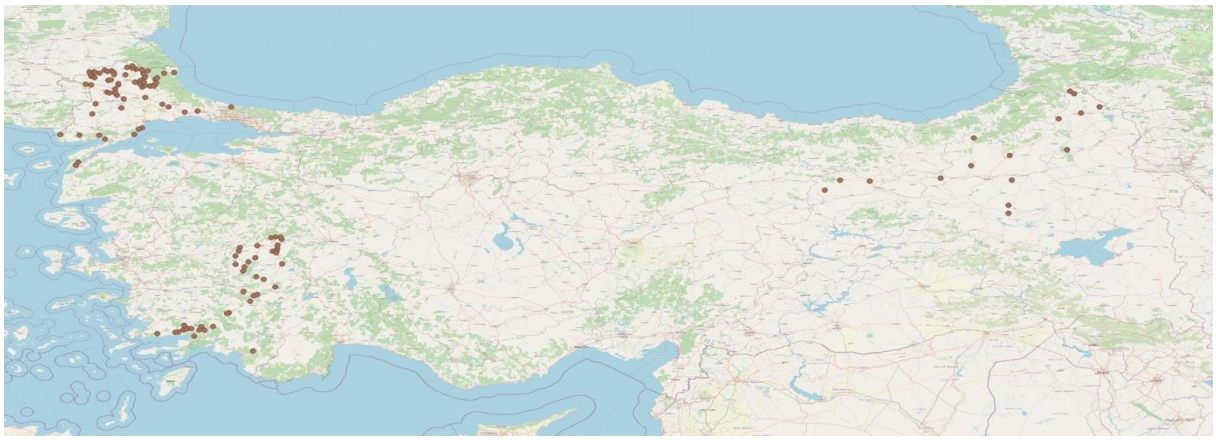

Fig.1. The localities where zygaenid moths were sampled during the study.

Results

In the present study, the results of the identification of zygaenid moths collected or photographed at 49 out of 132 localities in 12 provinces of the Aegean, eastern Anatolia and Thrace regions of Türkiye are presented (Fig. 1). 20 species belonging to five genera and within two subfamilies were identified.

Order LEPIDOPTERA
Family Zygaenidae Latreille
Subfamily Procridinae Boisduval

Theresimima ampellophaga (Bayle-Barelle, 1808): **C11**, 29.VI.2021, 1♂, leg. B. Ulaşlı.

Rhagades (*Wiegelia*) *amasina* (Herrich-Schäffer, 1851): **A1**, 13.VI.2020, 1♀, leg. F. Can; **A7**, 19.V.2020, 3♂♂, 1♀, leg. F. Can; **A37,** 06.VII.2020, 1♀, leg. F. Can; **C12**, 29.VI.2021, 1♂, leg. F. Can.

Adscita (*Adscita*) *statices drenowskii* (Alberti, 1939): **A21**, 24.V.2020, 3♂♂, leg. F. Can.

Jordanita (*Tremewania*) *notata* (Zeller, 1847): **A17**, 24.V.2020, 3♂♂, 1♀, leg. F. Can.

Jordanita (*Jordanita*) *graeca* (Jordan, 1907): **A20**, 24.V.2020, 1♂, 1♀, leg. F. Can.

Jordanita (*Jordanita*) *chloros* (Hübner, 1813): **C14**, 29.VI.2021, 1♀, leg. F. Can.

Jordanita (*Praviela*) *anatolica* (Naufock, 1929): **A2**, 19.V.2020, 1♂, leg. F. Can; **A24**, 27.V.2020, 1♂, leg. F. Can; **C11**, 29.VI.2021, 1♂, 2♀, leg. B. Ulaşlı; **C21**, 30.VI.2021, 4♂♂, 1♀, leg. F. Can.

Jordanita (*Solaniterna*) *subsolana* (Staudinger, 1862): **A8**, 21.V.2020, 6♂♂, leg. F. Can; **B1** 07.VII.2021, 4♂♂, leg. M. Ö. Koyuncu.

Subfamily Zygaeninae Fabricius, 1775

Zygaena (*Agrumenia*) *armena* Eversman, 1851 (Fig. 4): **B12**, 31.VII.2021, 02. VIII.2021, photo: E. Karaçetin; **B13**, 03.VIII.2021, photo: E. Karaçetin.

Zygaena (*Agrumenia*) *carniolica* (Scopoli, 1763) (Fig. 2): **A37**, 06.VII.2020, 6♂♂, leg. F. Can; **A38,** 06.VII.2020, 1♂, leg. F. Can; **B10**, 18.VII.2021, photo: E. Karaçetin; **B14,** 08. VIII.2021, photo: E. Karaçetin; **C5**, 28.VI.2021, 6♂♂, leg. F. Can; **C11**, 29.VI.2021, 4♂♂, 1♀, leg. F. Can; **C12**, 29.VI.2021, 1♂, 2♀, leg. B. Ulaşlı; **C20**, 30.VI.2021, 1♂, 1♀, leg. B. Ulaşlı; **C70**, 15.VII.2021, 1♂, leg. S. Akar; **C71**, 15.VII.2021, 1♂, 1♀, leg. S. Akar.

Zygaena (*Agrumenia*) *loti* ([Denis & Schiffermüller], 1775) (Fig. 3): **A25**, 28.V.2020, 2♀, leg. F. Can; **A31**, 18.VI.2020, 1♂, leg. F. Can; **A35**, 20.VI.2020, 1♂, leg. F. Can; **B8**, 13.VII.2021, photo: E. Karaçetin; **B9**, 14.VII.2021, photo: E. Karaçetin; **C11**, 29.VI.2021, 1♂, 1♀, leg. F. Can; **C12**, 29.VI.2021, 1♂, 1♀, leg. F. Can; **C20**, 30.VI.2021, 4♂♂, leg. F. Can.

Zygaena (*Agrumenia*) *olivieri* Boisduval, 1828: **A37**, 06.VII.2020, 4♂♂, leg. F. Can**; B6**, 09.VII.2021, photo: E. Karaçetin.

Zygaena (*Mesembrynus*) *diaphana* Staudinger, 1887 [Z. (*M.*) *minos* ([Denis &Schiffermüller], 1775)]: **A2**, 21.V.2020 1♀, leg. F. Can; **B12**, 31.VII.2021, photo: E. Karaçetin.

Zygaena (*Mesembrynus*) *laeta* (Hübner, 1790): **A37**, 06.VII.2020, 1♀, leg. B. Ulaşlı; **C11**, 29.VI.2021, 1♂, leg. F. Can; **C11**, 29.VI.2021, 1♂, leg. F. Can; **C12**, 29.VI.2021, 1♂, 3♀, leg. F. Can; **C71**, 15.VII.2021, 1♂,1♀, leg. S. Akar.

Zygaena (*Mesembrynus*) *lydia* Staudinger, 1887: **B2**, 08.VII.2021, 3♂♂, leg. M. Ö. Koyuncu.

Zygaena (*Mesembrynus*) *punctum* Ochsenheimer, 1808: **A1**, 13.VI.2020, 1♀, leg. F. Can; **A2**, 13.VI.2020, 1♂, 1♀, leg. F. Can; **A7**, 13.VI.2020, 2♀, leg. F. Can; **A32**, 20.VI.2020, 3♂♂, 1♀, leg. F. Can; **A37**, 06.VII.2020, 5♂♂, leg. F. Can; **A39**, 06.VII.2020, 1♂, leg. F. Can; **A40**, 06.VII.2020, 6♂♂, leg. F. Can; **A41**, 06.VII.2020, 3♂♂, leg. F. Can; **A44**, 06.VII.2020, 4♂♂, leg. F. Can; **C4**, 28.VI.2021, 1♂, leg. F. Can; **A20,** 24.V.2021, 19♂♂, 1♀, leg. F. Can; **C5**, 28.VI.2021, 9♂♂, leg. F. Can; **C6**, 28.VI.2021, 8♂♂, 2♀, leg. F. Can; **C11**, 29.VI.2021, 1♂, leg. F. Can.

Fig. 2. *Zygaena (Agrumenia) carniolica*. Edirne, Karamahmut, 40°42’52” N; 26°45’17” E, 310 m. Photo: F. Can.

Zygaena (*Zygaena*) *dorycnii* Ochsenheimer, 1808 (Fig. 5): **B3**, 07.VII.2021, 1♂, 1♀, leg. M. Koyuncu; **B4**, 08.VII.2021, photo. E. Karaçetin; **B5**, 08.VII.2021, photo: E. Karaçetin; **B7**, 11.VII.2021, photo: E. Karaçetin; **B8**, 13.VII.2021, photo: E. Karaçetin; **B9**, 14.VII.2021, photo: E. Karaçetin; **B11**, 30.VII.2021, photo: E. Karaçetin; **B12**, 31.VII.2021, photo: E. Karaçetin; **B13**, 03.VIII.2021, photo: E. Karaçetin; **B15**, 05.VIII.2021, photo: E. Karaçetin; **B16**, 05.VIII.2021, photo: E. Karaçetin.

Zygaena (*Zygaena*) *ephialtes* (Linnaeus, 1767) (Fig. 6): **A34**, 20.VI.2020, 2♂♂, leg. F. Can; **C71**, 15.VII.2021, 1♂, 1♀, leg. S. Akar.

Zygaena (*Zygaena*) *filipendulae* (Linnaeus, 1758): **A26,** 17.VI.2020, 1♂, 1♀, leg. F. Can; **A34**, 20.VI.2020, 1♂, leg. F. Can; **A44**, 06.VII.2020, 1♂, leg. F. Can; **B9**, 14.VII.2021, 15.VII.2021, photo: E. Karaçetin; **B11**, 27.VII.2021, 31.VII.2021, photo: E. Karaçetin; **B12**, 31.VII.2021, photo: E. Karaçetin; **C1**, 28.VI.2021, 5♂♂, 1♀, leg. F. Can; **C2**, 28.VI.2021, 1♂, leg. F. Can; **C11**, 29.VI.2021, 7♂♂, leg. F. Can; **C23**, 30.VI.2021, 1♂, leg. F. Can; **C71**, 15.VII.2021, 2♂♂, leg. S. Akar.

Zygaena (*Zygaena*) *lonicerae* (Scheven, 1777): **B9**, 15.VII.2021, photo: E. Karaçetin; **B10**, 17.VII.2021, photo: E. Karaçetin; **B12**, 01.VIII.2021, photo: E. Karaçetin.

Fig.3. *Zygaena* (*Agrumenia*) *loti*. Kırklareli, Kaynarca, 41°41’42” N; 27°28’54” E, 300 m. Photo: F. Can.

Fig.4. *Zygaena* (*Agrumenia) armena*. Ardahan, 41°29’0” N; 42°40’70” E, 1818 m. Photo: E. Karaçetin.

Fig.5. *Zygaena* (*Zygaena*) *dorycnii*. Ardahan, 41°01’07” N; 42°25’06” E, 2067 m. Photo: E. Karaçetin.

Fig. 6. *Zygaena ephialtes chalkidikae*. Kırklareli, Sergen, Vize, 41°40'57" N; 27°41'03" E, 384 m, scale bar: 0.5 mm. Photo: S. Akar.

Discussion

Türkiye has an extraordinarily rich biodiversity with approximately 12,000 plant species (Güner 2014) and unknown number of insect species. Everyday new species are being introduced to the scientific community and more of the research in Türkiye is therefore oriented towards taxonomic studies. However, in a world where biodiversity is in dire crisis, more work is needed for protecting the nature and its biodiversity. Studies like systematic and regular observations of species, producing distribution maps, identifying rare/endemic species and their localities, and identifying their threats are increasingly becoming more important so that a basis for protection of species can be established.

Zygaenidae species are among the well-studied group of moths in Lepidoptera. The species of the Zygaenidae family are excellent indicators of environmental conditions (Efetov, 2005) and a decline in their population size is often a consequence of degradation their habitats due to land-use, intensification of agriculture, and recently, the global climate change (Hofmann and Tremewan, 2017). In the book prepared about the Zygaenidae species in the western palearctic region, the systematic features, life cycles, ecological demands, genetic and behavioral characteristics of the Zygaenidae family are explained in detail (Naumann *et al.* 1999). Hoffmann and Tremewan published the systematic catalog of the Zygaeninae subfamily (1996). In addition, new species in the genus Zygaena were also identified in the neighboring country Iran (Tremewan 1979, Hofmann 2000, Hofmann & Kia-Hofmann 2008, Hofmann & Tremewan 2001, Hofmann & Tremewan 2003). The production of the distribution maps of zygaenid species is an ongoing process. *Biooffice* software has been used for generating the distribution maps of zygaenid species all over the world. This software has been used to create the maps for 13,000 different species from the Alps in the Tyrol region, in addition to the Zygaenidae species in Iran and Procridinae species in the western palearctic region (Tarmann 2010). However, in Türkiye, studies on the Zygaenidae family are very limited with fewer visits and large gaps on the distribution map are present. This study aims to partly fill this gap on the zygaenid species records by reporting the new data collected within 132 localities in 12 provinces of the Aegean, eastern Anatolia and Thrace regions of Türkiye during the subsequent field studies carried out in 2020 and 2021. In this study we recorded thirteen species from the Aegean, 10 species from the eastern Anatolia, 10 species from the Thrace provinces (Table 1). A total of 20 species were recorded during the fieldwork.

The family Zygaenidae also comprises some pest species (Tarmann, 2003). The vine bud moth, *Theresimima ampellophaga* (Bayle-Barelle, 1808), whose larvae feed on the leaves of *Vitis vinifera*, *Parthenocissus vitacea* and *P. quinquefolia*, have been considered an important pest for wine production. Other examples to pests from Zyganidae family are *Rhagades* (*Wiegelia*) *amasina* (Herrich-Schäffer, 1851) and *Rhagades (Rhagades) pruni* (Denis & Schiffermüller, 1775). *Rhagades amasina*, whose larvae feed on *Prunus* and *Crataegus* species, is known from Bulgaria, Greece, Türkiye, northern Syria and Lebanon. *Rhagades pruni* is a pest of *Vaccinium uliginosum*, *Calluna vulgaris* and *Andromeda polifolia* and found in most of Europe (except for the British Isles) up to East Asia, including Japan. Among these three pest species we recorded two of them in Aegean and Trace provinces. We recorded a male *T. ampellophaga* in Edirne, Karamahmut, in end of July of 2021. It was not present in any other locations we visited. The other pest, *R. amasina,* was collected from four different locations in three provinces: Dağdibi Village and Ula (Muğla), Keşan Dam (Edirne) and Çukurpınar (Kırklareli). Its flight period changes from mid May to end of June depending on the elevation.

Except from the two pest species, all other species of zygaenids recorded during this study are specialized in natural areas. None of the species are listed under the IUCN threatened species categories, not because they are not threatened but their threat categories have not been evaluated and assigned. In particular, local and rare species might be endangered as many human activities are present in their natural habitats. One local and rare species recorded in this study is *Zygaena* (*Agrumenia) armena*, which was recorded in Ardahan in only two different locations. The distribution of this moth species includes a rather narrow range in Transcaucasia, in a very restricted region in Georgia and Ardahan (Türkiye). Its foodplant is reported as *Securigera varia* and its habitats are identified as forest clearings and old tracks with herbaceous margins (Hoffman & Tremewan, 2020). During the fieldwork, the species was recorded in forest clearings within broad-leaved forests in Ardahan (Fig. 7). Two major human activities in its natural habitats were forestry and cattle grazing. Although it is believed that a level of grazing is required to keep the forest openings stay open, overgrazing might lead to degradation of plant structure leading to the decline in population size of the moth. Therefore, it is recommended that the local grazing activities should be managed. Also, in one of its locations, the habitat was plowed, and pine trees were planted for forestry purposes, which might lead to future population decline for this species.

Fig. 7. The habitat of *Zygaena armena* in Ardahan (**B12**, 31.VII.2021)

Table 1. Distribution of the zygaenid species identified in three different regions of Türkiye in the recent years. Asterix (*) means that endemic species to the eastern Anatolia region of Türkiye.

	A-Aegean	B-Eastern Anatolia	C-Thrace
PROCRIDINAE			
Adscita (*Adscita*) *statices drenowskii*	+	-	-
Jordanita (*Jordanita*) *chloros*	-	-	+
Jordanita (*Jordanita*) *graeca*	+	-	+
Jordanita (*Praviela*) *anatolica*	+	-	-
Jordanita (Solaniterna) subsolana	-	+	-
Jordanita (*Tremewania*) *notata*	+	-	-
Rhagades (*Wiegelia*) *amasina*	+	-	+
Theresimima ampellophaga -		-	+
ZYGAENINAE			
Zygaena (*Agrumenia*) *armena*	-	+	-
Zygaena (*Agrumenia*) *carniolica*	+	+	+
Zygaena (*Agrumenia*) *loti*	+	+	+
Zygaena (*Agrumenia*) *olivieri*	+	+	-
Zygaena (*Mesembrynus*) *diaphana*	+	+	-
Zygaena (*Mesembrynus*) *laeta*	+	-	+
Zygaena (*Mesembrynus*) *lydia*	-	+	-
Zygaena (*Mesembrynus*) *punctum*	+	-	+
Zygaena (*Zygaena*) *dorycnii*	-	+	-
Zygaena (*Zygaena*) *ephialtes*	+	-	+
Zygaena (*Zygaena*) *filipendulae*	+	+	+
Zygaena (*Zygaena*) *lonicerae*	-	+	-

In this study, we also had a chance to correct a mistake of a historical record. During the study, a specimen of *Zygaena ephialtes chalkidikae* Holik, 1937 (ephialtoid, 5-spotted, red) was collected from the European side of Türkiye (in Kırklareli province) (Fig. 5). Historically, a red coloured peucedanoid specimen published from the European side of Istanbul was listed as *Zygaena dorycnii* in Herrich-Schäffer, 1845. As the natural distribution of *Z. dorycnii* does not include western Türkiye, this historical specimen should have been misidentified as *Z. dorycnii* and instead it should be *Z. ephialtes wagneriana*, the only peucedanoid, 6-spotted, red specimen with red cingulum we recorded in this region. However, a caution is still warranted as this was 200 years ago, and in the meantime the distribution boundaries of the different subspecies may have changed (Gerhard M. Tarmann, personal communication: February 25, 2022).

Overall, this paper reports the zygaenids from 12 provinces in the Aegean, eastern Anatolia, and Thrace regions of Türkiye, the first record of *Z. ephialtes* in Thrace region of Türkiye since Herrich-Schäffer (1845), current records of *Z. lydia*, an endemic species to Türkiye, and new localities of the restricted ranged species *Z. armena*.

Acknowledgement

The authors are grateful to Prof. Dr. Konstantin Efetov (Crimea), Prof. Dr. Gerhard M. Tarmann (Austria) and Mr. Axel Hofmann (Germany) for their valuable comments, editing, and help. We wish to express our thanks to Mürşit Ömür Koyuncu (Gaziantep, Türkiye) for his records of *Jordanita subsolana, Zygaena lydia and Z. dorycnii*, Kaan Yılmaz and Mustafa Durmuş for their help in the fieldwork and Jethro Bell for reviewing the article and correcting grammatical errors. We are also thankful to the reviewers for their valuable comments.

Ethics Committee Approval: Since the article does not contain any studies with human or animal subject, its approval to the ethics committee was not required.

Author Contributions: All authors contributed equally to this manuscript in its all stages.

Conflict of Interest: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study has received no financial support.

References

1. Alberti, B. 1954. Über die stammesgeschichtliche Gliederung der Zygaenidae nebst Revision einiger Gruppen (Insecta, Lepidoptera). *Mitteilungen aus dem Zoologischen Museum der Humboldt-Universität Berlin,* 30: 115-480.
2. Alberti, B. 1958. Über den stammesgeschichtlichen Aufbau der Gattung *Zygaena* ihrer Vorstufen (Insecta, Lepidoptera). *Mitteilungen aus dem Zoologischen Museum der Humboldt-Universität Berlin,* 34: 203-242.
3. Alberti, B. 1959. Über den stammesgeschichtlichen Aufbau der Gattung Zygaena F. und ihrerVorstufen (Insecta, Lepidoptera). *Mitteilungen aus dem Zoologischen Museum der Humboldt-Universität Berlin*, 34: 245-396.
4. Can, F., Efetov, K.A., Burman, J., Kaya, K., Kucherenko, E.E., Ulaşlı, B. & Tarmann, G.M. 2019. A study of the Zygaenidae (Lepidoptera) fauna of Central Anatolia, Turkey. *Turkish Journal of Entomology* (*Türkiye Entomoloji Dergisi*), 43(2): 189-199.
5. Can Cengiz, F., Özsemerci, F., Karsavuran, Y. ve Subchev, M., 2012. *Theresimima ampellophaga* (Bayle-Barelle, 1808) in the Aegean region of Turkey (Lepidoptera: Zygaenidae; Procridinae), 3. Paper presented at the XIII. International Symposium on Zygaenidae, 16-23 September, Innsbruck, Tirol, Austria.
6. Can Cengiz, F., Efetov, K.A., Kaya, K., Kucherenko, E.E., Okyar, Z. & Tarmann, G.M. 2018. Zygaenidae (Lepidoptera) of Thrace Region of Turkey. *Nota Lepidopterologica*, 41(1): 23-36.
7. Çıplak, B. 2003. Distribution of Tettigoniinae (Orthoptera, Tettigoniidae) bush-crickets in Turkey: the importance of the Anatolian Taurus Mountains in biodiversity and implications for conservation. *Biodiversity and Conservation*, 12(1): 47-64.
8. Davis, P.H., Coode, M.J.E. & Cullen, J. 1965-1985. *Flora of Turkey and the East Aegean Islands*. 11 Volumes, University Press, Edinburgh.
9. Efetov, K.A. 1999. *Inouela* gen. n. from Japan and Taiwan (Lepidoptera: Zygaenidae, Chalcosiinae). *Entomologist's Gazette* 50(2): 91-95.
10. Efetov, K.A., 2005. *The Zygaenidae (Lepidoptera) of the Crimea and other regions of Eurasia*. CSMU Press, Simferopol, 420 pp.
11. Efetov, K.A., Mollet, B., Tarmann, G.M. 2010a. The biology and early stages of Adscita (*Adscita*) *capitalis* (Staudinger, 1879) (Lepidoptera: Zygaenidae, Procridinae). *Nachrichten des entomolgischen Vereins Apollo, N.F.*, 31(3): 119-125.
12. Efetov, K.A., Can, F., Toshova, T.B. & Subchev, M. 2010b. New sex attractant for *Jordanita anatolica* (Naufock) (Lepidoptera: Zygaenidae: Procridinae*). Acta Zoologica Bulgarica*, 62(3): 315-319.
13. Efetov, K.A., Hofmann, A., Tarmann, G.M. & Tremewan, W.G. 2014. Taxonomic comments on the treatment of the Zygaenidae (Lepidoptera) in volume 3 of *Moths of Europe*, Zygaenids, Pyralids 1 and Brachodids (2012). *Nota Lepidopterologica*, 37(2): 123-133.
14. Efetov, K.A., Kirsanova, A.V., Lazareva, Z.S., Parshkova, E.V., Tarmann, G.M., Rougerie, R. & Hebert P.D.N. 2019. DNA barcoding of Zygaenidae (Lepidoptera): results and perspectives. *Nota Lepidopterologica*, 42(2): 137-150.
15. Efetov, K.A., Lazareva, Z.S., Parshkova, E.V. & Tarmann, G.M. 2021. Molecular genetic characters of species of the genus *Jordanita* Verity, 1946 (Lepidoptera: Zygaenidae, Procridinae): DNA barcodes and corresponding amino acid sequences. *Russian Journal of Genetics*, 57(1): 61-69.

16. Efetov, K.A. & Tarmann, G.M. 2012. *A Checklist of the Palaearctic Procridinae (Lepidoptera: Zygaenidae)*. CSMU Press, Simferopol and Innsbruck, 108 pp.

17. Efetov, K.A. & Tarmann, G.M. 2014. *Illiberis* (*Alterasvenia*) *banmauka* sp. nov. (Lepidoptera: Zygaenidae, Procridinae) from China and Myanmar. *Entomologist's Gazette* 65(1): 62-70.

18. Efetov, K.A. & Tarmann, G.M. 2016. *Pseudophacusa multidentata* Efetov & Tarmann, a new genus and species of Procridini from Myanmar, China and Laos (Lepidoptera: Zygaenidae, Procridinae). *SHILAP Revista de lepidopterologia* 44(173): 81-89.

19. Efetov, K.A. & Tarmann, G.M. 2017. The hypothetical ground plan of the Zygaenidae, with a review of the possible autapomorphies of the Procridinae and the description of the Inouelinae subfam. nov. *Journal of the Lepidopterists' Society*, 71(1): 20-49.

20. Epstein, M.E. 1996. *Revision and Phylogeny of the Limacodidgroup Families, With Evolutionary Studies On Slug Caterpillars (Lepidoptera, Zygaenoidea).* Smithsonian Institution Press, Washingon D.C., 112 pp.

21. FAO, 2019. *Türkiye'nin Biyoçeşitliliği: Genetik Kaynakların Sürdürülebilir Tarım ve Gıda Sistemlerine Katkısı*. Ankara. 222 pp.

22. Görgner, E. & Hofmann, A. 1982. Eine neue Zygaenanartfür die Türkei (Lepidoptera; Zygaenidae, *Zygaena* Fabricious, 1775, Subgenus *Mesembrynus* Hübner [1819]). *Entomofauna* 3: 33-54.

23. Güner, A. 2014. *Resimli Türkiye Florası*. Nezahat Gökyiğit Botanik Bahçesi. Flora Araştırmaları Derneği ve Türkiye İş Bankası yayını, İstanbul. 761 pp.

24. Herrich-Schäffer, G.A.W. 1845: 1843-1855. Systematische Bearbeitung der Schmetterlinge von Europa, zugleich als Text, Revision und Supplement zu Jakob Hübner's Sammlung europäischer Schmetterlinge, 39 pp.

25. Hofmann, A., 2000. Contribution to the knowledge of the genus *Zygaena* Fabricious, 1775 in İran (Lepidoptera, Zygaenidae). Part I: Introduction, systematic part: *Zygaena (Mesembrynus) seitzi, Z. seitzi nocturna, Z. manlia.* Linneana Belgica, Wetteren 17: 171-196.

26. Hofmann, A. & Kia-Hofmann, T., 2008. Contribution to the knowledge of the genus *Zygaena* Fabricious, 1775 in İran (Lepidoptera, Zygaenidae). Part VIII: Bionomics of high-mountain species in the Alborz Mountains and adjacent areas (Introductions: *Z. speciosa, Z. cacuminum*). *Nota Lepidopterologica*, 31(1): 25-52.

27. Hofmann, A. &Tremewan, W.G. 1996. *A Systematic Catalogue of the Zygaeninae (Lepidoptera: Zygaenidae*). Harley Books, Colchester, 251 pp.

28. Hofmann, A. & Tremewan. W. G., 2001. Contribution to the knowledge of the genus *Zygaena* Fabricious, 1775 in İran (Lepidoptera, Zygaenidae). Part V: *Zygaena tamara.* Linneana Belgica, Wetteren 18: 125-136.

29. Hofmann, A. & Tremewan. W. G. 2003. Contribution to the knowledge of the genus *Zygaena* Fabricious, 1775 in İran (Lepidoptera, Zygaenidae). Part VI: *Zygaena nocturna, Z. aisha, Z. rubricollis* and *Z. fredi.* Linneana Belgica, Wetteren 19: 9-20.

30. Hofmann, A. & Tremewan, W.G. 2017. *The Natural History of Burnet Moths, Part I.* Museum Witt Munich and Nature Research Center Vilnius. 630 pp.

31. Hofmann, A. & Tremewan, W.G. 2020. *The Natural History of Burnet Moths, Part II.* Museum Witt Munich and Nature Research Center Vilnius. 530-1095 pp.

32. Holik, O. & Sheljuzhko, L. 1953-1958. Über die Zygaenen-Fauna Osteuropas, Kleinasiens, Irans, Zentralasiens und Sibiriens. *Mitteilungen der Münchner Entomologischen Gesellschaft,* 42: 166-297.

33. Karaçetin, E., Welch, H.J., Turak, A., Balkız, Ö. & Welch, G. 2011. *Conservation Strategy of the Butterflies in Turkey*. Doğa Koruma Merkezi, Ankara, 125 pp.

34. Lambert, B. & Naumann, C. M. 1992. *Zygaena* (*Zygaena*) *nevadensis* Rambur, 1866 (Lepidoptera: Zygaenidae) new for the fauna of Turkey, pp. 184-186. In Dutreix, C., Naumann, C. M. & Tremewan, W. G. (Eds), Proceedings of the 4th Symposium on Zygaenidae, Nantes 11-13 September 1987. Recent advances in burnet moth research (Lepidoptera: Zygaenidae). *Theses Zoologicae* 19: 193 pp.

35. Mann, J.J. 1862. Verzeichniss der im Jahre 1851 bei Brussa in Kleinasien gesammelten Schmetterlinge, Tafel 3. *Wiener Entomologische Monatsschrift*, 6: 373-409.

36. Naumann, C.M., Tarmann, G.M. & Tremewan, W.G. 1999. *The Western Palaearctic Zygaenidae (Lepidoptera).* Stenstrup, 304 pp.

37. Naumann, S. & Naumann, C. M. 1980. Ein Beitrag zur Kenntnis der Zygaenen-Fauna Nord- und Ost-Anatoliens (Lep., Zygaenidae). *Entomofauna* 1: 302-353.

38. Okyar, Z., Efetov, K.A., Kaya, K., Tarmann, G.M. & Can, F. 2018. Preliminary list of the Zygaenidae (Lepidoptera) of Turkey, 37. Paper presented at the *XVI. International Symposium on Zygaenidae,* 1-5 May, İzmir, Turkey.

39. Reiss, G. 1981. *Zygaena* (*Mesembrynus*) *haematina* Kollar [1849] und ihre Verbreitung (Lep. Zygaenidae). *Atalanta*, 12: 368-385.

40. Reiss, H. & Reiss, G. 1969. Beitrag zur Verbreitung der *Zygaena* (*Agrumenia*) *ganymedes* H.-S., und der *Zygaena* (*A.*) *laetifica* H.-S. der *olivieri* Gruppe (Lep.). *Stuttgarter Beiträge zur Naturkunde.* 205: 1-7.

41. Reiss, H. & Reiss, G. 1972a. Beitrag zur Zygaenenfauna der Süd- und der Südostürkei (Lep., Zygaenidae). *Stuttgarter Beiträge zur Naturkunde*, 249: 1-6.

42. Reiss, H. & Reiss, G. 1972b. On two new races of the genus *Zygaena* Fabricius from Asia Minor (Lep., Zygaenidae). *The Entomologist's Record and Journal of Variation*, 84: 226-229.

43. Reiss, H. & Reiss, G. 1973. On the *Zygaena* Fauna of the Neighbourhood of Lake Van in Asia Minor (Lep., Zygaenidae). *The Entomologist's Record and Journal of Variation*,. 85: 191-196.

44. Reiss, H. & Schulte, A. 1968. On a new subspecies of *Zygaena* (*Agrumenia*) *ganymedes* Herrich-Schäffer (Lep., Zygaenidae). *The Entomologist's Record and Journal of Variation*, 80: 1-2.

45. Takhtajan, A., Crovello, T.J. & Cronquist, A. 1986. *Floristic regions of the world*, Vol. 544, University of California Press, Berkeley, 522 pp.

46. Tarmann, G.M. 1984. Generische Revision der amerikanischen Zygaenidae mit Beschreibung neuer Gattungen und Arten (Insecta: Lepidoptera). *Entomofauna*, Supplemantary, 2(1): 176 pp.

47. Tarmann, G.M. 1994. A preliminary review of the classification of the zygaenid subfamily Procridinae (Lepidoptera). *Nota Lepidopterologica*, 5: 115-123.

48. Tarmann, G.M. 2003. Zygaenidae as pest species, 151-229. Paper presented at the Proceedings of the 7th International Symposium on Zygaenidae (Lepidoptera), 4-8 September, Innsbruck, Autstria.

49. Tarmann, G.M., 2004. *Zygaenid moths of Australia*: *A revision of the Australian Zygaenidae (Procridinae: Artonini)*. CSIRO Publishing, Collingwood, 248 pp.

50. Tarmann, G.M. 2010. The long way to an electronic Zygaenidae data network - a report of five years of ups and downs. 1. Paper presented at the XII. International Symposium on Zygaenidae, 5-9 May, Hatay, Türkiye.

51. Tremewan, W.G. 1979. On *Zygaena* Fabricious, 1775 (Lepidoptera, Zygaenidae) from Iran. *Entomologist's Gazette, Brightwood* 30: 249-256.

52. Ulaşlı, B. & Can, F. 2021. Determination of Zygaenidae (Lepidoptera) species by morphological and molecular methods in the Eastern Mediterranean Region of Turkey. *Turkish Journal of Entomology*, (*Türkiye Entomoloji Dergisi*), 45(2): 255-268.

53. UN, 2020. Human Development Report. UNDP. https://hdr.undp.org/sites/default/files/hdr2020.pdf (Date accessed: 28 March 2022).

54. Warren, M.S., Maes, D., van Swaay, C.A.M., Goffart, P., van Dyck, H., Bourn, N.A.D., Wynhoff, I., Hoare, D. & Ellis, S. 2021. The decline of butterflies in Europe: Problems, significance, and possible solutions. *Proceedings of the National Academy of Sciences of the United States of America*, 118(2): 1-10.

55. Yen, S.-H. 2003. Phylogeny and systematics of the major lineages of Chalcosiinae s. l. (Zygaenidae s. l.), 293-348. Paper presented at the Proceedings of the 7th International Symposium on Zygaenidae, 4-8 September, Innsbruck, Austria.

56. Zeller, P.C. 1847. Verzeichniss der von Prof. Dr Loew in der Türkei und Asiengesammelten Lepidoptera. *Isis von Oken*, 40: 3-39.