

TYPE LOCALITIES OF ODONATA SPECIES DESCRIBED IN TÜRKIYE AND THEIR CONNECTIONS TO THE COUNTRY'S BIODIVERSITY

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Abstract

Situated at the crossroads of Europe and Asia, Türkiye has a diverse and rich biodiversity. The number of Odonata species identified from Türkiye so far is approximately 73% of the total number identified in Europe. Twenty-one taxa (15 species and 6 subspecies) were first described from Türkiye. The country lies at the intersection of three global biodiversity hotspots – Caucasus, Irano-Anatolian, and the Mediterranean Basin – which overlap geographically with the type localities of the Odonata species described in the country. These regions, where species diversity is high, also host endemic Odonata species. Three taxa (*Calopteryx waterstoni* Schneider 1984, *Cordulegaster amasina* Morton 1916, and *Cordulegaster kalkmani* Schneider *et al.*, 2021) are endemic to Türkiye. The presence of endemic species in biodiversity hotspots, where original habitats have been lost at an alarming rate, highlights the urgent need to assess their conservation status according to the IUCN Red List categories. Ensuring the long-term conservation of Odonata biodiversity in Türkiye depends on sustainable protection programs that address pollution, habitat fragmentation, and overexploitation of the remaining relatively natural freshwater ecosystems.

KEY WORDS: Type localities, biodiversity, endemic species, biodiversity hotspots, dragonfly, Türkiye

Introduction

Türkiye is geographically situated at the intersection of the European and Asian continents, and its total surface area (including lakes and islands) is 814,578 km². The part of Türkiye located in Europe, known as the Thrace Region, has an area of 24,378 km², while the Asian part, Anatolia, has an area of 790,200 km² (Avcı, 2014). The geomorphology of Türkiye features mountain formations shaped by the Alpine orogeny that took place about 65-70 million years ago. In the Thrace region, the Istranca Mountains (also known as the Yıldız Mountains) extend in a northwest-southeast direction in the north, while the Ganos and Koru Mountains run in two parallel lines in a northeast-southwest direction in the south (Dönmez, 1990; Demirsoy, 1996). On the Anatolian side, the mountain ranges include the North Anatolian Mountains (Black Sea Mountains) in the north

and the Taurus Mountains in the south. The Eastern Anatolian Mountains, located between eastern and central Anatolia, began to form during the period and continued to rise due to volcanic activities that occurred in the Miocene. The mountain range known as the Anatolian Diagonal consists of the Amanos Mountains, Binboğa Mountains, Munzur Mountains (Mercan Mountains), Kargapazari and Palandöken Mountains and Allahuekber Mountains, extending from south to north, serves as a barrier for faunal and floral elements (Demirsoy, 1996) (Fig. 1).



Figure 1. The important mountain ranges in Türkiye. White dots show type localities of Odonata species described from the country.

Türkiye's topographic and climatic heterogeneity, its role as a refuge for species migrating from north to south during the Pleistocene glacial periods, and its position on the migration route of faunal elements coming from three continents (Asia, Europe, and Africa) are the main reasons for the country's rich biological diversity (Demirsoy, 1996; Gür, 2017). The intersection of three global biodiversity hotspots (Mediterranean, Iran-Anatolia, and Caucasus) on the Anatolian Peninsula increases the species diversity and endemism rate of the region (Gür, 2017) (Fig. 2).

While the area of the European continent is approximately 13 times larger than that of Türkiye, the number of Odonata species identified in Europe is 146, whereas Türkiye home to 106 species (Kalkman *et al.*, 2010; Hacet, 2017; Boudot *et al.*, 2021; Schneider *et al.*, 2021; De Knijf *et al.*, 2024). Approximately 57% (83 species/subspecies) of European Odonata species are found in Türkiye, the remaining species are either endemic to the country or primarily distributed across the Asian continent. The first data on Türkiye's Odonata fauna were collected in the first half of the 19th century, and since then, studies by both local and foreign researchers have gradually revealed a comprehensive picture of the country's Odonata fauna (Charpentier, 1840; Kalkman *et al.*, 2010; Hacet, 2017; Boudot *et al.*, 2021; Schneider *et al.*, 2021).

Type localities of species are important for systematic studies. A type locality is a geographic location where the type specimen, from which a species is identified or named, was first collected, observed, or captured (ICZN, 1999). Although type localities do not mean much for cosmopolitan species, they provide information about narrowly distributed and habitat-selective species and endemic species. Type localities constitute the starting point of the information source needed to evaluate the habitat characteristics where the species can be found, water types, the historical development of the distribution limits of narrow-range species, and changes in the land and aquatic environment during conservation activities.

According to the available data, the first Odonata species described from Türkiye was *Epallage fatime* (Charpentier, 1840). Later, Schneider (1845) described 8 new species (3 of which are synonyms) based on the material collected in the country by the entomologist Loew. These records are species described from Türkiye by Kolenati (1846), Selys & Hagen (1850), Schmidt (1853, 1854), Selys (1884, 1887), Bartenev (1909, 1912), Morton (1916), Dumont (1974), Schneider (1984), and Schneider *et al.* (2021), respectively.

In this study, Odonata species with described type locations, which were first identified in Türkiye in the 1800s and continue to be studied today, are listed. When the locations of these are mapped across the country's geography, it becomes apparent that they overlap with Türkiye's regions of high biodiversity.

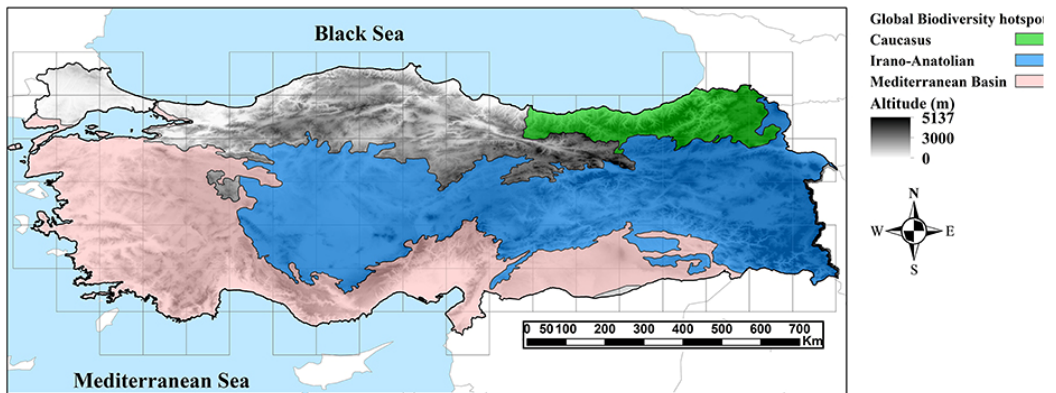


Figure 2. Three global biodiversity hotspots in Türkiye (Noroozi *et al.*, 2019).

Materials and Methods

Odonata species with the type locations in Türkiye were examined based on original articles, publications related to Türkiye, and the World Catalogue of Odonata. The taxonomic status of each species (species/subspecies) is evaluated in the notes section. For each species, type locality information is provided, including the name of the locality recorded in the original article (shown in square brackets), followed by the current name of the locality. Additionally, data on the species' distribution in both the world and Türkiye are presented. Distributional information given for Türkiye is at the province level (Fig. 3), and province names are given in alphabetical order.

The taxonomic ranks of taxa used in the Results Section were classified into three groups: A – species, B – subspecies, and C – taxa regarded as subspecies or synonyms of nominate subspecies.



Figure 3. Map of the provinces of Türkiye.

Results

A. Species

Family: Calopterygidae

Calopteryx waterstoni Schneider, 1984

Type locality: [Trabzon (Turkey), 41°00'N/39°43'E (Schneider, 1984)]. = Trabzon Province.

Distribution in the World: Türkiye (Boudot *et al.*, 2009; 2021).

Distribution in Türkiye: Trabzon, Giresun, Rize (Schneider, 1984; Kalkman *et al.*, 2004a; Miroğlu *et al.*, 2011).

Note: The species was originally described at the species level by Schneider (1984) from Türkiye (northeastern Anatolia). In later studies, it was given as a subspecies of *Calopteryx splendens* (Kalkman *et al.*, 2003; Kalkman *et al.*, 2004a; Kalkman, 2006; Miroğlu *et al.*, 2011). Boudot *et al.* (2009; 2021) consider this taxon at the species level in their studies. The subspecies *C. splendens waterstoni* has been re-evaluated as a synonym for *C. splendens* in the most recent update of the World Odonata List (Paulson *et al.*, 2022). This taxon (as sp. or ssp.) is registered only from the Eastern Black Sea region (Trabzon and Rize) and is endemic to Türkiye.

Family: Euphaeidae

Epallage fatime (Charpentier, 1840)

Agrion fatime Charpentier, 1840

Type locality: [Turcia=Türkiye (Charpentier, 1840); Thrace (Turkey-in-Europe) (Bridge, 1994)]. = Thrace Region (European part of Türkiye).

Distribution in the World: The species is distributed from Bulgaria, Greece, Macedonia, and the European part of Türkiye in the west to Anatolia (the Asian part of Türkiye), Afghanistan, and Pakistan in the east, and extends southwards to the Jordan region (Kalkman *et al.*, 2015a).

Distribution in Türkiye: Adana, Adıyaman, Afyon, Amasya, Ankara, Antalya, Artvin, Balıkesir, Bilecik, Bingöl, Bitlis, Bursa, Denizli, Düzce, Elazığ, Erzurum, Eskişehir, Gaziantep, Giresun, Hatay, Isparta, İstanbul (European side), İzmir, Kahramanmaraş, Kayseri, Kars, Kırklareli, Konya, Kütahya, Malatya, Manisa, Mardin, Mersin, Muğla, Ordu, Osmaniye, Sakarya, Samsun, Şanlıurfa, Sinop, Tokat, Trabzon, Yozgat (Schneider, 1845; Schmidt, 1954; Selys, 1887; Mac Lachlan, 1899; Kempny, 1908; Navas, 1933; St. Quentin, 1964; Dumont, 1977; Demirsoy, 1982; Schneider, 1985; Dumont *et al.*, 1988; Busse, 1993; Kazancı, 1995; Seidenbusch, 1995; Ardiç & Uygun, 1996; Hacet & Aktaç, 1997; Salur & Kıyak, 2000a; Hacet & Aktaç, 2004; Kalkman *et al.*, 2004a, b; van Pelt, 2004; Salur & Kıyak, 2006; Hope, 2007; Salur & Kıyak, 2007a; Kazancı, 2008; Miroğlu & Kartal, 2008; Pisica & Popescu-Mirceni, 2008; Hacet, 2009; Miroğlu *et al.*, 2011; Salur *et al.*, 2012a; Hacet, 2017).

Note: Türkiye is centrally located within the global distribution range of the species. Three *E. fatime* subspecies have been described from Türkiye and Iran: (subspecies *amasina* Selys, 1879 – from Amasya, Türkiye; subspecies *anatolica* Selys, 1869 – from Davas, Türkiye; subspecies *alma* Selys, 1879 – from Astarabad, Iran) (Schneider, 1986). These subspecies have not been actively used in the taxonomy of the species and are currently regarded as synonyms of the species (Paulson *et al.*, 2022).

Family: Coenagrionidae

***Ceriagrion georgifreyi* Schmidt, 1953**

Type locality: [Sariseki (İskenderun) (Schmidt, 1953)]. = Hatay Province: İskenderun- Sariseki.

Distribution in the World: Türkiye, Greece, Syria, and Israel (Boudot *et al.*, 2021).

Distribution in Türkiye: Adana, Antalya, Burdur, Denizli, Hatay, Mersin, Muğla, Tokat-Niksar (!) (Selys, 1887; Schmidt, 1953, 1954; Dumont, 1977; Demirsoy, 1982; Ardiç & Uygun, 1996; Kalkman *et al.*, 2004a, b; Kalkman & van Pelt, 2006; Salur & Kıyak, 2006; Hope, 2007; Salur & Kıyak, 2007a; Pisica & Popescu-Mirceni, 2008; Seidenbusch, 2010).

***Ischnura intermedia* Dumont, 1974**

Type locality: [Halber Çayı on Fırat River (Eufırat), road from Adıyaman to Samsat: 20 km (Dumont, 1974)]. = Adıyaman Province: ca. 25 km E, Kalburcu Stream (Dumont *et al.*, 1988).

Distribution in the World: Türkiye, Cyprus, Syria, Iraq, Iran, and Turkmenistan (Boudot *et al.*, 2021)

Distribution in Türkiye: Adana, Adıyaman (Dumont, 1977; Dumont *et al.*, 1988; Salur & Kıyak, 2006).

Family: Aeshnidae

***Caliaeschna microstigma* (Schneider, 1845)**

Aeschna microstigma Schneider, 1845

Type locality: [Kellemiş (Schneider, 1845)]. = Antalya Province: Kaş- Gelemiş.

Distribution in the World: Southeast Europe, Türkiye, the Levant and Iran, Turkmenistan, Georgia, Armenia, Azerbaijan, and the Black Sea coast (Boudot *et al.*, 2021).

Distribution in Türkiye: Adana, Amasya, Ankara, Antalya, Artvin, Balıkesir, Bingöl, Bolu, Burdur, Denizli, Düzce, Elazığ, Erzincan, Erzurum, Giresun, Gümüşhane, Hakkari, Hatay, Isparta, İstanbul, Kahramanmaraş, Kastamonu, Kayseri, Kırklareli, Konya, Kütahya, Malatya, Mersin, Muğla, Niğde, Osmaniye, Rize, Sakarya, Samsun, Siirt, Sivas, Trabzon (Schneider, 1845; Selys, 1887; Morton, 1915; Schmidt, 1954; Dumont, 1977; Demirsoy, 1982; Dumont *et al.*, 1988; Busse, 1993; Seidenbusch, 1994; Kazancı, 1995; Seidenbusch, 1995;

Ardıç & Uygun, 1996; Hacet & Aktaç, 1997; Salur & Kıyak, 2000b; Kalkman *et al.*, 2004a, b; van Pelt, 2004; Salur & Kıyak, 2006, 2007b; Miroğlu & Kartal, 2008; Hacet, 2009; Miroğlu *et al.*, 2011).

Family: Gomphidae

***Gomphus schneiderii* Selys, 1850**

Type locality: [Kellemiş (Selys & Hagen, 1850)]. = Antalya Province: Kaş- Gelemiş.

Distribution in the World: Southern Balkans, Türkiye, Georgia, Armenia, Azerbaijan, the Caucasus Region of Russia, Iran, Turkmenistan, and Afghanistan (Boudot *et al.*, 2021).

Distribution in Türkiye: Adana, Afyon, Amasya, Ankara, Antalya, Bursa, Denizli, Düzce, Hatay, Isparta, İstanbul (Asian side), İzmir, Kahramanmaraş, Karabük, Kars, Kastamonu, Kayseri, Kırşehir, Konya, Malatya, Manisa, Mersin, Muğla, Sakarya, Tekirdağ, Tokat, Trabzon, Yozgat (Hagen, 1863; Selys, 1887; Morton, 1915; Schmidt, 1954; St. Quentin, 1964; Dumont, 1977; Demirsoy, 1982; Yazıcıoğlu, 1982; Kohler, 1993; Kazancı, 1995; Seidenbusch, 1995; Seidenbusch, 1997a; Salur & Kıyak, 2000b; Kalkman *et al.*, 2004 a, b; Salur & Öz Saraç, 2004; van Pelt, 2004; Kalkman & van Pelt, 2006; Hope, 2007; Salur & Kıyak, 2007b; Kazancı, 2008; Hacet, 2009; Salur *et al.*, 2012a).

***Onychogomphus assimilis* (Schneider, 1845)**

Gomphus assimilis Schneider, 1845

Type locality: [Kellemiş (Schneider, 1845)]. = Antalya Province: Kaş- Gelemiş.

Distribution in the World: Türkiye, Georgia, Armenia, Azerbaijan, Iran, Turkmenistan (Boudot *et al.*, 2021).

Distribution in Türkiye: Adana, Antalya, Artvin, Denizli, Erzurum, Hakkari, Isparta, Kahramanmaraş, Karaman, Malatya, Mersin, Muğla, Tunceli, Zonguldak (Schneider, 1845; Schmidt, 1954; St. Quentin, 1964, 1968; Dumont, 1977; Demirsoy, 1982; Seidenbusch, 1999; Kalkman *et al.*, 2004a, b; Kalkman & van Pelt, 2006; Salur & Kıyak, 2006; Hope, 2007; Salur & Kıyak, 2007b; Kazancı, 2010; Ikemeyer & Olthoff, 2013).

***Onychogomphus flexuosus* (Schneider, 1845)**

Gomphus flexuosus Schneider, 1845

Type locality: [Kellemiş (Schneider, 1845)]. = Antalya Province: Kaş- Gelemiş.

Distribution in the World: Türkiye, Iran, Syria, Iraq, the Levant region, Georgia, Armenia, Azerbaijan, Tajikistan, Afghanistan, Uzbekistan, Kyrgyzstan, Russia, Kazakhstan (Boudot *et al.*, 2021).

Distribution in Türkiye: Adana, Amasya, Ankara, Antalya, Denizli, Hatay (!), Kırşehir, Malatya, Mersin, Muğla (Schneider, 1845; Selys, 1887; Morton, 1924; Schmidt, 1954; Dumont, 1977; Demirsoy, 1982; Kalkman *et al.*, 2004a, b; Salur & Öz Saraç, 2004; Hope, 2007; Salur & Kıyak, 2007b).

***Onychogomphus macrodon* Selys, 1887**

Type locality: [Beyrut et Antioche (Selys, 1887)]. = Lebanon: Beirut Province and Türkiye: Hatay Province, Antakya District.

Distribution in the World: Southeast Türkiye, Syria, Jordan, Israel, Lebanon (Boudot *et al.*, 2009).

Distribution in Türkiye: Adana, Batman, Hatay, Kahramanmaraş, Osmaniye (Selys, 1887; Schmidt, 1954; Seidenbusch, 2001; Kalkman *et al.*, 2004a; Salur & Kıyak, 2006; Schneider & Schneider, 2010; Boudot *et al.*, 2021).

Stylurus ubadschii* (Schmidt, 1953)Gomphus ubadschii* Schmidt, 1953

Type locality: [Misis (Schmidt, 1953)]. = Adana Province: Misis.

Distribution in the World: Türkiye, the Levant, Georgia, Armenia, Azerbaijan, and Central Asia (Boudot *et al.*, 2021).Distribution in Türkiye: Adana, Afyon, Ankara, Antalya, Aydın, Balıkesir, Bolu, Bursa, Çanakkale, Çankırı, Denizli, Elazığ, Erzurum, Hatay, Isparta, Kahramanmaraş, Kayseri, Kırşehir, Kütahya, Manisa, Mersin, Muğla, Ordu, Sakarya, Samsun, Şanlıurfa, Trabzon, (Schmidt, 1953, 1954; Dumont, 1977; Demirsoy, 1982; Kazancı, 1995; Salur & Kıyak, 2000b; Kalkman *et al.*, 2004a, b; Salur & Özserağ, 2004; van Pelt, 2004; Salur & Kıyak, 2006; Hope, 2007; Salur & Kıyak, 2007b; Kazancı, 2008).

Family: Cordulegastridae

Cordulegaster amasina* Morton, 1916Cordulegaster insignis amasinus* Morton, 1916

Type locality: [Amasia (Morton, 1916)]. = Amasya Province.

Distribution in the World: Türkiye (Schneider *et al.*, 2021).Distribution in Türkiye: Amasya, Ankara, Kastamonu, Konya, Niğde, Yozgat (Morton, 1916; Fraser, 1929; Schmidt, 1954; Schneider *et al.*, 2021).

Note: This taxon was first described as a subspecies of *C. insignis* by Morton (1916). Later, Fraser (1929) identified it from Amasya. Schmidt (1954) gives it at a subspecies level (*amasina*) from Niğde Pövince-Ulukışla and Konya Pövince-Akşehir. Recent studies emphasize the need for more material to clarify the described subspecies of *Cordulegaster insignis* (Kalkman, 2006) and suggest that molecular studies could lead to new taxonomic revisions (Boudot *et al.*, 2021). The taxon was revised to species level in studies by Schneider *et al.* (2021), based on molecular and morphology data. Its distribution area extends from the Black Sea coast between Kastamonu and Samsun provinces to Central Anatolia, reaching as far as Ankara province.

Cordulegaster charpentieri* (Kolenati, 1846)Aeschna charpentieri* Kolenati, 1846Type locality: [Exact location is unknown. Probable location: "Bollochgöl territorii, provinciae Transcaucasiae Elisabethopol" (Kolenati, 1846; Dumont, 1976)]. = Ağrı Province: Balık Gölü (Balık Lake). The type specimen was lost, and a neotype was described from Bitlis Province in Türkiye (Schneider *et al.*, 2021).Distribution in the World: Central Türkiye eastward to the South Caucasus, Russia, Iran, Iraq, Armenia, Azerbaijan, and Turkmenistan (probably) (Boudot *et al.*, 2021; Schneider *et al.*, 2021).Distribution in Türkiye: East Anatolia: Ağrı, Bitlis, Erzurum, Kayseri, Sivas, Van (Kolenati, 1846; Morton, 1916; van Pelt, 2004; Schneider *et al.*, 2021).***Cordulegaster cilicia* Schneider, Vierstraete, Müller, van Pelt, Caspers, Ikemeyer, Snegovaya & Dumont, 2021**Type locality: [Kahramanmaraş, Göksun, Gücüksu, Göksun River (Schneider *et al.*, 2021)].Distribution in the World: Türkiye, Lebanon (Schneider *et al.*, 2021).Distribution in Türkiye: Erzurum, Kahramanmaraş, Kayseri, Niğde (Schneider *et al.*, 2021).

***Cordulegaster insignis* Schneider, 1845**

Type locality: [Kellemisch (Schneider, 1845)]. = Antalya Province: Kaş- Gelemiş.

Distribution in the World: From Macedonia, Serbia, Bulgaria, Romania, Greek Aegean Islands, and European Türkiye in Europe to western Türkiye and Lebanon (Boudot *et al.* 2021).

Distribution in Türkiye: Adana, Antalya, Balıkesir, Burdur, Denizli, Edirne, Gökçeada Island, Hatay, Isparta, Kahramanmaraş, Kırklareli, Kütahya, Mersin, Muğla, Osmaniye (Havza & Aktaç, 1987; Ardiç & Uygun, 1996; Hacet & Aktaç, 2004; Kalkman *et al.*, 2004a, b; van Pelt, 2004; Hacet & Aktaç, 2006; Salur & Kıyak, 2006; Hope, 2007; Salur & Kıyak, 2007b; Hacet, 2017).

***Cordulegaster kalkmani* Schneider, Vierstraete, Müller, van Pelt, Caspers, Ikemeyer, Snegovaya & Dumont, 2021**

Type locality: [Kars, 16 km NE Sarıkamis (Schneider *et al.*, 2021)]. = Kars Province: Sarıkamış.

Distribution in the World: Türkiye (Schneider *et al.*, 2021).

Distribution in Türkiye: Kars, Van (Schneider *et al.*, 2021).

Note: While Schneider *et al.* (2021) give the distribution of the species, they suggest that it may also be found in northwestern Iran as well as eastern Anatolia. However, based on the available data, the species is currently considered endemic to Türkiye.

B. Subspecies**Family: Gomphidae*****Onychogomphus forcipatus albotibialis* Schmidt, 1954**

Type locality: Pozanti-Ulukischla (Schmidt, 1954). = Niğde Province: Ulukışla.

Distribution in the World: Türkiye (including Gökçeada Islands), the Western Aegean Islands in Greece, southern Caucasus, Iran, and Turkmenistan (Boudot *et al.*, 2009; Boudot & Proess, 2015).

Distribution in Türkiye: Adana, Afyon, Ankara, Antalya, Artvin, Aydın, Balıkesir, Bartın, Burdur, Bursa, Bolu, Çanakkale, Çankırı, Çorum, Denizli, Düzce, Elazığ, Eskişehir, Erzurum, Giresun, Gökçeada Island, Gümüşhane, Hatay, Isparta, İstanbul (Asian side), İzmir, Kahramanmaraş, Karabük, Kastamonu, Kırşehir, Konya, Kütahya, Manisa, Mersin, Muğla, Ordu, Osmaniye, Sakarya, Samsun, Sinop, Tokat, Trabzon, Yozgat (Kempny, 1908; Dumont, 1977; Dumont *et al.*, 1988; Seidenbusch, 1994; Kalkman *et al.*, 2004a, b; Salur & Öz Saraç, 2004; van Pelt, 2004; Hacet & Aktaç, 2006; Salur & Kıyak, 2006; Hope, 2007; Salur & Kıyak, 2007b; Kazancı, 2008; Miroğlu & Kartal, 2008; Pisica & Popescu-Mirceni, 2008; Hacet, 2009; Hacet & Aktaç, 2009; Miroğlu *et al.*, 2011; Salur *et al.*, 2012a).

Family: Libellulidae***Orthetrum coerulescens anceps* (Schneider, 1845)**

Libellula anceps Schneider, 1845

Type locality: Mermeriza (Schneider 1845). = Muğla Province: Marmaris.

Distribution in the World: Southwestern Asia and North Africa (Kalkman & Ambrus, 2015)

Distribution in Türkiye: Adana, Adıyaman, Afyonkarahisar, Antalya, Artvin, Aydın, Balıkesir, Bartın, Bitlis, Bolu, Burdur, Bursa, Çanakkale, Çankırı, Denizli, Diyarbakır, Düzce, Edirne, Elazığ, Erzincan, Erzurum, Gaziantep, Giresun, Gökçeada Island, Hatay, İstanbul, İzmir, Isparta, Kahramanmaraş, Karabük, Kastamonu, Kayseri, Kırklareli, Kırşehir, Konya, Mersin, Muğla, Rize, Sakarya, Siirt, Sivas, Şanlıurfa, Tekirdağ, Trabzon, Tunceli,

Tokat, Van (Schneider, 1845; Spagnolini, 1877; Morton, 1922; Schmidt, 1954; Dumont, 1977; Demirsoy, 1982; Yazıcıoğlu, 1982; Dumont *et al.*, 1988; Busse, 1993; Kohler, 1993; Kazancı, 1995; Seidenbusch, 1995; Ardiç & Uygun, 1996; Salur & Kıyak, 2000b; Dijkstra & Kalkman, 2001; Hacet & Aktaş, 2004; Kalkman *et al.*, 2004a, b; Salur & Özşaraç, 2004; van Pelt, 2004; Hacet & Aktaş, 2006; Salur & Kıyak, 2006; Hope, 2007; Salur & Kıyak, 2007b; Pisica & Popescu-Mirceni, 2008; Ayten & Özgökçe, 2009; Hacet, 2009; Hacet & Aktaş, 2009; Miroğlu *et al.*, 2011; Salur *et al.*, 2012b).

***Sympetrum vulgatum decoloratum* (Selys, 1884)**

Diplax vulgata race *decolorata* Selys, 1884

Type locality: Tartoum (Selys, 1884). = Erzurum Province: Tortum.

Distribution in the World: Türkiye in Western Asia to Central Asia (Kalkman *et al.*, 2015b).

Distribution in Türkiye: Afyonkarahisar, Amasya, Antalya, Artvin, Bayburt, Bitlis, Erzurum, Hatay, Kahramanmaraş, Kayseri, Kırşehir, Konya, Kütahya, Malatya, Mersin, Niğde, Sivas, Tunceli, Van (Selys, 1887; Morton, 1914; Dumont, 1977; Demirsoy, 1982; Kalkman *et al.*, 2004a; van Pelt, 2004; Miroğlu *et al.*, 2011; Salur *et al.*, 2012b).

C. Taxa regarded as subspecies or synonyms of nominate subspecies on

***Calopteryx splendens* (harris, 1780) complex in türkiye**

Calopteryx splendens, with a Western Palearctic distribution, has several subspecies that have been identified from Türkiye to date. Recent studies have highlighted that the morphological characters used to differentiate the subspecies, such as the male wing spot width and the color of the ventral side of the last abdominal segment, are insufficient and that molecular studies are now considered necessary to further clarify subspecies differentiation (Kalkman, 2006; Boudot *et al.*, 2009; Kulijer & Marinov, 2010).

Considering recent studies, it is evident that the taxa identified within the *Calopteryx splendens* complex are classified at different taxonomic ranks. A molecular study of Palearctic *splendens* material by Sadeghi *et al.* (2010) emphasized that there is significant gene flow and morphological variation among taxa in the *splendens* lineage, including those from Türkiye.

The latest update of the List of World Odonata considers subspecies *amasina* Bartenev, 1912, *intermedia* Selys, 1890, *waterstoni* Schneider, 1984, and *tschaldirica* Bartenef, 1909, identified from Türkiye, as synonyms of *splendens* (Paulson *et al.*, 2022). Boudot *et al.* (2021) discussed the subspecies *waterstoni* at the species level and emphasized that the status of the subspecies defined in this species complex is not clear.

Future phylogenetic studies using new molecular techniques on the subspecies identified within *C. splendens* may reveal different groupings of taxa or alternative classifications among these taxa. Therefore, the puzzle of the *C. splendens* complex remains incomplete.

***Calopteryx splendens amasina* Bartenev, 1912**

Type locality: [Asia Minor (Bartenev, 1912; Bridges, 1994; Steinmann, 1997)]. = Anatolia (Asian part of Türkiye).

Distribution in the World: Greece (Stobbe, 1990); Türkiye (Steinmann, 1997; Sadeghi & Dumont, 2014).

Distribution in Türkiye: It is distributed throughout Türkiye, except *C. splendens intermedia* Selys, 1887, which is found in the south and east, and *C. s. waterstoni* Schneider, 1884, which occurs in northeast Türkiye (Dumont, 1977; Yazıcıoğlu, 1982; Hacet & Aktaş, 2004; Kalkman *et al.*, 2004b; van Pelt, 2004; Hope, 2007;

Salur & Kiyak, 2007a; Salur & Mesci, 2007; Miroğlu *et al.*, 2011; Salur *et al.*, 2012a, b; Sadeghi & Dumont, 2014).

Note: So far, records of this subspecies have been reported from western and central Anatolia, and in Europe from eastern Greece (Stobbe, 1990) and the European side of Türkiye (Thrace Region). Since the *C. splendens* complex has been studied using various molecular techniques and taxa in recent years, interpreting the taxa within the complex has become difficult (Boudot & Kalkman, 2015). Therefore, the resolution of its taxonomic status awaits future studies.

***Calopteryx splendens intermedia* Selys, 1887**

Type locality: [Akbès (Syrie) (Selys, 1887)]. = Hatay Province: Akbez (Türkiye).

Distribution in the World: The distribution of taxon extends from the southern coastal region of the Taurus Mountains in southern Türkiye, passing west of Antalya province, to eastern Anatolia, Armenia, Iran, and Georgia (Seidenbusch, 1997b; Schröter *et al.*, 2015; Schneider *et al.*, 2018; Taily *et al.*, 2004).

Distribution in Türkiye: Distribution of this subspecies is known from the Mediterranean and eastern Anatolia regions of Türkiye (Kempny, 1908; Dumont, 1977; Demirsoy, 1982; Dumont *et al.*, 1988; Dumont, 1991; Seidenbusch, 1997b; Dijkstra & Kalkman, 2001; Salur & Kiyak, 2006; Ayten & Özgökçe, 2009).

***Calopteryx splendens tschaldirica* Bartenev, 1909**

Type locality: [Tschildir Lake (Bartenev, 1909)]. = Çıldır Lake is located on the border of Kars and Ardahan Provinces in Türkiye.

Distribution in the World: Türkiye, Georgia (Bartenev, 1909; Dumont *et al.*, 1987; Schröter *et al.*, 2015).

Distribution in Türkiye: Çıldır Lake (Bartenev, 1909); Kars Province (Dumont *et al.*, 1987).

Discussion

To date, 106 Odonata species have been recorded in Türkiye. The results of the present study reveal that type localities of 15 species and 6 currently accepted subspecies (including *C. splendens amasina*, *C. splendens intermedia*, and *C. splendens tschaldirica*, which are sometimes considered synonyms of the nominate subspecies) of Odonata were described from the country. Three of the taxa (*Calopteryx waterstoni*, *Cordulegaster amasina*, and *Cordulegaster kalkmani*) are currently endemic to Türkiye and distributed in Anatolia. Except for endemic taxa, the distributions of *C. splendens intermedia*, *C. splendens tschaldirica*, *O. assimilis*, *O. forcipatus albotibialis*, *O. macrodon*, *S. ubadschii*, *C. cilicia*, and *S. vulgatum decoloratum* species/subspecies are limited to the Asian continent. In addition, most of the distributions of *O. flexuosus* and *C. charpentieri* (which occur in the northern Caucasus region) are located on the Asian continent. *E. fatime*, *C. georgifreyi*, *C. microstigma*, *G. schneiderii*, and *C. insignis* are known from Asia and Europe, and *O. coeruleascens anceps* from the Asian and African continents.

When considering the general distributions of Odonata species with type localities described in Türkiye, it is evident that these species are either endemic to Türkiye or predominantly distributed across the Asian continent. There are also taxa that have diversified in the Anatolian geography, such as the species/subspecies of the genus *Cordulegaster* and the subspecies of *Calopteryx splendens*. Therefore, it is natural that these species were first described from Türkiye.

It is observed that most of the type localities of Odonata species known from Türkiye are situated within the borders of three biodiversity hotspots found in Türkiye, which are part of the 36 biodiversity hotspots defined in

the world (Figs. 1 and 2). The type localities of 12 species/subspecies (*C. splendens intermedia*, *I. intermedia*, *C. georgifreyi*, *O. assimilis*, *O. flexuosus*, *O. macrodon*, *G. schneiderii*, *S. ubadschii*, *C. cilicia*, *C. insignis*, *C. microstigma*, and *O. coerulescens anceps*) are located in provinces on the Mediterranean coast, which are within the Mediterranean hotspot. The type localities of *C. waterstoni* and *C. kalkmani* (Trabzon and Kars-Sarıkamış district, respectively) are located within the borders of the Caucasus region, which is one of the three biodiversity hotspots in Türkiye. Also, the type localities of *C. charpentieri*, *O. forcipatus albotibialis*, *S. vulgatum decoloratum*, and *C. splendens tschaldirica* (Niğde-Ulukışla district, Ağrı-Balık Lake, Erzurum-Tortum district and Kars-Çıldır Lake) are found in Irano-Anatolian biodiversity hotspot.

Although Türkiye is a well-studied region in terms of the Odonata group, it still hosts taxa with problematic taxonomy, such as the subspecies *Calopteryx splendens* and the defined or undefined subspecies of the *Cordulegaster* genus. Recently, in a molecular study of the Palearctic *Cordulegaster* genus, Schneider *et al.* (2021) described two new species from Anatolia for the world. The type locality list provided in this study may change as the taxonomic positions of the subspecies are clarified, their synonymy status is determined, and new species described from the country are included.

Biodiversity hotspots are regions with high endemism and significant threats. They are defined as regions that contain at least 0.5% (approximately 1500 species) of the world's 300,000 vascular plants and have lost at least 70% of their original distribution (Hambler, 2004). The overlap of type localities with the three biodiversity hotspots, defined as regions with high biodiversity, also facilitated the identification of these species from Türkiye for the first time. Biodiversity hotspots are regions with high biodiversity, but they are also areas where habitat destruction is particularly intense. Considering the species with type localities in Türkiye compiled in this study, it is observed that *C. georgifreyi* is classified in the EN (Endangered) category (Jovic & Boudot, 2020), *O. assimilis*, *O. flexuosus*, and *O. macrodon* are in the VU (Vulnerable) category, and *I. intermedia* is in the NT (Near Threatened) category on the IUCN World Red List (Boudot & Kalkman, 2014). Of these species, most of the distribution of *C. georgifreyi* and approximately half of the distribution of *O. macrodon* is within Türkiye, and the latter is a limited endemic species to this region, distributed in a narrow area that includes the Levant region (Boudot *et al.*, 2021). In the present study, it is seen that 5 (50%) of the 10 species with type locality in Türkiye that are assessed in the Global IUCN Red List (*E. fatime*, *C. georgifreyi*, *I. intermedia*, *C. microstigma*, *G. schneiderii*, *O. assimilis*, *O. flexuosus*, *O. macrodon*, *C. insignis*, and *O. c. anceps*), are classified in the Threatened or Near Threatened categories. In the Eastern Mediterranean region, where Türkiye is also located, the primary threats to Odonata are related to their essential habitats – freshwater ecosystems. These threats include high levels of water extraction from water sources, degradation and loss of the physical structure of aquatic habitats, water pollution, and climate change (Boudot & Kalkman, 2014).

Currently, the three Odonata species endemic to Türkiye (*C. waterstoni*, *C. amasina*, and *C. kalkmani*) do not have IUCN Red List status. The known distributions of *C. waterstoni* and *C. kalkmani* remain within the Caucasus biodiversity hotspot. While a type locality of *C. amasina* is within the Northern Anatolia freshwater ecoregion, which includes the temperate coastal rivers in the north of the country outside the hotspots (Smith *et al.*, 2014), its other distributional area is within the Irano-Anatolian biodiversity hotspot. Since endemic species are limited to certain regions around the world, they are considered priority species for protection in species conservation programs. Considering the presence of these three species in two biodiversity hotspots in the country and the pollution and overuse observed in freshwater resources in these regions, it is crucial to investigate these species urgently, and if any threats are identified that could endanger the species in their habitats, protective measures should be implemented.

As Darwin and his colleagues inferred from the fossil record, the world is a constantly changing place. Living things that existed in the past are no longer alive today. Therefore, understanding the dynamic requires us to be cautious in our actions towards nature to avoid losing the diversity that exists today. Odonata species diversity in Türkiye is higher compared to Europe and the Eastern Mediterranean Region when the surface

area is taken into account (Boudot & Kalkman, 2014; De Knijf *et al.*, 2024). In addition to morphological diversity, genetic studies in some taxa show that Anatolian populations exhibit high genetic diversity, and some may be the origin of European ancestry (Rokas *et al.*, 2003). This situation, like in all countries in the world, imposes a responsibility on Türkiye to protect its biological diversity.

To preserve the diversity of Odonata in the Türkiye in the near future, it is essential to first address data deficiencies (such as habitat needs and possible threat factors) for Odonata species endemic to the country, as well as those that are regionally endemic within of Türkiye and neighboring countries, through dedicated research. It is important to keep conservation assessments for species up to date, as threat factors may change over time and vary across regions. The continued richness of Odonata diversity in the country requires the rehabilitation of degraded or polluted freshwater ecosystems and the management of existing high-quality freshwater resources through sustainable conservation programs.

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ТИПСКИ ЛОКАЛИТЕТИ ВРСТА ВИЛИНСКИХ КОЊИЦА ОПИСАНИХ У ТУРСКОЈ И ЊИХОВА ПОВЕЗАНОСТ СА БИОДИВЕРЗИТЕТОМ ЗЕМЉЕ

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Извод

Смештена на раскрсници Европе и Азије, Турска има разнолик и богат биодиверзитет. Број врста вилинских коњица идентификованих у Турској до сада чини приближно 73% од укупног броја врста у Европи. 21 таксон (15 врста и 6 подврста) први пут је описано из Турске. Турска се налази на раскрсници три глобална жаришта биодиверзитета – Кавказа, Иранско-анадолског и Медитеранског басена. Они се географски преклапају са типским локалитетима врста Odonata описаних у Турској. Ови региони, где је разноврсност врста велика, такође представљају станишта ендемичним врстама Odonata. Три таксона (*Calopteryx waterstoni* Schneider 1984, *Cordulegaster amasina* Morton 1916, и *Cordulegaster kalkmani* Schneider *et al.*, 2021) су ендемична за Турску. Присуство ендемичних врста у жариштима биодиверзитета, где су изворна станишта изгубљена алармантном брзином, наглашава хитну потребу да се процени њихов статус очувања према категоријама IUCN црвене листе. Обезбеђивање дугорочног очувања биодиверзитета вилинских коњица у Турској зависи од одрживих програма заштите који се баве загађењем, фрагментацијом станишта и прекомерном експлоатацијом преосталих релативно природних слатководних екосистема.

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