

The Odonata of Kefalonia island, Greece – distributional data and conservation implications

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Abstract

The Odonate species on Kefalonia island were studied based on field surveys during 2022 and 2023, literature data and previously unpublished records. In total, we gathered 361 Odonata records from 52 localities on the island. Twenty-nine species are certainly present on Kefalonia, *Aeshna mixta* and *Sympecma fusca* are firstly recorded. Most species are found at Avythos lake and the two reservoirs near Tzanata, three of the less disturbed wetlands of Kefalonia. There is strong evidence that *Lindenia tetraphylla* and *Selysiothemis nigra* arrived at the island quite recently, and established populations at the two recently constructed reservoirs on Kefalonia. The vast majority of Odonata records are located near the 20 wetlands on the island, since about half of Kefalonia's landscape is mountainous with dry and rocky soil, unsuitable for Odonata. Such strong dependence on habitat suitability highlights the importance of wetland protection for the conservation of Odonata. Though many wetlands on the island are degraded due to habitat destruction, water pollution and/or eutrophication, the recent legislation prohibiting housing, new roads, drainage, embankments, waste disposal, and expansion of cultivation at eight wetlands of Kefalonia is a big step towards that goal.

Zusammenfassung

Die Libellen der Insel Kefalonia, Griechenland (Odonata) – Verbreitungsdaten und Auswirkungen auf den Naturschutz – Die Verbreitung von Libellenarten auf der Insel Kefalonia (Griechenland) wurde aufgrund von Feldbeobachtungen im Laufe der Jahre 2022 und 2023, Literaturdaten und bisher unveröffentlichten Meldungen erforscht. Wir haben insgesamt 361 Libellenmeldungen in 52 Fundpunkten auf der Insel dokumentiert. 29 Arten

(11 Zygoptera and 18 Anisoptera) kommen auf Kefalonia mit Sicherheit vor; zwei davon (*Aeshna mixta*, *Sympecma fusca*) wurden erstmals für die Insel nachgewiesen. Der Großteil der Libellenarten ist bei dem Avythossee und bei den beiden Stauseen in der Nähe von Tzanata dokumentiert. Es gibt deutliche Indizien dafür, dass *Lindenia tetraphylla* und *Selysiotthemis nigra* erst vor kurzem auf der Insel angekommen sind, da der steigende Wasserbedarf es erfordert, Wasser in neu errichteten Stauseen zurückzuhalten, welche die Arten als Fortpflanzungsgewässer nutzen können. Die überwiegende Anzahl der Libellenmeldungen stammt aus der Nähe der 20 Feuchtgebiete Kefalonias. Etwa die Hälfte der Landschaften der ganzen Insel sind bergig mit trockenem und felsigen Boden und bieten keine geeigneten Libellenhabitate. Somit ist der Schutz der Feuchtgebiete von enormer Bedeutung für die Erhaltung der Libellenarten auf der Insel. Obwohl viele Feuchtgebiete auf der Insel aufgrund von Habitat- bzw. Lebensraumzerstörung, Wasserverschmutzung und/oder Eutrophierung degradiert sind, die jüngste Gesetzgebung zum Wohnverbot, Straßeneröffnung, Entwässerung, Eindämmungen, Abfallentsorgung und Anbauerweiterungen in acht Feuchtgebieten Kefalonias ist ein vielbedeutender Schritt in diese Zielrichtung.

Introduction

Regarding Greece, little was known on the distribution of Odonate species before the publication of the first book dedicated to the subject (LOPAU & WENDLER 1995). The information on Odonata of Greece was greatly increased through Wolfgang Lopau's series of papers titled 'Previously unpublished dragonfly observations from Greece' (LOPAU 1999, 2000, 2005, 2010). Today, the total number of Odonata species in Europe is 143, of which 79 are present in Greece, including three endemic species, and 12 of the 20 species assessed as threatened in Europe, more than any in other European country (BOUDOT & KALKMAN 2015; KALKMAN et al. 2018).

The Odonate faunas of the seven main islands of the Ionian Archipelago are not equally studied. Corfu is the only thoroughly studied island, especially after the publication of a book by STILLE & STILLE (2018), which includes distributional maps for each species on Corfu, whereas our knowledge on the other six islands is mainly based on the works of W. Lopau and the two atlases which include Greece (BOUDOT et al. 2009; BOUDOT & KALKMAN 2015). To this day, there is no comprehensive study on the Odonata of Kefalonia, the largest island in the Ionian Archipelago (773 km²), except a few recent papers including data on Odonata species from Kefalonia (MANGER 2013; MAROULIS & XANTHAKIS 2015; GRAZIANI et al. 2019) and a photographic travelogue which includes a checklist of Odonata on Corfu, Kefalonia, Lefkada, and Zakynthos (GHINIS et al. 2024).

Our aim in this paper is to unveil the distribution of all Odonate species on Kefalonia island, based on our own survey, literature review, and previously unpublished data, in relation to the conservation status of Odonata and wetlands on Kefalonia.

Material and methods

We collected geographic data on Odonata species from Kefalonia based on published papers and previously unpublished lists provided by Odonata researchers and enthusiasts, as well as online faunistic resources (GBIF.ORG; INATURALIST; OBSERVATION.ORG) which are accompanied with photographs, in order to avoid misidentifications. We excluded all unpublished records prior to 1990.

Our field work on the island was conducted during three sampling periods: May, July, and late August–September of 2022 and 2023, for a period of 7–10 consecutive days during each sampling period. Individuals of dragonflies and damselflies were observed with a naked eye or using a 70–300 mm zoom lens. Our research was carried out near the wetlands of Kefalonia as well as anywhere else on the island, since many Odonata species are known to fly far from their preferred habitats. Nomenclature follows SCHORR & PAULSON (2024).

Study area

Kefalonia is known for its high altitudes, especially the Ainos mountain range with an elevation of 1,628 m. *Abies cephalonica* forests are typical above 800 m on Ainos, while maquis dominates most of the rest of the island with flora species such as *Quercus coccifera*, *Pistacia lentiscus*, *Quercus ilex*, *Phillyrea latifolia*, *Arbutus unedo*, and *Arbutus andrachne*. Even though Kefalonia is famous for its numerous caves (e.g., Melissani, Drogarati), there are also several inland and coastal wetlands which are among the main faunal biodiversity hotspots of the island. These are mainly marshes, lakes, ponds or reservoirs, and permanent or seasonal brooks or streams. Based on our own study and online data (YGROTOPIO.GR), we distinguished 20 wetlands on Kefalonia (excluding caves) with a total area of approximately 15.9 km² (Fig. 1).

In total, our data based on 52 localities on Kefalonia (20 wetlands plus 32 non-wetland localities). The co-ordinates, altitude, area and the dates of observations at the 20 wetlands follow:

Loc 1. Koutavos lagoon: N38.1641, E20.5064; 4 m a.s.l.; 14.476 km². Located in the mouth of the Argostoli gulf, its largest part is occupied by the lagoon with an average depth of 80 cm, separated from the rest of the bay by Drapanos bridge. The marshy areas are degraded, limited to the SE side of the lagoon. Flora: *Eucalyptus* sp., *Pinus halepensis*, *Phragmites australis*, *Populus alba*, *Tamarix* sp., *Typha* sp.: (a) 08.vii.2010; (b) 10.ix.2010; (c) 24.ix.2011; (d) 10.vii.2017; (e) 05.xi.2017; (f) 04.vii.2022; (g) 22.x.2022; (h) 16.v.2023; (i) 08.vii.2023.

Loc 2. Livadi marsh: N38.2824 E20.4302; 2 m a.s.l. 0.681 km². Located at the mouth of Livadi bay, it consists mainly of salt and brackish water marshes. Its area has decreased due to drainage and expansion of crops. It is the most important terrestrial wetland of Kefalonia due to its area and biodiversity. Flora: *Phragmites australis*, *Tamarix* sp., *Juncus* spp., *Typha domingensis*, *Eu-*

- calyptus* sp., *Pistacia lentiscus*: (a) 29.iv.2013; (b) 17.ix.2013; (c) 05.vii.2022; (d) 15.v.2023; (e) 07.viii.2023.
- Loc 3.** Livadi beach marsh: N38.2665 E20.4214; 2 m a.s.l.; 0.201 km². Located NE of Livadi village, on the west coast of Livadi bay, it is remnant of a larger wetland that was fragmented due to expansion of crops. Flora: *Sarcocornia fruticosa*, *Carex* spp., *Arundo donax*, *Juncus acutus*, *Tamarix* sp.: (a) 27.v.1998; (b) 31.viii.2017; (c) 08.ix.2021; (d) 07.viii.2023.
- Loc 4.** Marsh east of Kouvalata: N38.2415 E20.4297; 3 m a.s.l.; 0.277 km². An elongated seasonal brackish water marsh on the west coast of Livadi bay, 2.5 km long and 60 m in average width. Flora: *Carex* spp., *Sarcocornia fruticosa*, *Arundo donax*, *Eucalyptus* sp., *Phragmites australis*: 11.v.1998.
- Loc 5.** Marsh north of Lixouri: N38.2199 E20.4383; 2 m a.s.l.; 0.013 km². Seasonal coastal marsh, 1 km north of Lixouri. In the past it formed a single wetland with wetland 19 (see below). Flora: *Salicornia fruticosa*, *Arundo donax*, *Phragmites australis*, *Tamarix* sp.: (a) 31.x.2022; (b) 07.ix.2023; (c) 27.x.2023.
- Loc 6.** Lake Avythos: N38.1713 E20.7108; 293 m a.s.l.; 0.003 km². Located near Agios Nikolaos village. The lake water is mainly used for irrigation and is 11 m deep. The overflowing waters feed the small river Vochynas (see 16). Flora: *Phragmites australis*, *Ficus carica*, *Laurus nobilis*, *Typha* sp.: (a) 10.v.1998; (b) 28.v.1998; (c) 02.v.2013; (d) 28.vii.2013; (e) 04.viii.2016; (f) 09.v.2018; (g) 23.vii.2018; (h) 28.vii.2019; (i) 07.vii.2023.
- Loc 7.** Lake Akoli: N38.1994 E20.6757; 220 m a.s.l.; 0.003 km². Located approximately 1 km east of Koulourata with a maximum depth of 7.5 m. Flora: *Platanus orientalis*, *Rubus* sp., *Phragmites australis*, *Ficus carica*: (a) 04.viii.2016; (b) 11.v.2022; (c) 07.vii.2023.
- Loc 8.** Karavomylos lake: N38.2549 E20.6298; 3 m a.s.l.; 0.006 km². Brackish shallow lake with a maximum depth of 13 m, located in the coastal part of Karavomylos village, one of the largest estuaries of karst waters in Sami bay. Flora: *Carex* sp., *Phragmites australis*, *Lotus* spp.: (a) 29.iv.2013; (b) 31.viii.2017; (c) 15.vii.2020; (d) 08.vii.2023.
- Loc 9.** Ammoudares pond: N38.215 E20.4139; 1 m a.s.l.; 0.00015 km². The smallest wetland of Kefalonia with a perimeter of just 91 m. Flora: *Juncus acutus*, *Carex* spp., *Pistacia lentiscus*: (a) 29.viii.2009; (b) 06.v.2013; (c) 07.viii.2013; (d) 23.viii.2015; (e) 26.x.2016; (f) 10.viii.2020; (g) 21.viii.2023.
- Loc 10.** Reservoir near Tzanata (1): N38.1335 E20.755; 59 m a.s.l.; 0.063 km². Reservoir with a covered membrane, 1 km SE of Tzanata and only 110 m east of wetland 10 (see below). Its construction was completed in 2003. It has a capacity of 500,000 m³ of water used for irrigation and water supply. Flora: *Phragmites australis*, *Rubus* sp., *Tamarix* sp., *Typha* sp., *Nerium oleander*, *Eucalyptus* sp.: (a) 28.v.1998; (b) 10.vii.2010; (c) 18.xi.2015; (d) 09.v.2018; (e) 23.07.2018; (f) 28.vi.2019; (g) 09.vi.2021; (h) 17.vi.2021; (i) 07.vii.2022; (j) 06.vii.2023.

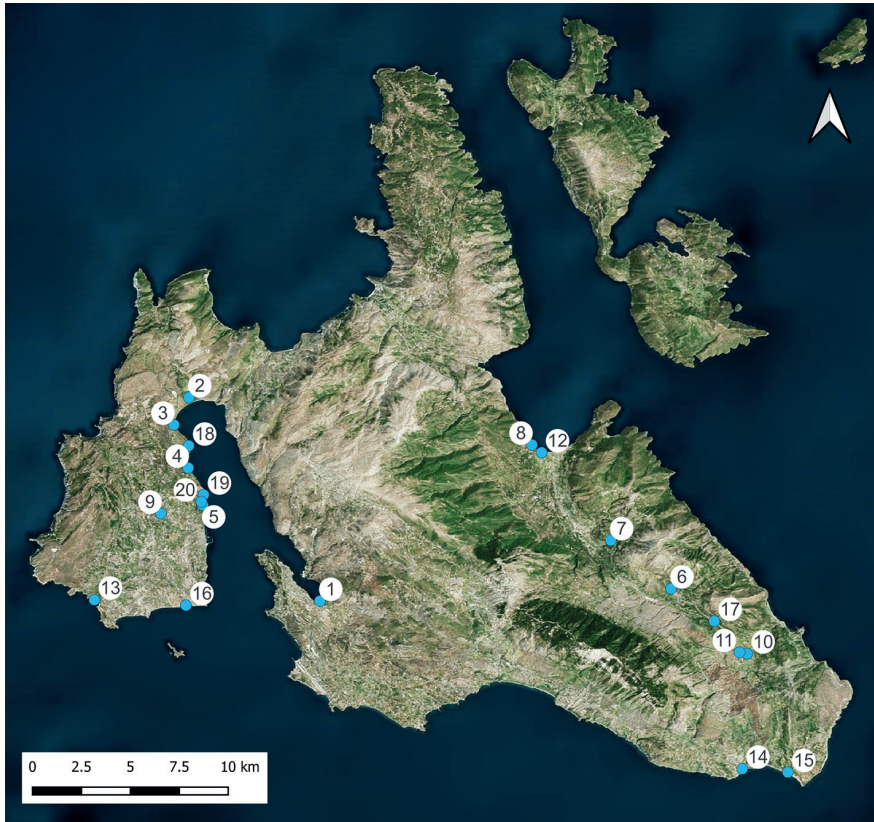


Figure 1. Wetlands of Kefalonia (except caves). **1** Koutavos lagoon; **2** Livadi marsh; **3** Livadi beach marsh; **4** Marsh east of Kouvalata.; **5** Marsh north of Lixouri; **6** Lake Avythos; **7** Lake Akoli; **8** Karavomylos lake; **9** Ammoudares pond; **10** Reservoir near Tzanata (1); **11** Reservoir near Tzanata (2); **12** Sami stream; **13** Stream near Vatsa beach; **14** Brook near Kato Kateleios; **15** Runnel near Mounda beach; **16** Megas Lakkos (Mia Lakkos) brook; **17** Vochinas stream; **18** Kleisoura brook; **19** Mersia brook; **20** Brook north of Lixouri. – **Abbildung 1:** Feuchtgebiete von Kefalonia (abgesehen von Höhlen). **1** Lagune von Koutavos; Marschland von Livadi; **2** Livadi Marschland; **3** Marschland von Livadi Strand; **4** Marschland östlich von Kouvalata; **5** Marschland nördlich von Lixouri; **6** Avythossee; **7** Akolisee; **8** Karavomylossee; Kleingewässer von Ammoudares; **9** Teich von Ammoudares; **10** Stausee in der Nähe von Tzanata (1); **11** Stausee in der Nähe von Tzanata (2); **12** Fluss von Sami; **13** Fluss in der Nähe von Vatsa Strand; **14** Bach in der Nähe von Kato Kateleios; **15** Rinnsal in der Nähe von Mounda Strand; **16** Bach von Megas Lakkos (Mia Lakkos); **17** Fluss von Vochinas; **18** Bach von Kleisoura; **19** Bach von Mersia; **20** Bach nördlich von Lixouri.

- Loc 11.** Reservoir near Tzanata (2): N38.1343 E20.7506; 65 m a.s.l.; 0.062 km². Reservoir with an uncovered membrane. Its construction was completed in 1995. It has a capacity of 500,000 m³ of water used for irrigation and water supply. Flora: *Phragmites australis*, *Rubus* sp., *Tamarix* sp., *Typha* sp., *Nerium oleander*, *Eucalyptus* sp.: (a) 28.v.1998; (b) 13.ix.2010; (c) 01.v.2013; (d) 23.vii.2018; (e) 07.vii.2022; (f) 06.vii.20223.
- Loc 12.** Sami stream: N38.2504 E20.6354; 4 m a.s.l.; 0.008 km². Its estuary is located 700 m east of Karavomylos village. It has a seasonal flow and a length of 1.2 km. Flora: *Phragmites australis*, *Eucalyptus* sp., *Juncus* spp., *Typha* sp.: (a) 31.viii.2017; (b) 09.ix.2018; (c) 06.ix.2023.
- Loc 13.** Agios Nikolaos estuary: N38.1648 E20.3752; 3 m a.s.l.; 0.008 km². Wide stream located west of Vatsa beach. Degraded wetland, essentially limited to the bed of the stream. Flora: *Quercus coccifera*, *Phragmites australis*, *Arundo donax*, *Juncus* sp.: (a) 08.v.1998; (b) 31.viii.2017; (c) 25.viii.2014; (d) 01.ix.2022; (e) 15.v.2023.
- Loc 14.** Brook near Kato Kateleios: N38.0667 E20.7522; 4 m a.s.l.; 0.007 km². Its estuary is located almost 300 m NE of Kato Katelios village. It has a seasonal flow and a length of 1 km. Flora: *Platanus orientalis*, *Rubus ulmifolius*, *Phragmites australis*, *Pteridium aquilinum*, *Spartium junceum*: (a) 08.v.1998; (b) 06.vii.2010; (c) 23.vii.2018; (d) 11.v.2022.
- Loc 15.** Runnel near Mounda beach: N38.0647 E20.7787; 2 m a.s.l.; 0.003 km². Small seasonal runnel west of Mounda beach. Most of its estuary consists of degraded sand dunes. Flora: *Phragmites australis*, *Arundo donax*, *Tamarix* sp., *Vitex agnus-castus*: 20.viii.2015.
- Loc 16.** Megas Lakkos (Mia Lakkos) brook: N38.1617 E20.4285; 5 m a.s.l.; 0.003 km². Its estuary is located 2.5 km south of Soullaroi village. The riparian vegetation is very degraded. Flora: *Arundo donax*, *Phragmites australis*, *Juncus* sp.: (a) 13.ix.2018; (b) 07.v.2022.
- Loc 17.** Vochinas stream: N38.1525 E20.7359; 99 m a.s.l.; 0.032 km². It originates from lake Avythos (6) and empties into Poros bay. It has a seasonal flow and is dry for most of the year. Flora: *Platanus orientalis*, *Quercus ilex*, *Quercus coccifera*, *Arbutus* sp.: (a) 10.v.1998; (b) 01.v.2013; (c) 02.vii.2022.
- Loc 18.** Livadi brook: N38.2543 E20.43; 4 m a.s.l.; 0.019 km². Seasonal brook. Its estuary is located 800 m SE of Livadi village. Flora: *Phragmites australis*, *Juncus* spp., *Tamarix* sp.: 08.vii.2023.
- Loc 19.** Mersia brook: N38.2259 E20.4387; 2 m a.s.l.; 0.012 km². Seasonal brook. Its estuary is located 600 m SE of Agios Dimitrios village, on the eastern coast of Livadi bay. Flora: *Phragmites australis*, *Juncus* spp., *Tamarix* sp., *Opuntia ficus-indica*: 07.ix.2023.
- Loc 20.** Brook north of Lixouri: N38.2218 E20.4374; 4 m a.s.l.; 0.01 km². Seasonal brook. Its estuary is located 1.5 km north of Lixouri. Flora: *Juncus* spp., *Ammophila arenaria*, *Phragmites australis*, *Arundo donax*, *Tamarix* sp.: 07.ix.2022.

The 32 non-wetland localities are:

- Loc 21.** Crops south of Chionata village: N38.0822 E20.7139; 147 m a.s.l.: (a) 29.vii.2019; (b) 29.ix.2022.
- Loc 22.** Near east coast, 1.35 km north of Skala village: N38.086 E20.8005; 27 m a.s.l.: (a) 08.v.1998; (b) 26.vii.2022.
- Loc 23.** Skala beach: N38.0715 E20.7994; 2 m a.s.l.: (a) 13.ix.2018; (b) 29.ix.2023; (c) 03.x.2023.
- Loc 24.** Near Sisia beach: N38.1 E20.6534; 21 m a.s.l.: (a) 25.ix.2011; (b) 29.vii.2019.
- Loc 25.** Near Lourdata beach: N38.1124 E20.6376; 8 m a.s.l.: (a) 09.ix.2018; (b) 17.vii.2022.
- Loc 26.** Kountourata village: N38.1123 E20.5735; 103 m a.s.l.: (a) 28.viii.2019; (b) 31.vii.2022; (c) 24.vii.2023.
- Loc 27.** Near Agios Thomas beach: N38.1169 E20.5991; 30 m a.s.l.: (a) 29.ix.2011; (b) 11.ix.2022; (c) 30.vi.2023.
- Loc 28.** Near International Airport: N38.1263 E20.4979; 19 m a.s.l.: (a) 31.x.2020; (b) 30.v.2021; (c) 16.v.2023.
- Loc 29.** Kefalonia Botanical Garden: N38.1598 E20.4958; 65 m a.s.l.: (a) 16.vi.2018; (b) 03.vii.2022; (c) 03.viii.2022.
- Loc 30.** North of Xi beach: N38.1648 E20.4155; 10 m a.s.l.: (a) 08.vii.2014; (b) 09.vii.2022.
- Loc 31.** NE of Argostoli: N38.19 E20.4747; 39 m a.s.l.: (a) 15.ix.2010; (b) 19.vii.2022.
- Loc 32.** Assos village: N38.3776 E20.539; 6 m a.s.l.: (a) 31.viii.2022; (b) 16.x.2023.
- Loc 33.** Shrublands SW of Chavdata village: N38.1957 E20.3762; 188 m a.s.l.: (a) 29.viii.2014; (b) 15.v.2023.
- Loc 34.** Soullaroi village: N38.1839 E20.4124; 42 m a.s.l.: (a) 27.viii.2010; (b) 01.viii.2014; (c) 11.viii.2018.
- Loc 35.** Lixouri: N38.2017 E20.4342; 5 m a.s.l.: (a) 12.vi.2018; (b) 22.vi.2019.
- Loc 36.** Shrubland 1 km NW of Skala village: N38.0817 E20.786; 144 m a.s.l.: 21.viii.2015.
- Loc 37.** Shrubland SW of Pastra village: N38.0911 E20.7449; 293 m a.s.l.: 28.v.1998.
- Loc 38.** Ai Chelis beach: N38.1041 E20.5236; 3 m a.s.l.: 29.v.2023.
- Loc 39.** Klismata village: N38.1054 E20.5586; 120 m a.s.l.: 10.ix.2019.
- Loc 40.** 1 km west of Vlachata village: N38.1247 E20.6136; 85 m a.s.l.: 29.vi.2022.
- Loc 41.** Shrubland 1.5 km SW of Chavriata village: N38.1805 E20.3657; 61 m a.s.l.: 15.v.2023.
- Loc 42.** Atheras beach: N38.3358 E20.4107; 1 m a.s.l.: 29.vii.2012.
- Loc 43.** Crop 1.3 km NE of Petani beach: N38.2665 E20.3927; 160 m a.s.l.: 15.v.2023.
- Loc 44.** Shrubland 0.95 km NE of Kipoureon Monastery: N38.2103 E20.354; 168 m a.s.l.: 07.ix.2023.

- Loc 45.** Shrubland 0.73 km SW of Kipoureon Monastery: N38.2 E20.3403; 26 m a.s.l.: 07.ix.2023.
- Loc 46.** 0.5 km SE of Platis Gialos beach: N38.1475 E20.4871; 11 m a.s.l.: 28.vii.2021.
- Loc 47.** Kounopetra: N38.1493 E20.3882; 7 m a.s.l.: 14.viii.2022.
- Loc 48.** Mantoukata village: N38.2144 E20.3932; 190 m a.s.l.: 08.ix.2019.
- Loc 49.** Shrubland 0.73 km west of Myrtos beach: N38.3408 E20.5433; 265 m a.s.l.: 13.x.2023.
- Loc 50.** Early Byzantine Basilica: N38.4624 E20.5805; 28 m a.s.l.: 22.viii.2021.
- Loc 51.** Lassi village: N38.1641 E20.4827; 35 m a.s.l.: 14.ix.2019.
- Loc 52.** Ragia beach: N38.1636 E20.7659; 9 m a.s.l.: 04.ix.2023.

Results

Based on our research and bibliographic or previously unpublished data, 29 Odonata species (11 Zygoptera and 18 Anisoptera) are certainly present on Kefalonia. In total, we gathered 361 Odonata records (Fig. 2).

***Chalcolestes parvidens* (Artobolevskii, 1929)**

9a, e; 13c, d; 25; 51.

***Lestes barbarus* (Fabricius, 1798)**

4; 6c, f; 18.

***Lestes macrostigma* (Eversmann, 1836)**

3a; 4.

***Sympecma fusca* (Vander Linden, 1820)**

13c, d.

***Calopteryx splendens* (Harris, 1780)**

6a, b, i; 11a; 12c; 17b; 37.

***Coenagrion pulchellum* (Vander Linden, 1825)**

6a, b, c, f.

***Coenagrion scitulum* (Rambur, 1842)**

10a; 11c.

***Enallagma cyathigerum* (Charpentier, 1840)**

10d, e, g; 11c.

***Erythromma viridulum* (Charpentier, 1840)**

10e.

***Ischnura elegans* (Vander Linden, 1820)**

1h; 2a, d; 3a, b; 4; 6f, g; 8a, d; 11b, c; 14b; 26b; 31a; 42.

***Platycnemis pennipes* (Pallas, 1771)**

1a; 6b, f; 7b; 8d; 10g; 11a; 12c; 14a, b, c; 17b, c; 22a.

***Aeshna mixta* Latreille, 1805**

1c, i; 5a, b.

***Anax ephippiger* (Burmeister, 1839)**

13a; 17a.

***Anax imperator* Leach, 1815**

1b, i; 2d; 4; 6a, b, c; 7c; 8a; 10a, e, g, i, j; 11b, c, e; 12c; 14a; 31a; 32a; 34b.

***Anax parthenope* (Selys, 1839)**

1a, i; 2a, c; 6b; 7c; 10a, b, c, f, g, h; 11c; 13c, d; 16b; 23c; 30a, b.

***Isoaeschna isoceles* (Müller, 1767)**

2d; 6b, c, d, f, i.

***Lindenia tetraphylla* (Vander Linden, 1825)**

10b, h, i, j; 11e.

***Onychogomphus forcipatus* (Linnaeus, 1758)**

1a, i; 6g; 11a; 17b, c.

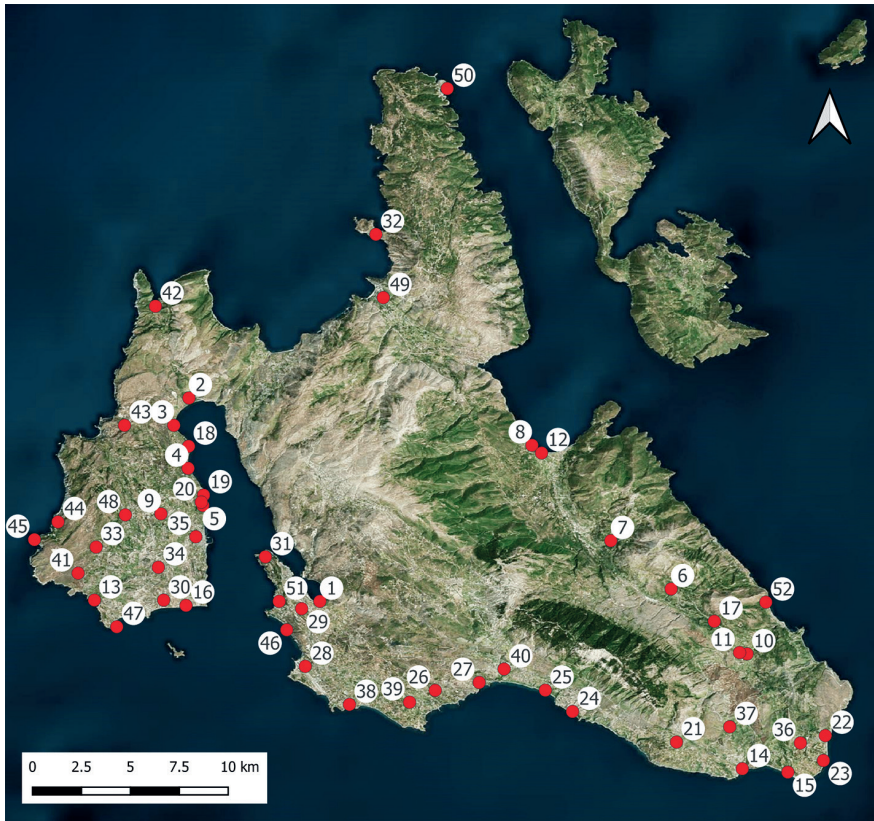


Figure 2. Localities of the Odonata records on Kefalonia included in this study. – **Abbildung 2:** Die Lage der Libellenmeldungen auf Kefalonia, welche in unserer Studie enthalten sind.

***Crocothemis erythraea* (Brullé, 1832)**

2d; 6e, i; 7a; 9a; 10a, e, j; 11b; 13c, d, e; 14b; 16b; 21a; 23b; 29a; b; 34b; 35a, b; 36; 41.

***Libellula depressa* Linnaeus, 1758**

9b.

***Libellula fulva* Müller, 1764**

1a, h; 2c, d; 6a, b, c, d, f, i; 7b.

***Orthetrum brunneum* (Fonscolombe, 1837)**

3b, c; 6f, h, i; 10e, i; 11e, f; 14b; 16b; 23a, b; 26b; 31a; 35a, b; 38; 42; 48.

***Orthetrum cancellatum* (Linnaeus, 1758)**

2a, c; 10a, i, j; 11d, e; 34b.

***Orthetrum coerulescens* (Fabricius, 1798)**

1a, d, f, i; 2a, b, c, e; 3d; 6a, b, e, f, g; 7a; 9c; 10i; 11b; 14b; 24a, b; 27b; 28b; 31a.

***Selysiothemis nigra* (Vander Linden, 1825)**

10b, e, g, i, j.

***Sympetrum fonscolombii* (Selys, 1840)**

1b, c, g, i; 2d; 4; 5c; 9c, e; 10e; 11b, c; 12b, c; 14d; 15; 16a; 19; 20; 23b; 25a; 28a, c; 31a; 32b; 34a, b, c; 43; 44; 45; 46; 47; 49; 50.

***Sympetrum meridionale* (Selys, 1841)**

2c; 3a, b; 9f; 11e; 13d; 33a, b; 41.



Figure 3. A male *Lindenia tetraphylla* at the reservoir near Tzanata (1) (wetland 10 in Fig. 1) (07.vii.2022). – **Abbildung 3:** Männchen von *Lindenia tetraphylla* am Stausee in der Nähe von Tzanata (1) (Feuchtgebiete 10 in Abb. 1), 07.07.2022. Photo: DK

***Sympetrum striolatum* (Charpentier, 1840)**

1c, e, i; 2d; 3a; 4; 18; 52.

***Trithemis annulata* (Palisot de Beauvois, 1807)**

1f, h; 5b; 8b, c, d; 9d, g; 10a, b, g, h, i, j; 11b, c, d, e; 12b, c; 13c, e; 19; 20; 21b; 22b; 23b; 25b; 26a, b, c; 27b, c; 29a, c; 31b; 34b; 39; 40.

Even though most of the localities (67.9%) are non-wetland, 78.9% of the records are near wetlands, and most of the records far from wetlands are in Paliki peninsula (west Kefalonia), where most of the Kefalonian crops as well as 10 of the 20 wetlands are located (Fig. 1). *Sympetrum fonscolombii* and *Anax imperator* have been recorded at 12 and 11 wetlands, respectively, more than all other Odonate species, and the richest Kefalonian wetlands in Odonata species are: Avythos lake (13 species), the two reservoirs near Tzanata (Loc. 10: 13 species; Loc. 11: 12 species), Koutavos lagoon (11 species), and Livadi marsh (10 species) (Table 1).

Discussion

Twenty-nine Odonata species were confirmed to occur on Kefalonia. *Sympetma fusca* and *Aeshna mixta* are first published records for the island. The Odonate fauna of Kefalonia represents 36.7% of the 79 species recorded in Greece, including mostly species widely distributed and well adapted to the Mediterranean climate. Based on our research, the presence of three more species (*Calopteryx virgo*, *Gomphus schneiderii*, *Brachytron pratense*) which have been reported from Kefalonia (GBIF.org; GHINIS et al. 2024) cannot be confirmed, but this may change in the future as all three are certainly present on Corfu (STILLE & STILLE 2018). All recorded species are present near at least one of the 20 wetlands of the island, except *Anax ephippiger* which has not yet been observed at a wetland on Kefalonia. *Trithemis annulata* is the most common dragonfly species on Kefalonia, having expanded its distribution on the island during the last decade probably as a result of global warming, the main driver of the extension of its range in the Mediterranean region (KALKMAN et al. 2015). *Lestes macrostigma* is reported only from wetlands 3 and 4 (Fig. 1) and has not been observed on Kefalonia since 1998 (Lopau 2006). It is assessed as NT B2ab(ii,iii) in the first IUCN assessment for Greece (KARAOUZAS & KALTSAS unpublished data), and is the only Odonate species on Kefalonia assessed higher than the Least Concern (LC) category for Greece.

Comparing the two largest islands of the Ionian Archipelago, Corfu hosts 27 of the Odonate species found on Kefalonia plus 12 more, even though Kefalonia is 1.3 times larger than Corfu. Strange as this may seem at first, the explanation lies in the landscape differences between the two islands. About half of Kefalonia is mountainous with dry and rocky soil, whereas Corfu is much flatter and its number of wetlands is approximately three times that of Kefalonia. As a matter of fact, 78.9% of all Odonata records from Kefalonia included in our study (Fig. 2) are located near the 20 wetlands on the island (Fig. 1), and all mountainous parts

Table 1. Presence of Odonata species at the 20 wetlands of Kefalonia (details in Fig. 1). –
Tabelle 1: Vorkommen von Libellenarten an 20 Feuchtgebieten Kefalonias (vgl. Abb. 1).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>C. parvidens</i>									+				+							
<i>L. barbarus</i>				+		+													+	
<i>L. macrostigma</i>			+	+																
<i>S. fusca</i>														+						
<i>C. splendens</i>						+						+							+	
<i>C. pulchellum</i>						+														
<i>C. scitulum</i>											+	+								
<i>E. cyathigerum</i>											+	+								
<i>E. viridulum</i>											+									
<i>I. elegans</i>	+	+	+	+		+		+			+			+						
<i>P. pennipes</i>	+					+		+					+	+					+	
<i>A. mixta</i>	+				+															
<i>A. imperator</i>	+	+		+	+	+	+	+			+	+	+		+					
<i>A. parthenope</i>	+	+				+	+				+	+		+					+	
<i>I. isoceles</i>			+			+														
<i>L. tetraphylla</i>											+	+								
<i>O. forcipatus</i>	+					+														+
<i>C. erythraea</i>						+	+		+	+	+		+	+				+	+	
<i>L. depressa</i>										+										
<i>L. fulva</i>	+	+				+														
<i>O. brunneum</i>			+			+					+	+			+				+	
<i>O. cancellatum</i>		+									+	+								
<i>O. coerulescens</i>	+	+				+	+		+	+	+				+					
<i>S. nigra</i>											+									
<i>S. fonscolombii</i>	+	+		+	+				+	+	+	+		+	+					+
<i>S. meridionale</i>		+	+						+					+						
<i>S. striolatum</i>	+	+	+	+																+
<i>T. annulata</i>	+				+			+	+	+	+	+								+
Total	11	10	5	6	4	13	4	4	7	13	12	5	5	7	1	3	4	2	2	2

of the islands are devoid of dragonflies and damselflies. Although Odonata are generally strongly associated with their preferred habitats, many species are also known to fly far from aquatic systems. Thus, this is a rather rare display of the acute dependence of Odonata on habitat suitability on a Greek island, as Kefalonia apparently hosts Odonate fauna in only about half of its total area.

Our current knowledge on the Odonate fauna of Kefalonia has increased significantly during the last decades. Eight species have been observed for the first time on the island since 2009. *Chalcolestes parvidens* (first observed in 2009), *Aeshna mixta* (in 2011), *Libellula depressa* (in 2013), and *Sympecma fusca* (in 2014) probably established populations on Kefalonia a long time ago, and had not been found earlier by W. Lopau, possibly due to their rather restricted distribution on the island. However, the same is not true for the other four recently recorded species on Kefalonia. *Lindenia tetrphylla* (first observed in 2010), *Enallagma cyathigerum* (in 2013), *Erythromma viridulum* and *Selysiothemis nigra* (both in 2018) have only been found at the reservoirs near Tzanata (wetlands 10, 11 in Fig. 1). Since the two reservoirs were constructed in 1995 (wetland 11) and 2003 (wetland 10) and these species have not been observed elsewhere on Kefalonia, it is highly possible that they arrived recently on the island. Besides, *S. nigra* was first observed in Corfu in 2007 (SUTTON 2009) and *L. tetrphylla* in 2014 (STILLE et al. 2014), both found only at Moschopoulou reservoir (about half the size of each reservoir near Tzanata; constructed in 2001) in the south part of the island. The fact that both species have such similar distributions on the two islands is no coincidence. These two species are currently generally increasing in Europe (DE KNIF et al. unpubl. data; KALKMAN 2010), and it is evident that in recent years this is partly due to climate change, as increasing demand for water leads these very capable flyers to establish at suitable habitats such as man-made reservoirs expanding their distribution, especially in the east Mediterranean region (KALKMAN & BOGDANOVIC 2015a, b), and both Ionian islands in particular. This is partly why both species today are assessed as of Least Concern in Europe (DE KNIF et al. unpubl. data) and Greece (KARAOUZAS & KALTSAS, unpublished data; KAZILA unpubl. data).

The restricted distribution of several Odonate species on Kefalonia, their strong connection with their preferred habitats and the constraints of the Kefalonian landscape highlight the importance of conservation of wetlands on the island. Eight wetlands of Kefalonia (5–8, 13, 18–20 in Fig. 1) are protected by presidential decree since 2012 and part of wetland 14 lies within the limits of Natura area GR2220004. However, many wetlands on Kefalonia are degraded due to habitat destruction, water pollution and/or eutrophication. The main threats for Odonate species on Kefalonia during recent decades are: drainage (wetlands 1, 2, 5), housing (wetlands 3–5, 8, 12–16, 20), expansion of cultivations (wetlands 2, 3, 4, 14–16, 20), roads (wetlands 2, 8, 14, 18, 19), and touristic development (wetlands 8, 13, 14). These lead to pressures for Odonata, mainly because of restriction or fragmentation, which is evident in the two largest wetlands on the island. The two separate marshes in Livadi bay (wetlands 2, 3) used to be a single marshland and the area of marsh in Koutavos lagoon has been significantly reduced.

On the other hand, most lakes or ponds are in very good condition and do not show any form of degradation. The only exception is Karavomylos lake (wetland 8) which is located in the coastal part of the town of Sami. It is no coincidence that lake Avythos (wetland 6) and the two reservoirs near Tzanata host more Odonata species than any other wetland on Kefalonia and even the tiny Ammoudares pond

(wetland 9) is quite rich in terms of Odonate fauna, including the sole record of *Libellula depressa* on Kefalonia till this day (Table 1).

The conservation of wetlands is very important for the protection of various special habitats associated with animal groups which live in freshwater ecosystems. The inclusion of 368 wetlands from 55 Greek islands (including 8 from Kefalonia) in a presidential decree in 2012 is a big step towards the conservation of wetlands in Greece. The legislation prohibiting housing, new roads, drainage, embankments, waste disposal, and cultivation expansion in these wetland areas, as included in the decree, are adequate conservation measures for successful freshwater habitat protection. However, the fact that today some unprotected wetlands of Kefalonia are in better condition than most of these eight newly protected wetlands is indicative of the anthropogenic pressures on the sites. Habitat restoration may take time and the application of environmental law is often contrary to activities such as agriculture and tourism. This is even more important for Kefalonia, where wetlands are fragmented because of its mountainous landscape and the geographic expansion of traditional human activities.

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