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ECOO

8th European Congress
on Odonatology, Poland

BOOK OF ABSTRACTS

Edited by:
Adam Tarkowski
Szymon Śniegula
Edyta Buczyńska
Anna Rychła
Agnieszka Tańczuk

Teresin, Poland
23-26 June 2026

Odonatrix Volume 22, Supplement 1

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of the Polish Entomological Society

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Thank you for standing with us!

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Foreword

On behalf of the Scientific Committee, I am pleased to welcome you to the European Congress on Odonatology (ECOO 2026) in Teresin, Poland.

This congress brings together researchers, conservation practitioners, students, and enthusiasts who share a common interest in dragonflies and damselflies. The abstracts collected in this volume reflect the diversity of contemporary odonatological research, covering topics ranging from ecology, evolution, and behaviour to conservation, climate change, and molecular approaches.

We are particularly pleased that ECOO 2026 is the first European Congress on Odonatology to be held in Poland. We hope that this meeting will provide an inspiring platform for presenting new research, exchanging ideas, strengthening existing collaborations, and establishing new ones.

On behalf of the Scientific Committee, I would like to thank all authors for contributing their work to the scientific programme. I also extend my sincere gratitude to the reviewers and members of the Organizing Committee whose efforts have made this congress possible.

We wish you a productive congress, stimulating discussions and an enjoyable stay in Poland!

Szymon Śniegula
Chairman of the Scientific Committee

Programme

Monday · 22 June

16:00 – 20:00 · **Registration**

18:45 · **Dinner**

Tuesday · 23 June

08:10–09:00 · **Registration**

08:00–09:00 · **Breakfast**

09:10–09:20 · **Opening Ceremony** · Adam Tarkowski
09:20–09:50 · **Introduction** · **Edyta Buczyńska** & Paweł Buczyński· Odonata of Poland

Global change, range shifts & biogeography

Time		Speaker	Title
09:50–10:25	**Plenary**	**Frank Johansson**	Effects of climate change on biotic interactions in Odonata
10:25–10:45	Talk	**Charles Gauci**	*Pantala flavescens* is now a regular breeding migrant in the Maltese Islands

10:45–11:05 · **Coffee break & Registration**

11:05–11:25	Talk	**Giacomo Assandri**	Unveiling continent-wide migration in *Anax ephippiger* through citizen science data
11:25–11:45	Talk	**Roy van Grunsven**	Causes of declines of Dutch dragonflies
11:45–12:05	Talk	**Nikola Góral**	From the rapid expansion to the unexpected decline: How medium-term climatic fluctuations explain the population dynamics of *Nehalennia speciosa*

12:05–12:30 · **Coffee break & Registration**

12:30–12:50	Talk	**Christoph Willigalla**	Migration of Aeshna mixta and *Sympetrum danae* along the Baltic coast
12:50–13:10	Talk	**Julia Guerra Carande**	Odonata communities in the whole Spanish territory: a biogeographical assessment by administrative boundaries

13:30–14:30 · **Lunch**

Anthropogenic stress & ecotoxicology

14:45–15:20	**Plenary**	**Robby Stoks**	Ecotoxicology on a warming planet
15:20–15:40	Talk	**Cecilia Sydor Estable**	The impact of road salt and tire-wear particles on Odonate (*S. vicinum*) eggs and larvae
15:40–16:00	Talk	**Hana Šigutová**	Post-mining aquatic habitats as potential ecological traps for odonates

16:00–16:20 · **Coffee break**

16:20–18:20 · **Workshop session**

18:30 · **Dinner**

Wednesday · 24 June

08:00–09:00 · **Breakfast**

Conservation, biological invasions & policy

09:35–10:10	**Plenary**	**Frank Suhling**	Dragonflies in temporary habitats: coping with or avoiding drought
10:10–10:30	Talk	**Leonardo Siddi**	The migration of a locally threatened damselfly reveals the need for habitat-specific and seasonally tuned conservation actions
10:30–10:50	Talk	**Krystian Adam Ołdak**	Environmental drivers of odonate occurrence in fish ponds of Polesie National Park (Eastern Poland)

10:50–11:30 · **Coffee break**

11:30–11:50	Talk	**Lisa Nicvert**	How are dragonflies doing in Europe? A quantitative assessment of dragonflies distribution trends over the last 25 years
11:50–12:10	Talk	**Geert De Knijf**	OdonTraits Europe. A European database of Odonata traits
12:10–12:30	Talk	**Marina Vilenica**	Responses of Odonata assemblages to artificial and heavily modified water channels
12:30–12:50	Talk	**Klaas-Douwe B. Dijkstra**	Political odonatology: can dragonflies make a difference?

13:30–14:30 · **Lunch**

14:30–14:50	Talk	**Karol Kram**	Kampinos National Park and its efforts to protect and restore wetland habitats and preserve rare dragonfly species
14:50–15:10	Talk	**Samuel Jolivet**	What do we need to enhance dragonfly conservation? A call to organise a collective improvement of knowledge
15:10–15:30	Talk	**Cesc Múrria**	Eight National Parks harbouring the majority of Iberian odonate species highlight the importance of habitat conservation

15:30–16:00 · **Coffee break**

Evolution & functional morphology

16:00–16:35	**Plenary**	**Nataliia Matushkina**	The cutting edge: How Odonata tailor their ovipositors
16:35–16:55	Talk	**Jette Söhnholz**	The role of cold and drought in the egg development of *Sympetrum depressiusculum* – a comparison between early and late laid eggs
16:55–17:15	Talk	**Günther Fleck**	First stridulatory apparatuses in Anisoptera
17:15–17:18	Lightning talk	**Marie Lamouille-Hébert**	Citizen Science to understand the distribution of *Aeshna juncea* (Linnaeus, 1758) in Southwestern Europe

18:30 · **Dinner**

Thursday · 25 June

08:00–09:00 · **Breakfast**

09:30–17:00 **Mid-Congress field trip** · Kampinos National Park & peatlands · Lunch

18:30 · **Dinner**

Friday · 26 June

08:00–09:00 · **Breakfast**			
Conservation, biological invasions & policy			
09:10–09:30	Talk	**Sönke Hardersen**	Changes in Odonata diversity in the nature reserve Bosco Fontana (Italy, Lombardy) between 2004 and 2025
09:30–09:50	Talk	**Brij Kishore Tyagi**	Indian dragonflies: cytotaxonomix diversity and conservation
09:50–10:30 · **Coffee break**			
Behaviour, ecology & population dynamics			
10:30–11:05	**Plenary**	**Adolfo Cordero Rivera**	Sexual conflict and mating behaviour of odonates
11:05–11:25	Talk	**Erland R. Nielsen**	Dragonflies in slow motion
11:25–11:45	Talk	**Jordi Vilanova**	Diet preferences of north American odonates
11:45–12:10 · **Coffee break**			
12:10–12:30	Talk	**Régis Krieg-Jacquier & Thomas Gruet**	Caves and underground habitats, a shelter or a trap for dragonflies?
Methods, monitoring in odonatology & ECOO community			
12:30–12:50	Talk	**Marie Lamouille-Hébert**	Detecting Odonata species in mountain ponds using the CIMaE protocol
12:50–13:10	Talk	**Gianandrea La Porta**	We caught, we marked, we learnt: Optimizing long-term CMR designs for *Coenagrion castellani*
13:30–14:30 · **Lunch**			
14:30–14:50	Talk	**Christian Göcking**	Dragonfly monitoring in Germany – current status
14:50–15:10	Talk	**Florent Prunier**	The dragonflies of the Guadiaro River basin (Andalusia, Spain)
15:10–15:30	Talk	**Magnus Billqvist**	The history of ECOO 2010-2026
15:30–16:00 · **Coffee break**			
16:00–17:00 · **Poster Session** & voting			
17:00–17:20	Talk	**Eva Bílková**	International Congress of Odonatology 2027, Ostrava, Czech Republic
17:20 · **Closing ceremony**			
19:00 · **Farewell dinner**			

Posters	
Eleana Kazila	New insights into the ecology and conservation *of Pyrrhosoma elisabethae*, a Critically Endangered European odonate
Maria J. Golab	Insights from comparative 16S analyses across life stages and overwintering strategies
M. Olalla Lorenzo-Carballa	Gone with the wind? population genomics uncover genetic population structure in *Ischnura hastata*
Marta Villasán Barroso	Odonata diversity in a proposed protected area: Insights from the Ñeembucú expedition, Southern Paraguay
Philippe Lambret	Assessing whether *Lestes macrostigma* is an umbrella species for the conservation of temporary brackish waters
Szymon Sniegula	Predicting life history responses to global warming in odonates: which temperature and photoperiod should be used?
Zuzana Šíblová	Faunistic and ecological study of dragonflies (*Insecta*: *Odonata*) of the Malé Karpaty mountains

Saturday · 27 June

08:00–09:00 · **Breakfast**

9:30 · **Departure for post-Congress field trip**

Introduction

Odonata of Poland

Edyta Buczyńska[1*], Paweł Buczyński[2]

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Keywords: Poland, odonatofauna, zoogeography, threats, changes

Poland is a medium-sized country located in Central and Eastern Europe, predominantly lowland. The northern and northwestern parts were shaped by the Würm glacial stage. The hydrological network is densest in the lake districts in the north and in the mountains and foothills in the south. The climate is transitional, temperate and warm. Changes are being observed, including warming and fluctuations in rainfall patterns, which negatively affect dragonfly habitats.

Poland is home to 74 dragonfly species – which is half of the fauna of Europe. The national fauna is primarily shaped by the location in the centre of Europe, its Ice Age history, the lack of east-west barriers to dragonfly migration, and their presence on the southern border. Palearctic, Western Palearctic, and Holarctic species dominate. Only a few have partially Afrotropical or Paleotropical ranges, and the circumtropical *Pantala flavescens* is also present. Many of the "southern" species either appeared in Poland or increased their range, frequency, and abundance only in the last three decades, as the climate warmed.

Western European endemic species do not reach Poland, but Siberian species are numerous, occurring most abundantly and most frequently in the east and north of the country (*Sympecma paedisca*, *Coenagrion hastulatum*, *C. lunulatum*, *Nehalennia speciosa*, *Aeshna viridis*, or *Leucorrhinia spp.*). A few post-glacial relicts occur only in the mountain (*Aeshna caerulea*, *Somatochlora arctica*).

Climate change is causing changes in the odonatofauna of Poland. There has been a spectacular geographic expansion of many Mediterranean species (sensu Dévai 1976), and their habitat range is expanding. At the same time, a number of Siberian species are in decline, the most severe in the case of *Coenagrion lunulatum* and *C. armatum*. The altitudinal range of *Aeshna caerulea*, once found at 830 m above sea level, is also changing, now known from only one site at 1,430 m. These changes are overlapped by the effects of human pressure.

Despite this, large areas of Poland remain in good condition and serve as havens for valuable dragonfly species and their communities. No species have become extinct yet, and the number of species in the high-risk category (VU) is small (5) – although the Polish Red List of Dragonflies is now 17 years old, and the current update may bring a worse picture. Furthermore, 21 species listed as threatened or near threatened in Europe and the European Union are recorded in Poland, including three in the EN category and nine in the VU category. For many species Polish populations are large and crucial for their preservation.

Effects of climate change on biotic interactions in Odonata

Frank Johansson*

Professor at
Department of Ecology and Genetics; Animal Ecology;
Uppsala University, Sweden
* email: Frank.Johansson@ebc.uu.se

We have some knowledge on how climate change affects range shift, phenology, and life history traits such as growth, development and survival of organisms including Odonata. However, growth, development and survival are also affected by intra- and interspecific interactions. In my talk I will present recent results on how intra- and interspecific interactions in larvae of Odonata is affected by temperature. Additionally, I will discuss areas that require further investigation within this topic.

Pantala flavescens is now a regular breeding migrant in the Maltese Islands

Charles Gauci*

* email: cjgauci48@yahoo.com

Keywords: oviposition, exuviae, June, Wied Katarina, Chadwick Lakes

First recorded in the Maltese Islands in 2013, *Pantala flavescens*, with one exception in 2022, has, since 2020, been found annually in late summer and autumn in the Maltese Islands. The species was recorded from various sites in autumn 2020 and bred successfully, with 128 exuviae found. Small numbers, mostly males, were seen the following year, but no breeding activity was observed. In 2023 and 2024 the species bred successfully in small pools at Wied Katarina, with 259 and 29 exuviae, respectively, being found. On 3, June 2025, a fresh exuvia was found at a permanent brackish reservoir, where oviposition had taken place the previous autumn. Had the egg or larva overwintered in diapause? In previous years imagines had always first appeared between the end of July and early September, but in 2025 regular breeding activity was found taking place from mid-June in small remnant pools at Chadwick Lakes. Most of these pools dried up by early July. No exuviae were found. Following the first autumn rains, breeding activity was witnessed at Wied Katarina from 28 September and again at Chadwick Lakes from mid-October to 20 November when the last imagines were seen as stormy weather set in. These could have belonged to a fresh wave of immigrants, as between 15-25 Sep there were 5 sightings of 1-3 individuals on the move in dry areas. However, the observations could also be the result of a second generation that emerged at other sites.

The species is appearing regularly in the Mediterranean, with breeding confirmed in Cadiz, Spain, in 2024 and 2025, as well as in Sicily in 2025. The finding of the early June exuvia is intriguing. Is the species adapting to the new circumstances brought about by climate change?

Unveiling continent-wide migration in *Anax ephippiger* through citizen science data

Giacomo Assandri[1*], Johanna H. Hedlund[2,3]

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Keywords: migration, Europe, *Anax ephippiger*, citizen science

Insect migration has received considerably less attention from zoologists compared to that of vertebrates, despite its major ecological relevance in transferring large amounts of biomass between ecosystems. This gap is primarily due to methodological limitations: the small size of insects does not allow the use of technologies and approaches that have proven fundamental in understanding vertebrate migration (e.g. bird banding or satellite telemetry). Among Odonata, a significant number of species exhibit migratory behaviour—an adaptation that has likely evolved in response to seasonal changes in their aquatic breeding habitats. However, the impossibility of directly tracking their large-scale movements necessitates the adoption of alternative unconventional approaches. *Anax ephippiger* is a tropical species that occurs seasonally in Europe and is known for its long-distance, and sometimes invasive, migrations. Despite this, very little is known about the characteristics of its migratory behaviour. This is due in part to the fact that, although it is one of the largest species in the European dragonfly fauna, tracking its large-scale movements remains challenging. In this study, we describe the spatial and temporal patterns of *Anax ephippiger* migration at the European scale using occurrence data derived from citizen science (>27,000 records). The results show that the species undertakes long-distance movements (>5,000 km) that follow consistent routes year after year. The migrants reaching Europe in early spring originate from Africa; these individuals reproduce in Europe, and their offspring give rise to a second migratory wave in late summer. These findings improve our understanding of dragonfly migration and highlight the need for unconventional approaches and methodologies to effectively describe their movements. Furthermore, they emphasise the conservation challenges posed by migratory insects, which exploit different areas and habitats at different stages of their life cycle and therefore require targeted conservation actions at different times of the year.

Causes of declines of Dutch dragonflies

Roy van Grunsven*

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* email: roy.vangrunsven@vlinderstichting.nl

Keywords: climate, Red List, Netherlands, oligotrophic, common

A new Red List of Dutch dragonflies has been published; this shows a decline of dragonflies of oligotrophic habitats, a pattern we see across Europe. These declines have accelerated over the last decade, and many species are now endangered or critically endangered. Climate change plays an important role for these species with northern distributions and a low Species Temperature Index. However, the proximate causes of the decline were not understood.

We looked at the microhabitat of larvae of *C. lunulatum*, *L. rubicunda* and *S. danae* and compared the oxygen uptake of larvae with more southern related species. We found that these species were limited to oxygen-rich refugia within ponds. Lab studies indicate that they are more sensitive to low oxygen levels than congeneric species. Finally, we looked at the oxygen consumption of sludge. This has increased as the acidity of heathland ponds has decreased, because of lower S- and N-deposition, and the temperature has increased. Oxygen limitation is likely an important factor causing the decline of these species and improving oxygen availability can be a way to mitigate impacts of climate change.

Other species that prefer lower temperatures such as *C. armatum*, *Aeshna grandis* and *Somatochlora metallica* are also declining but their proximate drivers are poorly understood.

Some previously widespread and common species such as *Calopteryx splendens*, *Ischnura elegans*, *Pyrrhosoma nymphula*, *Erythromma viridulum* and *E. najas*, are declining in abundance recently and are Red-Listed according to the IUCN-criteria. These are all species with very modest habitat requirements and are still widespread in eutrophic waterbodies such as ditches and ponds. They seem to be suffering from a decline of submerged vegetation. Why aquatic vegetations are disappearing on a large scale is unclear but water quality, both nutrients and chemicals, and exotic crayfish seem to play a major role.

From the rapid expansion to the unexpected decline: How medium-term climatic fluctuations explain the population dynamics of *Nehalennia speciosa*

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Keywords: SPEI drought index, long-term monitoring data, population dynamics, peatland specialist, climate change

Climate change is reshaping species distributions across Europe, often producing non-linear population dynamics in which declines are preceded by expansion phases or transient influxes. Such patterns have been documented particularly in species associated with vulnerable habitats.

Nehalennia speciosa, a shallow-water peatland specialist, declined in the 20th century. However, due to reduced peatland degradation and the presumed low dispersal, its distribution was expected to stabilise. This expectation is contradicted by both colonisation of new sites after 2008 and a subsequent decline after 2015.

We tested whether non-linear population dynamics are linked to water balance variability. Data from 74 sites in eastern Poland (1997–2024) were used to relate abundance to Standardised Precipitation Evapotranspiration Index (SPEI) calculated over 6–48-month periods.

The best model fit was obtained for the long-term SPEI48 index (marginal $R^2 = 0.495$), consistent with the slow accumulation of water deficits and surpluses in peatland habitats. The effect of SPEI was positive ($\beta = 2.08$) but strongly dependent on habitat type: the presence of an open waterbody mitigated climatic effects ($\beta = -1.96$) and promoted higher abundances regardless of SPEI values ($\beta = 3.46$).

These results suggest that the observed population decline arises not primarily from direct climatic effects on the species (direct thermal stress or annual rainfall), but from the gradual accumulation of water deficits, amplified by temperature-driven evapotranspiration. The alternation of multi-year dry and wet phases appears to underlie the unexpected shift from expansion to decline, revealing a highly dynamic response of *Nehalennia speciosa* populations and possibly of other peatland specialists.

Migration of *Aeshna mixta* and *Sympetrum danae* along the Baltic coast

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Keywords: dragonfly migration, stable isotopes, sydrogen, Baltic coast

Apart from few iconic species, knowledge gaps pertain regarding dragonfly migration particularly in Europe. *Aeshna mixta* was shown to migrate along the Baltic coast, while movements of other species such as *Sympetrum sanguineum* and *S. danae* are controversially discussed and assigned to either directed migration or multidirectional, stochastic dispersal.

We collected wings of dragonflies of *A. mixta*, *S. sanguineum* (n = 50 each), and *S. danae* (n = 23) caught in a bird trap at the ornithological station in Pape, Latvia, in autumn 2025. We analysed the isotope ratios of non-exchangeable hydrogen (δ2Hn) and assigned the potential natal origins based on spatially explicit probability calculations.

For *A. mixta*, we could confirm migration patterns previously reported. We identified a local (68%) and a migrating (32%) subpopulation based on the histograms of δ2Hn values of the wings. With one exception, the latter originated from N or NE of Pape, e.g. from Finland, Estonia or Belarus, indicating southwest-/southbound migration. Although we also found a local subpopulation of *S. sanguineum* (56%), movements were less clear. Non-local subpopulations originated both from the N/NE (8%) and from the S/SW (36%) suggesting stochastic processes associated with dispersal. None of the caught *S. danae* could be attributed to a local population, while the individuals (except for one) migrated from N/NE – a migration pattern similar to *A. mixta*. Our approach highlights that the identification of migration sensu strictu requires the inclusion of histograms of δ2Hn values of dragonfly wings to enable the differentiation between dispersal and migration. Furthermore, *A. mixta* and *S. danae* share the same potential natal origins which might suggest similar migration routes. Further studies are needed to shed light on the regularity of the observed migration patterns and on the potential migration of other European dragonfly species.

Odonata communities in the whole Spanish territory: a biogeographical assessment by administrative boundaries

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Keywords: biogeography, national inventory, community composition, historical

As a Mediterranean peninsula, Spain hosts a diverse mix of Odonata chorotypes, including relict species from past cold periods, Mediterranean species, and recent colonisations from North Africa. In our previous work, we compiled a comprehensive dataset of occurrence records for 88 Odonata species across all Spanish provinces, including mainland Spain, the Balearic and Canary Islands, and the autonomous cities of Ceuta and Melilla.

In this study, we explore how species composition is structured across Spain. We expect biogeographic conditions to influence species composition, although not fully determine it, given the wide range of settings and conservation practices affecting Spanish' aquatic habitats. To test this, we first examined spatial autocorrelation and then evaluated similarities among Odonata communities. We carried out separate analyses for Zygoptera and Anisoptera to account for their different dispersal abilities. Finally, using temporal patterns in species' first records, we compared how species have been recorded over time across provinces.

Together, these analyses offer an integrated overview to the ecological and biogeographic factors shaping Odonata diversity in Spain, and help to improve our understanding of biodiversity patterns in Mediterranean regions.

Ecotoxicology on a warming planet

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Keywords: ecotoxicology, global change, *Ischnura*

Organisms are increasingly exposed to pollutants and warming, which is especially problematic as the effects of both stressors may magnify each other. Based on a research programme focusing on larvae of the damselfly *Ischnura elegans*, I will illustrate the challenges animals face in order to survive on a polluted, warming planet. Specifically, I will discuss the effects of an increase in mean temperature, heat waves and daily temperature fluctuations on the toxicity of pesticides, and some of the underlying physiological mechanisms that we identified. Vice versa, I will discuss how pesticide exposure can reduce heat tolerance and the mechanisms underlying this effect. I will also report on the importance of thermal evolution along a latitudinal gradient shaping these patterns and on their ecological consequences in terms of predator-prey interactions. Finally, I will highlight how these interactions between pesticides and warming-related stressors challenge the ecological risk assessment of pesticides.

The impact of road salt and tire-wear particles on Odonate (*S. vicinum*) eggs and larvae

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Keywords: climate change, anthropogenic stress, odonate development, ecotoxicology

Multiple anthropogenic stressors can interact additively, synergistically, or antagonistically, with important consequences for ecosystems. Understanding the direction and magnitude of these interactions is key to predicting and mitigating their impacts. In regions with colder annual temperatures, precipitation and snowmelt events introduce tire wear compounds and road deicing salts into adjacent aquatic ecosystems. Tire wear particles have been linked to metabolic disruption in invertebrates and behavioural changes in aquatic insects. Similarly, increased aquatic salinisation from road salts is associated with community-level effects such as reduced biodiversity, loss of primary producers, and impaired immune responses. N,N′-diphenylguanidine (DPG) and 6PPD-quinone are among the most prevalent tire-wear contaminants detected at high concentrations in urban runoff across Canada. Common road deicing salts have been measured in freshwater systems at concentrations exceeding acute mortality thresholds for several aquatic macroinvertebrates. The toxicity of both road salts and tire-derived contaminants can increase with rising temperatures, raising concern under future climate scenarios.

Eggs from 18 dragonfly (*Sympetrum vicinum*) females were exposed to single and binary combinations of DPG, 6PPD-quinone, and road salt across a concentration gradient spanning sublethal levels to above environmentally-observed maxima. Treatments were conducted at the current seasonal average (20 °C) and a projected future average (24 °C). Hatchling mortality, rate, and size were monitored over two months post-exposure. Preliminary results indicate significant effects of road salt on hatch mortality, rate, and egg size. This study clarifies how multiple anthropogenic stressors impact an ecologically important species, whose decline could contribute to broader environmental disruptions.

Post-mining aquatic habitats as potential ecological traps for odonates

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Keywords: ecological traps, post-mining sites, *Sympetrum vulgatum*, habitat selection, larval performance

Restored post-mining pools and lakes are often considered freshwater diversity hotspots, attracting numerous odonate species. Nevertheless, considering their origin and subsequent development, we hypothesised that these sites could serve as ecological traps. Using *Sympetrum vulgatum* (Libellulidae) as a model species, we investigated 12 post-mining and 12 near-natural (control) habitats in Czechia to assess the potential discrepancy between their attractiveness for adults (number of ovipositing tandem pairs per time unit) and offspring performance (selected physiological, immunological, and morphological traits). For the latter, we installed cages with 30 four-instar larvae at each site, totaling 720 larvae, and we assessed their survival and body condition until (pen)ultimate instar. Attractiveness for adults did not differ between post-mining and control habitats. The sites attracting more tandems were not consistently the sites with higher larval performance, suggesting a decoupling of adult habitat selection and offspring performance. Larval survival did not differ between post-mining and control sites, and from all measured proxies of offspring performance (larval size, dry mass, mask length, phenoloxydase [PO] activity, protein and fat concentration, total hemocyte and K assay count), only PO activity (i.e., responsiveness of immune system) was significantly lower in post-mining sites. Dissolved oxygen emerged as the only environmental predictor positively associated with larval performance. Our results suggest a pattern of potentially reduced functional quality in restored post-mining habitats, and support the previously proposed hypothesis that development in attractive but lower quality habitats may lead to impaired offspring fitness, with the assumption of delayed impacts on freshwater community structure. Moreover, attractivity–quality decoupling in *S. vulgatum* can potentially contribute to the declining trend of this species in Europe.

Dragonflies in temporary habitats: coping with or avoiding drought

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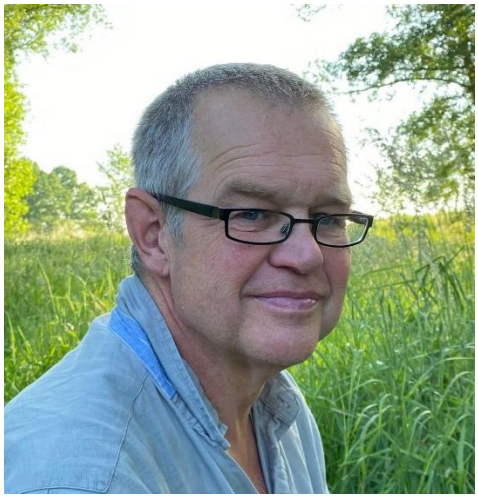

Several odonates are associated with temporary water habitats, which may serve as enemy-free habitats for species sensitive to fish predation. However, these habitats also pose challenges to the species. In my presentation, I will review the various life cycle stages and the traits that enable odonates to cope with the drying of their reproductive habitats. The presence of different traits in different stages defines the life cycle strategies of temporary water odonates, which may vary depending on the regional climate. Consequently, changing climate may also alter the ways a regional assemblage copes with temporary habitat conditions.

The migration of a locally threatened damselfly reveals the need for habitat-specific and seasonally tuned conservation actions

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Keywords: *Sympecma paedisca*, movement ecology, habitat connectivity

Among Palaearctic Odonates, adult overwintering is an evolutionary feature exclusive to the genus *Sympecma*. In Italy, *Sympecma paedisca* breeds mainly in the Piedmontese rice-growing district, while the lowland heathlands between Piedmont and Lombardy constitute its primary overwintering habitat. To clarify how this locally threatened species moves between these two disjunct areas, which are separated by tens of kilometres, we studied the multi-seasonal effects of habitat composition on species abundance, and fine-scale habitat selection. We performed 60 transects along a gradient comprising heathland fragments and the surrounding agricultural matrix, repeated five times from August 2023 to April 2024 to cover the species' entire non-reproductive season. At the landscape scale, species abundance increases significantly with the growth of well-preserved heathland cover, showing a consistent relationship across seasons. Conversely, the effect of agricultural cover varies seasonally: positive in summer, strongly negative in autumn, and slightly negative in winter and spring. Habitat selection analysis showed that in summer, the species uses marginal uncultivated herbaceous vegetation in agricultural areas, abandoning it as winter approaches. Concurrently, an increasing positive trend in the selection of heathlands was observed, while degraded ones are generally avoided. These results indirectly support the hypothesis that, in late summer, the species migrates from breeding sites toward overwintering heathlands by following the network of grassy margins in agricultural landscapes; surviving individuals return in spring following the same network. Conservation efforts should be tuned on the different needs of the species throughout its life cycle: well-preserved heathlands are crucial for the overwintering of the species and thus require active management to limit forest encroachment. In parallel, grassy margins in agricultural landscapes must be preserved to maintain connectivity between wintering and breeding grounds.

Environmental drivers of odonate occurrence in fish ponds of Polesie National Park (Eastern Poland)

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Keywords: physicochemical properties of water, aquatic vegetation, riparian vegetation, surrounding vegetation, conservation

In the context of climate change and increasing desiccation of natural waters, anthropogenic water bodies play an increasingly important role in maintaining biodiversity. Fish ponds constitute important secondary habitats for aquatic insects, including odonates; however, our understanding of the environmental factors shaping odonate assemblages, including the occurrence of species of conservation concern, remains incomplete. Therefore, this study aimed to determine the influence of environmental conditions on odonate assemblages in fish ponds in Polesie National Park.

In 2025, observations of imagines were conducted and exuviae were collected at six ponds. Concurrently, data on water physicochemical properties as well as the spatial structure of the sites and their surroundings were recorded. Subsequently, canonical correspondence analysis (CCA) was performed to assess the influence of the studied variables on odonate occurrence.

A total of 43 species were recorded. The largest proportion of variation in odonate occurrence was explained by pond structure (31% for imagines and 24% for exuviae) and physicochemical water properties (29% and 25%, respectively). Smaller contributions were associated with riparian vegetation (10% and 16%) and surrounding vegetation (11% in both cases). Among the pond structure variables, reed height was the most important for imagines, whereas anthropogenic pressure was most important for exuviae. Regarding water properties, the key variables were temperature and dissolved oxygen, respectively. Species richness and diversity (for both imagines and exuviae) were associated with slightly above-average dissolved oxygen levels.

From an odonate conservation perspective, the strong influence of pond structures on assemblages is particularly important. Pond structure comprises features that can be modified through human management and are therefore highly relevant for active conservation, which is often required in dynamic secondary habitats.

How are dragonflies doing in Europe? A quantitative assessment of dragonflies distribution trends over the last 25 years

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Keywords: distribution trends; occupancy; opportunistic data

A wealth of dragonfly occurrence data exists across Europe. However, most databases gather data at the national or subnational scales, and most data are collected without a defined sampling protocol. Therefore, obtaining a clear picture of the status of dragonflies at the European scale requires aggregating data and using adapted statistical methods.

For this study, we collated and harmonised dragonfly occurrence data across Western Europe from 27 regional and national partners, spanning 19 countries. In total, we gathered more than 15 million occurrences. We then analysed these data using occupancy models, which take imperfect species detection and spatial sampling bias into account.

We inferred the distribution trend for 128 European dragonflies between 2000 and 2024 at a 20-kilometer scale. More than 41% of dragonflies are declining across Europe. Most other species are stable (47%) and only a few are increasing (12%). We explore how trends differ between Northern, Central and Mediterranean areas in Europe. We also explore to what extent these trends can be explained by species' habitats and thermal preferences.

Our results present the first quantitative assessment of dragonfly trends at the European scale. They paint a rather worrying picture, with a large number of species declining, especially in the latest years. This calls for fast and targeted conservation action to reverse these declines.

OdonTraits Europe. A European database of Odonata traits

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Keywords: traits, morphology, ecology, geography, conservation status

Species traits are an important facet of biodiversity and are important in ecological research. Conserving dragonflies means understanding their traits relative to the changing environment. Some initiatives to centralise species traits have emerged in recent years, but there are still large gaps in species traits' knowledge both in the number of species included and in the geographical coverage. Odonata (dragonflies and damselflies) are present in all freshwater and surrounding ecosystems and are important indicators of freshwater health and conditions across the land-water interface. Here we present OdonTraits Europe, a database aggregating traits of all 143 European resident Odonata species. Our database compiles 43 traits representing adult and larval morphology, life history, behaviour, phenology, and other ecological attributes, along with species legality, endemism, and conservation status, with a taxonomic coverage of > 95% for all traits. Accessible and robust coverage of Odonata species traits will help to advance knowledge and applications involving this sentinel of the freshwater realm.

Responses of Odonata assemblages to artificial and heavily modified water channels

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Keywords: anthropogenic impact, freshwater, Odonata, diversity

Increasing anthropogenic pressures threaten freshwater habitats worldwide, reducing habitat quality and suitability for many organisms. Many artificial habitats are important for preserving biodiversity in human-impacted environments. We assessed the suitability of man-made and heavily modified channels for dragonflies, a widely used macroinvertebrate group in biomonitoring programmes. We analysed relationships between dragonfly assemblages and habitat characteristics related to surrounding land-use, hydro-morphology, structure and composition of macrophyte assemblages, and water quality in 20 channels in Croatia. A total of just 10 species were recorded, occurring at only 65% of the sites, with between one and four species per occupied site. The most common and abundant species was *Platycnemis pennipes*. At sites with diverse macrophyte assemblages, we also recorded *Sympetrum vulgatum*, a species of conservation concern. Overall, sites with higher local dragonfly taxonomic and functional diversity had greater macrophyte abundance and diversity, and lower hydro-morphological impairment. Among water quality parameters, total organic carbon (TOC) showed the strongest association with dragonfly assemblage metrics. Higher dragonfly diversity at sites with higher concentrations of TOC likely reflects greater availability of prey in more organic-rich habitats. Our results showed that artificial canals support low dragonfly diversity. However, when characterised by good habitat structure (assessed through macrophyte diversity), they can provide suitable habitat for some rare and threatened species.

Political odonatology: can dragonflies make a difference?

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Keywords: dragonflies, damselflies, popularization

Perhaps the greatest revelation of my odonatological career occurred in a brewery. As I stepped into the Darling Brewery in South Africa for lunch, I was greeted by red and purple bottles stacked to the ceiling. The Ruby Jewel and Cherry-eye Sprite weren't just damselfly species anymore: they had become beers! When my colleagues and I standardised and completed the English common names for all African odonates, we obviously did so to popularize them. To see them take on a whole new meaning, barely seven years later, was nonetheless a huge surprise. How much more of a cultural impact could odonates make? The talk reflects on this and presents my latest contribution: a guide to their global diversity and, therefore, to the beauty and sensitivity of all life on Earth.

Kampinos National Park and its efforts to protect and restore wetland habitats and preserve rare dragonfly species

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Keywords: Kampinos National Park, wetlands, active conservation

Kampinos National Park (KPN) is characterized by a high diversity of habitats, with dry dunes and large areas of wetlands. Although there are practically no larger water reservoirs, the large number of small ponds, canals, and backwaters provide a potentially favorable habitat for water-related organisms. Drainage, climate change, and the resulting increasing droughts pose a serious threat to aquatic and near-water species, including many dragonfly species. Active conservation efforts undertaken by KPN attempt to counteract these trends, and one of the species targeted by conservation efforts is the dragonfly – large red-faced darter (*Leucorrhinia pectoralis*).

What do we need to enhance dragonfly conservation? A call to organise a collective improvement of knowledge

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Keywords: knowledge gap, research resources, network, database, Action Plan

Following the last European red list of dragonflies, it has been recommended to move from assessment to conservation planning. A first goal is “to have a European network of experts providing knowledge, tools and expertise to support effective dragonfly conservation”. A keystone to achieve this goal consists in informing the distribution, trends and ecology of threatened species.

The French National Action Plan (FNAP) for dragonflies is a strategic operational tool that aims at conserving or restoring dragonfly populations into a favourable conservation status. To do so, having a thorough knowledge on the life-history traits and the ecology of threatened species especially is necessary. As many gaps in our knowledge exist, designing and supporting targeted research projects have been identified as priority actions. We started reviewing the lacks of knowledge during a workshop of the FNAP halfway point, in January 2026. Participants outlined the topics that are key for conserving dragonflies, such as the ecology of eggs and larvae or habitat connectivity and dispersal ability. They also pointed out resources, such as scientific papers, ongoing research projects or existing research groups.

Yet, this task should not be restrained to national borders. More relevant would be an international framework, as for the already initiated European database of the life-history, morphological and habitat characteristics of dragonflies. Hence, our talk will be designed as a springboard workshop to collectively assess knowledge gaps, prioritise topics, identify future contributors and organise resources under the aegis of Dragonfly Conservation Europe.

Eight National Parks harbouring the majority of Iberian odonate species highlight the importance of habitat conservation

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Keywords: diversity patterns, environmental factors, current and historical inventories

Over the last decades, ubiquitous habitat changes and degradation, overexploitation of natural resources, and pollution have resulted in a global biodiversity crisis. Climate change is exacerbating this crisis through increasing the frequency and severity of droughts and altering precipitation patterns. Based on the global-scale demographic time-series, the diversity and abundance of some odonata species are declining. To elucidate these trends and predict odonate capacity to respond to environmental changes, we sampled 78 sites in the network of eight Iberian National Parks (NPs) over one year to determine the patterns of α- and β-diversity and identify underlying environmental factors, and compare current and historical inventories to determine changes over time. A total of 11,557 individuals (10,071 adults, 1,486 larvae) were sampled, representing 10 families, 30 genera, and 62 species (50.38% Anisoptera, 49.62% Zygoptera). The highest diversity was found in the middle of the Iberian Peninsula and a NP that covers a wide elevation range (1023–2141 m a.s.l.), whereas the parks with the highest elevation showed the lowest diversity, but harboured more threatened species. As a general pattern, species richness decreased with elevation, while it increased along the conductivity and temperature gradients. Estimates of β-diversity indicated high biotic homogenization inside the low-elevation NPs, whereas the highest dissimilarity was found in high-elevation. The comparison of time spam and current data (2025) revealed different patterns across the NP network; mostly temporal stability (4 NPs), but also dramatic decline (1), or species turnover (1). At the highest elevations (2 NPs), the number of species increased over time. With little pressure from human activities and large variability of Iberian ecosystems over vast area, the NP network is effective to conserve a high number of sensitive species. Moreover, our findings indicate that human activities could be the main driver of species decline.

Changes in Odonata diversity in the nature reserve Bosco Fontana (Italy, Lombardy) between 2004 and 2025

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Keywords: monitoring, invasive species, climate change, local extinctions

The nature reserve Bosco Fontana, situated in Italy in the heart of the Po Valley, is rich in aquatic habitats. Here, the odonate fauna had been studied in detail in the year 2004. Two decades later, in the years 2024 and 2025, the dragonflies were surveyed again, using the same methods; a combination of quantitative and non-quantitative methods. A comparison of these data allowed for a detailed analysis of the changes in the odonate assemblages of the nature reserve. In 2004, a total of 31 species had been observed, at a point of time, when the invasive crayfish *Procambarus clarkii* had only just begun to colonise this protected area. In contrast, in 2024 only 23 dragonfly species were recorded, and *P. clarkii* was now the dominant macroinvertebrate species. Over these 20 years, a total of nine species had become locally extinct and a significant decline in the abundance of a further seven species had occurred. In contrast, three odonate species have become more common during this period and *Trithemis annulata* colonised the reserve. The invasive crayfish *P. clarkii* is likely the main cause of the profound changes observed in the dragonfly community, but the arrival of exotic fish species, the deterioration of water quality and global warming have all likely contributed to the observed changes. For example, the effects of climate warming are indicated by the colonisation by the Afrotropical species *T. annulata* and by the fact that the taxa that became locally extinct over 20 years were, on average, relatively cold adapted species.

Indian dragonflies: cytotaxonomix diversity and conservation

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India, with nearly 550 species (app. 10% of the world's species), possesses one of the richest assemblages of dragonflies and damselflies (Order Odonata) in the Oriental region, reflecting remarkable ecological, morphological, and evolutionary diversity. Beyond their ecological significance as predators and bioindicators of freshwater ecosystem health, dragonflies provide important opportunities for cytotaxonomic investigations that contribute to understanding speciation, phylogeny, chromosomal evolution, and biodiversity assessment. Cytotaxonomy, integrating cytogenetics with classical taxonomy, has revealed substantial chromosomal diversity among Indian odonates, including variation in chromosome numbers, sex-determining mechanisms, meiotic behaviour, presence of micro-chromosomes, and karyotypic organization. Such chromosomal studies are valuable for resolving taxonomic ambiguities, identifying cryptic species, and interpreting evolutionary relationships among closely related taxa. Indian dragonflies inhabit a wide range of ecosystems including wetlands, streams, rivers, forest pools, paddy fields, and montane habitats. However, these ecosystems are increasingly threatened by habitat destruction, urbanization, pollution, pesticide exposure, hydrological alteration, invasive species, and climate change. Since odonate larvae are highly dependent upon freshwater quality and habitat stability, dragonflies serve as highly sensitive indicators of ecological disturbance and environmental degradation. This review emphasizes the importance of cytotaxonomic diversity in understanding the evolutionary biology and conservation needs of Indian dragonflies. Integration of cytogenetic data with molecular taxonomy, ecological monitoring, and conservation biology can strengthen species identification and biodiversity management strategies. Enhanced cytotaxonomic surveys, habitat protection, long-term monitoring, and climate-resilient conservation planning are urgently required to preserve India's rich odonate diversity and freshwater ecosystem integrity in an era of accelerating environmental change.

The cutting edge: How evolution tailored odonate ovipositors for egg-laying in plants

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Keywords: morphology, ovipositor, egg laying, biomechanics

Insects have achieved much of their ecological success thanks to the evolution of the ovipositor, a specialised organ that enables precise egg placement. In several lineages of Odonata, females use the ovipositor for endophytic oviposition, inserting eggs into plant tissues. This behaviour represents one of the few direct interactions between these predatory insects and plants, and is reflected in both ovipositor design and characteristic oviposition patterns.

This presentation synthesises recent insights into odonate ovipositor ecomorphology and the material composition of their endophytic ovipositors. We explore how variation in shape, serration, and cuticle heterogeneity corresponds to the mechanical challenges posed by different oviposition substrates. Particular attention is given to how material properties enhance cutting efficiency, penetration, and durability under repeated loading.

By linking morphology, material composition, and oviposition behaviour, our work highlights ovipositors as finely tuned biological tools. Deposited egg patterns preserved in plant tissues may also provide useful proxies for oviposition strategies. Together, these perspectives reveal an often overlooked plant-insect interaction and open new avenues for comparative structural, biomechanical, functional, and evolutionary research in Odonata.

The role of cold and drought in the egg development of *Sympetrum depressiusculum* – a comparison between early and late laid eggs

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Keywords: diapause, development duration, hatching synchronization, temporary

Sympetrum depressiusculum breeds in habitats characterized by a summer flooding and a winter drought period. Understanding how the development at sensitive life stages is connected to the habitat conditions is of key importance to undertake conservation actions. We investigated whether cold and drought affect the duration of embryonic development, and whether there are differences between early versus late oviposition timing.

Eggs were collected from several families in August (early cohort) and September (late cohort). Each egg clutch was divided into 50 eggs, flooded and kept at 20°C with natural photoperiod. In October, eggs were subjected for 21 days to winter photoperiod (9.5:14.5 h L:D) and to four treatments: cold (5°C, flooded), drought (20°C, not flooded), cold + drought (5°C, not flooded), and control (20°C, flooded). Afterwards, eggs were returned to flooded conditions at 20°C, yet at spring photoperiod (15:9 h L:D) to induce hatching. Hatching was monitored twice a week. Egg development features were assessed using GLMMs with treatment and cohort as fixed effects and family as random factor.

Cold exposure was not an obligatory trigger to terminate diapause. And drought did not appear to be an important trigger for embryonic development. However, in the early cohort, cold exposure accelerated development duration (time to first hatchling in the four treatments: 104 days in cold, 102 days in cold + drought vs. 134 days in drought, 141 days in control. The same pattern was observed in the late cohort. Cold, contrarily to drought, increased hatching synchronization (decreased time to Q50) in the early cohort but not in the late cohort. Synchronization was observed within families, but mean hatching date differed across families within treatments. Further, hatching of larvae of the same family was less synchronized in late laid eggs. Hence, such risk-spreading seems influenced by both genetics and oviposition date.

First stridulatory apparatuses in Anisoptera

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Keywords: Anisoptera, stridulation, predation, jet-propulsion

Some dragonfly larvae (Anisoptera: Gomphidae, Oxygastridae), produce vibrations through a stridulatory apparatus engaging specialized structures. Two distinct types of stridulatory apparatuses are reported for the first time in the suborder Anisoptera. They are used in defense against predators. One of this stridulatory apparatus is apparently unique within Odonata or even Insecta. The second one, homologous to that of suborder Epiophlebioptera, could belong to the ground plan of Anisoptera and related stem groups and could be at the origin of the rectal jet propulsion, a unique means of locomotion used by Anisoptera larvae within Insecta.

Citizen Science to understand the distribution of *Aeshna juncea* (Linnaeus, 1758) in Southwestern Europe

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Keywords: conservation, connectivity, dispersal, population genetics

Aeshna juncea (Linnaeus, 1758) is in danger of extinction, and is listed on the European Red List (De Knijf et al., 2024). In the Alps, it has been shown that a decrease in connectivity between mountain ponds could lead to a decreased probability of Odonata occupancy. To preserve *A. juncea*, it is urgent to better understand its distribution and dispersal pathways to promote efficient conservation strategies. Genetic tools, and in particular citizen science-based DNA approaches, can support conservation efforts for *A. juncea*.

Here, we will present the sampling design and the progress of the collective collection of *A. juncea* specimens, as well as future sampling perspectives at the geographical margins of its distribution in southwestern Europe. Specimens were collected during the summers of 2025 and 2026. At the end of the first summer, 137 samples had been collected by 28 odonatologists. The aim is to obtain 500 samples collectively by the end of the summer of 2026.

Sexual conflict and mating behavior of odonates

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Sexual conflict occurs when the evolutionary interests of the two sexes do not match, and is a prominent force in the evolution of reproductive tactics and sexual behaviours. Odonates have been used as models to study the evolution of postcopulatory sexual selection, including the male (sperm competition) and the female perspective (cryptic female choice). In this talk, I review the evolutionary forces behind sexual conflicts in odonates, with special reference to mating frequency and mating duration in damselflies. The evidence suggests that males control mating duration, but females have evolved behavioural and morphological adaptations that allow them to exert considerable control over mating decisions, including female colour polymorphism, monogamy, vulvar spines and postcopulatory sperm ejection.

Dragonflies in slow motion

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Keywords: flight, interactions, visual sensory, high speed video

Filming dragonflies and damselflies at high frame rates, reveals behaviors that cannot be observed with the naked eye. Over the last decade I filmed various types of behavior, both in Europe and abroad, at 500 frames per second, including: the visual tracking of prey by perchers, and the attack on prey by fliers; head movements of dragonflies in flight, "looking" left or right; Fight between males in flight, contact or non-contact interactions; Bending of abdomen by females, avoiding male tandem attempt; Reproduction behavior of *Libellula quadrimaculata* at higher densities; the various flight modes of *Calopteryx species*.

Diet Preferences of North American Odonates

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Keywords: eDNA, diet ecology, trophic ecology

Efficient monitoring of animal diet is useful to gain a better understanding of their trophic links, to better guide their conservation and to improve assessments of ecosystem resilience in a changing world. Through dietary studies, the factors influencing community assembly and the coexistence of species with seemingly similar niches can be understood. Odonates are key components of freshwater ecosystems as they regulate lower trophic levels and represent trophic links between the aquatic and terrestrial realms. Consequently, gaining knowledge of their trophic ecology is crucial to better understand their role in freshwater ecosystems and assist in their conservation. Traditionally, odonates have been assumed as generalists with low diet preferences; however, there is a lack of empirical evidence confirming this assumption. It was not until recently that feasible methods to evaluate odonate diet composition were developed due to the avenue of dietary analyses through eDNA metabarcoding. Therefore, the goal of this study is to analyse the diet preferences of North American dragonflies and damselflies from Quebec and British Columbia, identifying the biotic factor that could influence such preferences, such as suborder and body size. Throughout the summers of 2020, 2021, and 2024, we collected, extracted DNA, and sequenced the faeces of over 1000 specimens from 7 species of dragonflies and 4 of damselflies. To our knowledge, this is the first large-scale study on odonate diet using metabarcoding techniques. Our analyses show that odonate preference of prey from multiple insect orders depends on odonate suborder (Anisoptera vs Zygoptera) and body size. These results could be explained by differences in the biology and ecology or niche between dragonflies and damselflies; and could explain the coexistence of species in highly diverse odonate communities.

Caves and underground habitats, a shelter or a trap for dragonflies?

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Keywords: caves, larval development, dark zone, ecological trap, France

Global research has followed the discovery of adults, but also of odonate larvae in underground habitats, both natural and artificial. Observations in France have shown that odonate larvae can survive in the „dark zone" of underground habitats, allowing them to develop until they emerge and fly away.

Here we present some specific examples in France, provided by speleologists and entomologists. A focus is placed on a natural underground river where several species emerge and on an artificial underground gallery where *Cordulegaster bidentata* has been monitored for about ten years. We then discuss the cost/benefit ratio of using these habitats at the individual and population levels (concept of ecological traps).

Detecting Odonata species in mountain ponds using the CIMaE protocol

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Keywords: sampling design, false absence, France

Effective conservation measures require reliable knowledge of species distribution. However, most of the studies on which these measures are based do not consider species detection issues that can lead to poorly designed measures, as species can be overlooked despite being present.

Conducting several observations at the right times and for the appropriate duration is, therefore, essential to establish a protocol that maximises species detection probabilities and, in turn, provides reliable information for local management.

High-altitude ponds remain largely unexplored and are home to several endangered species. The CIMaE protocol was developed in the Alps and the Pyrenees to survey Odonata species threatened with extinction. Here, our aim was to explore the role of life stages, the number of visits and sampling conditions (such as environmental and observational) in explaining detection probability variation. We tested different hypotheses using absence-presence data collected from 270 ponds in 2021 and 2022 and multi-species occupancy models. We showed that:

(1) The greater the number of life stages identified and/or site visits, the higher the probability of detection.

(2) Species detectability is also influenced by vegetation cover and visit duration.

We will present the preliminary results, which will ultimately help consolidate the CIMaE protocol, with the ultimate goal of improving our understanding of the distribution of Odonata and preserving them more effectively.

We caught, we marked, we learnt: Optimizing Long-Term CMR Designs for *Coenagrion castellani*

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Keywords: capture-mark-recapture, Bayesian power analysis, *Coenagrion castellani*

The Italian endemic damselfly *Coenagrion castellani* is one of the focus species of the LifeIMAGINE project (LIFE19 IPE/IT/000015). Since 2017, a population of this taxon has been monitored during the flight season in a small freshwater body crossing the intensively farmed lowlands of Central Italy. Listed in Annex II of the Habitats Directive, the species is subject to periodic surveillance under Article 11 of the same Directive, making robust demographic estimates especially valuable. Over ten years, nearly 6000 adults were marked, and recapture data provided the empirical basis for estimating apparent survival (φ) and detection probability (p). Using this long-term dataset, we investigated how to design effective capture-mark-recapture (CMR) sampling schemes for *C. castellani*. To this end, we developed a Bayesian power-analysis framework based on the Cormack-Jolly-Seber (CJS) model and explored the design space along three orthogonal dimensions: the number of sessions K, the temporal spacing Δt between consecutive sessions, and the minimum number of marked adults. The resulting framework identifies the most efficient sampling configurations, balancing precision and sampling effort.

Dragonfly monitoring in Germany – current status

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Keywords: monitoring, methods

The primary aim of the Society of German-speaking Odonatologists (GdO) is to promote knowledge about dragonflies and to protect native dragonfly species. A key foundation for this is the collection of data on dragonfly distribution. This data can be used, for example, to identify the distribution and abundance of individual species. Of particular interest is the identification of changes over many years. However, the existing data set is quite heterogeneous as the methodological approach to the surveys varies enormously. Furthermore, the recording methods underlying the data are not clearly evident from most databases. This makes a reliable evaluation difficult, if not impossible.

To achieve a more robust data foundation in future, it is essential to establish a standardised method for collecting dragonfly data.

In 2025 and 2026, an initial trial tested the structured recording of dragonflies using the Observation.org reporting portal and the associated Observation app, which is available for smartphones.

This presentation will provide a current introduction to the monitoring programme and outline the procedures for data collection and data entry, as well as presenting the initial findings. It will also provide an overview of the results from the pilot study and look ahead to the next steps and opportunities for public participation.

The dragonflies of the Guadiaro River basin (Andalusia, Spain)

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Keywords: Odonata, Mediterranean rivers, *Macromia splendens*, *Oxygastra curtisii*, *Gomphus graslinii*, citizen science, exuviae sampling

The Guadiaro River basin, including the Hozgarganta and Genal tributaries, is a European hotspot for Odonata. It hosts a unique assemblage of Mediterranean rheophiles, African colonists, and endemic European species. This diverse but vulnerable odonate fauna was surveyed extensively in 2025 and 2026, focusing on threatened species: *Macromia splendens*, *Oxygastra curtisii* and *Gomphus graslinii*. In May and June 2025, adults were recorded using the Observation.org app along transects covering >42 km of rivers and exuviae were collected along >6 km of transects, resulting in nearly 2,000 records. Additional bibliographical and previous data allow the preparation of distribution maps based on tetrads (2×2 km squares). Preliminary results confirm the extreme localisation of *M. splendens*, its probable extirpation from the Genal River, and significant phenological succession among Gomphidae. The project also served as a field training school for young ecologists. The campaign is scheduled to be repeated in the coming years to monitor population trends and refine conservation strategies for these threatened rheophilic species

The History of ECOO 2010-2026

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Keywords: ECOO, participation, history, field trips

In this presentation I will review all editions of the European Congress on Odonatology since the first one in Portugal in 2010. How many people participated from how many countries? What topics were covered? How many lectures and posters were presented? Where have post-congress field trips taken place? Have there been any particularly memorable events?

This presentation is apparently not scientifically based, but rather to entertain and convey memories, while also showing the importance of ECOO being carried out. It will naturally be more or less subjective reviews of the history of ECOO.

International Congress of Odonatology 2027, Ostrava, Czech Republic

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Keywords: ICO2027, Ostrava, Czech Republic

The Organizing Committee is delighted to invite you to the International Congress of Odonatology 2027 (ICO2027), to be held on 20–25 June 2027 at the City Campus of the University of Ostrava, followed by a Post-Congress Tour from 26 June to 1 July 2027.

Under the theme “Thriving in the Anthropocene: post-industrial and urban sites as refuges for Odonata diversity,” ICO2027 will explore how dragonflies and damselflies respond to a rapidly changing world. Sessions will address odonates in urban, agricultural, and post-industrial landscapes, the impacts of climate change on their distribution and ecology, and new perspectives in conservation biology and biogeography. The programme will also highlight advances in phylogenetics, taxonomy, genomics, AI, and automated monitoring tools that are reshaping odonate research.

Ostrava, a city transformed from its industrial past into a landscape of ecological renewal, offers a fitting and inspiring setting for these discussions. We look forward to welcoming you to Czechia for the stimulating days of science, collaboration, and memorable field experiences.

We warmly invite you to join us in Ostrava in 2027!

New insights into the ecology and conservation of *Pyrrhosoma elisabethae*, a Critically Endangered European odonate

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Keywords: Greek red damselfly, Coenagrionidae, rare species, habitat assessment, threatened

Pyrrhosoma elisabethae is one of only two European odonates assessed as Critically Endangered (De Knijf et al. 2024), yet detailed knowledge of its habitat requirements and population status has remained scarce. Expanding this knowledge is imperative for effective conservation planning.

During May 2025, all known localities were surveyed in Corfu and Peloponnese in Greece, recording biotic and abiotic characteristics across both the aquatic and riparian zones. Basic statistics and penalized regression models were applied to characterize habitat use and identify predictors of occurrence across all surveyed localities.

A new locality was confirmed in Corfu and a new population discovered in the Peloponnese, while the species was absent from four historically known localities. The two geographically distinct populations differ markedly in habitat characteristics: The Peloponnese population occupies a broad substrate niche, ranging from rivers dominated with coarse substrate to silted agricultural ditches, whereas the Corfu population appears restricted to fine-medium substrates and exclusively in slow-flowing water bodies. Oxygen saturation at Peloponnese presence localities ranged widely (15–114%), and interestingly the highest individual counts were recorded at localities with saturation below 50%, suggesting the species tolerates low oxygen conditions better than expected. Penalized regression models across all presence localities identified bare ground in the riparian zone as a strong negative predictor of occurrence. The dominant threats across both populations are water abstraction, unmanaged riparian vegetation through either cutting or overgrowth, and water pollution.

In Corfu, populations are highly localized and fragmented, increasing their vulnerability to local extinction, whereas in Peloponnese a more continuous distribution across the Vouraikos river system and adjacent canals suggests inter-site connectivity. Despite this, most localities in both areas fall outside designated protected area boundaries. Sustainable water resource management and appropriate riparian vegetation management at agricultural ditches and canals are identified as key conservation priorities for this rare species.

Insights from comparative 16S analyses across life stages and overwintering strategies

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Keywords: damselflies, microbiome, vertical transmission, overwintering strategy, developmental stages

Microbiomes may help insects survive environmental stress, but little is known about how microbiomes change during development and whether they are vertically transmitted in aquatic insects. In this study, we investigated microbiome dynamics in damselflies with two different overwintering strategies: species overwintering as eggs and species overwintering as larvae. We hypothesized that (1) microbiome composition changes between developmental stages, (2) overwintering strategy influences microbiome structure, and (3) selected bacteria are vertically transmitted from mothers to offspring.

We analyzed adults, eggs, and newly hatched larvae from populations collected in Poland, the Czech Republic, and Hungary using 16S rRNA V4 sequencing. Microbiome diversity and composition were analyzed using alpha and beta diversity metrics, mixed models, PERMANOVA, and maternal–offspring similarity tests.

Developmental stage was the strongest factor shaping microbiome composition and diversity. Overwintering strategy also affected microbiome trajectories across stages. However, we did not detect one universal “wintering microbiome”. Vertical transmission was detected mainly for selected bacterial genera, especially Wolbachia and Rickettsia. At the whole-community level, offspring microbiomes were only slightly more similar to their mothers than to unrelated females.

Our results suggest that damselfly microbiomes are strongly reorganized during development and that vertical transmission is selective rather than complete.

Gone with the wind? Population genomics uncover genetic population structure in *Ischnura hastata*

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Keywords: RADseq, long-distance dispersal, islands

Ischnura hastata is the only species of Odonata known to reproduce by parthenogenesis. Previous work based on the results of microsatellite loci genotyping showed no genetic structure among sexual populations in America. Here, we employ a ddRAD-seq approach to characterize the diversity and population structure of ~400 samples of sexual and parthenogenetic *I. hastata*. Together with an increase sampling, this genomic approach has uncovered the population structure of this species at the sexual distribution range, allowing us to pinpoint the geographical origin of the parthenogenetic populations of the species found in the Azores archipelago. The results of our analyses point to a wind-driven long-distance dispersal event as the origin of the asexual populations of *I. hastata*.

Odonata Diversity in a Proposed Protected Area: Insights from the Ñeembucú Expedition, Southern Paraguay

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Keywords: Paraguay, list of species, conservation, expedition, monitoring

The Ñeembucú Wetlands complex in southern Paraguay, particularly along the Paraná River, harbours critical but understudied ecosystems, including grasslands and savannas. Within the framework of the SULU Project (Safeguarding underutilised ecosystems: protection, management, and restoration of grasslands and savannas in Argentina, Colombia, and Paraguay), funded by the German government and coordinated by Fundación Yvy Pora for WWF, a 10-day Rapid Ecological Evaluation was conducted. The primary objective was to assess the biodiversity and to generate baseline data to support the proposal of a new protected area, Estero Pirá Guasú, and the consolidation of another two protected areas (Isla Carrizal and Carrizales del Paraná). A multidisciplinary team of specialists surveyed herpetofauna, ichthyofauna, mammals (including bats), birds, flora and limnology across 28 sampling points distributed within the three target areas.

This study presents the results of the Odonata assessment. A total of 15 odonate species were recorded, belonging to four families: Coenagrionidae, Gomphidae, Libellulidae, and Aeshnidae. The family Libellulidae showed the highest richness, with species such as *Erythemis peruviana*, *Erythrodiplax umbrata*, and *Miathyria marcella*. Notably, our survey documented the presence of *Perithemis tenera* (Libellulidae). While this species has been recorded in the country through citizen science platforms, its occurrence in Paraguay lacks formal scientific publication and represents a new confirmed record for the region. This finding underscores the significant knowledge gaps regarding the country's odonata fauna. The baseline data on dragonfly diversity, including this new record, provides crucial information for conservation planning, emphasising the high biodiversity value of the Estero Pirá Guasú wetland and reinforcing the need for its formal protection within the Ñeembucú landscape. Our results contribute to the broader SULU project goals by highlighting the importance of these subvaluated ecosystems for aquatic insect conservation.

Assessing whether *Lestes macrostigma* is an umbrella species for the conservation of temporary brackish waters

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Keywords: water management, habitat restoration, restoration success, threatened

Despite their unique biodiversity, temporary brackish waters have been dramatically altered by human activities. *Lestes macrostigma*, a damselfly threatened in Western Europe, typically reproduces in this habitat. From the early 2010s, this charismatic species was used to anchor a conservation program that resulted (1) in the creation of temporary ponds with no water management and (2) in the restoration of marshes through changing their water management scheme.

The targeted communities need a long time to colonise these habitats. As this colonisation was only studied during a short period after the field works, we are lacking a robust assessment of the success of this program, whether considering sites without or with water management targeting *L. macrostigma*. This hinders our capacity to improve the restoration technical route and to replicate such conservation actions. Further, to what extent the use of *L. macrostigma* as a flagship benefits other organisms typical from temporary brackish waters remains unknown. In other words, we so far ignore whether *L. macrostigma* is an umbrella species.

To fill this gap of knowledge, we are launching a new project called “EvaTempo” as for the EVAluation of the success of the restoration and of the water management of TEMPOrary brackish waters. This project will consist in surveying aquatic insects (including odonates), amphibians, and plants together with their viruses. Surveys will be lead during two ecological years (2026-27 and 2027-28) in several temporary brackish waterbodies that were created or restored or, as control, that are still natural. More results will be available for ECOO 2028.

Extinction risk and population trends of Odonata in Germany

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Keywords: Odonata conservation, Red List assessment, population trends, extinction risk

Based on the assessment of the expert group Ott et al. (2021) 79 species of Odonata (51 dragonflies and 28 damselflies) in Germany, are currently classified as established, of which almost one third (29 %) are considered to be at risk of extinction (German national Red List). Furthermore, 8 % of the species are considered as 'near threatened', and only half of the dragonfly and damselfly species (54%) are classified as not at risk.

In addition to the risk categories, population trends are also described in Germany`s Red Lists based on several criteria. The long-term population trend describes developments over the past 50 to 150 years, whereas the short-term population trend describes developments over the last 10–25 years. The population trend of most species (n = 47) were considered to be in decline in the long-term. Of the species with declining population trends, the populations of 24 species remained stable in the short-term trend, while 14 species even showed an increase. For nine species, however, the declining population trend continues. As in most European countries, the main threats to Odonata are the entry of nutrients and pesticides into aquatic environments, loss of habitat structures and the desiccation of water bodies.

Predicting life history responses to global warming in odonates: which temperature and photoperiod should be used?

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Keywords: experimental ecology, phenotypic plasticity, photoperiod, seasonal cues,

A key goal in predictive ecology is understanding how global warming affects ectotherm growth and development. Researchers often rear odonates under constant temperature and photoperiod regimes, raising the question of whether responses under these simplified conditions reflect those in realistic, seasonally varying environments. We examined key life history traits of the damselfly *Lestes sponsa* across six combinations of constant and seasonal temperature and photoperiod regimes, simulating present-day and future climates with a projected 4°C warming. Trait responses differed qualitatively and quantitatively among treatments. Mass and development responses to warming shifted direction depending on regime. For example, the response in mass was reversed between constant and seasonal varying environments: decreased and increased mass respectively. In addition, developmental synchrony was stronger under seasonal photoperiods, and the temperature–size rule held only under constant conditions. Our results highlight that incorporating seasonal variation is crucial for making a realistic framework for predicting odonates' responses to climate change.

Faunistic and ecological study of dragonflies (Insecta: Odonata) of the Malé Karpaty mountains

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Keywords: dragonflies, faunistic, ecology, Malé Karpaty Mts., Slovakia

The Malé Karpaty Mts. in southwestern Slovakia serve as a significant biogeographical segment at the junction of the Western Carpathians and the Eastern Alps. Despite its importance, comprehensive ecological data on dragonfly communities in this forested mid-mountain landscape remained fragmented. This study aims to provide a systematic faunistic and ecological synthesis of available data to establish a baseline for further research and the conservation management of this protected area. The research is based on 539 occurrence records from 166 sites collected between 1956 and 2024, documenting 3,375 individuals across various developmental stages. Data were obtained through semi-quantitative field surveys using entomological and hydrobiological nets, supplemented by museum collections and verified photographic records. Ecological structuring was analysed using DCA and CCA in Canoco5 to evaluate the relationships between species composition and 13 identified habitat types. A total of 43 dragonfly taxa were documented, representing approximately 60% of the species known in Slovakia. The eudominant species identified were *Aeshna affinis* (29.78%), *Cordulegaster heros* (16.86%), *Coenagrion puella* (12.53%), and *Platycnemis pennipes* (12.36%). The study confirmed 17 species of conservation concern, including the Balkan Goldenring (*Cordulegaster heros*), which occurred at 121 sites, highlighting the region as a key stronghold for this species of Community interest. CCA revealed that submontane streams (metarithral) are the most influential environmental factor, explaining 10.1% of species variability, while small water reservoirs serve as vital secondary habitats for local biodiversity hotspots. The findings emphasise the high conservation value of the Malé Karpaty Mts., particularly for stable populations of forest-dwelling dragonflies like *C. heros*. Maintaining natural forest streams and managing small water reservoirs are identified as essential priorities for preserving the region's aquatic biodiversity. This synthesis provides critical data for the ongoing monitoring and legislative protection of rare and specialised species within the Natura 2000 network.

Odonata of Poland

Edyta Buczyńska, Paweł Buczyński

Geographical background

Poland is located at the edge of western and eastern Europe (49°00'-54°50' N, 14°07'-24°09' E) and borders Germany to the west, Czech Republic and Slovakia to the south, Ukraine and Belarus to the east and Lithuania and Russia to the north (its enclave – Kaliningrad Oblast). Large part of the northern border is outlined by the Baltic Sea. The surface of the country covers 313.933 km^2, including land area (together with inland waters): 311.091 km^2. Poland is, in this respect, on the 11th place in Europe, after Finland and Italy. Population estimates 38.3 mln people.

The country is mainly low-lying: average elevation above sea level is 173 m and 91.4% of the area lies below 300 m a.s.l. Predominant types of topography are arranged approximately latitudinally. The whole northern part is covered by young-glacial lake districts, at the western boarder ranging a little bit more to the south; continental glacier (glaciation Würm) ebbed circa 11,700 years ago. Behind them, there are zones of: lowlands, uplands, and along the southern border – foothills and mountains. There are as follows: the most eastern part of the Sudetes, in Poland – the maximum height 1,603 m a.s.l. Śnieżka in Karkonosze (The Giant Mountains)), as well as extremely western part of the Carpathian Mountains – up to 2,499 m (Rysy in the Tatra Mountains). The only mountainous range located in the centre of the country is the Świętokrzyskie Mountains, old (their origin – Caledonian orogeny) and low (to 612 m a.s.l.).

Almost the whole area of the country lies in the catchment of the Baltic Sea, only 0.3% – in catchments of TheBlack Sea and The North Sea. The longest rivers are: Wisła (The Vistula) (1,047 km) and Odra (The Oder) (845 km, including 742 km in Poland). In total, their basins encompass 89.6% of the country surface area. Drainage system is very diverse, with the greatest density in mountainous areas in the south and a little less in lake districts in the north, and the least in uplands. Rivers are moderately polluted which impinges on their ecological condition.

Very good ecological potential has been verified in 0.04% consistent parts of surface waters, good condition – in 5.63%. In majority, there are waters with moderate (51.31%) and weak potential (26.64%).

The number of lakes with the surface of over 1 ha is 7,081, in total ca. 0.9% of the area of Poland. That is the regress in comparison to the half of 20th century: lake percentage dropped down c. 11%, mostly because of decline of large number of small water bodies. Small lakes predominate: only c. 14% of water bodies have the area of over 50 ha. In Poland there are lakes: glacial (mainly), coastal, karstic, thermokarst and fluvial. Most of them are located in the north of the country. The group of several dozen of lakes lies also in the central-eastern part of Poland in the Łęczna-Włodawa Lakeland (Western Polesia). The small number of lakes lie also in the mountains. Moreover, in the valleys of large rivers, especially in the lower reaches of Wisła, Odra and Bug, one may encounter oxbows so large and deep that typical lacustrine biocenoses may be formed. Polish lakes, especially the big ones, are liable to anthropopression. Only 0.1% of water bodies included into The State Environmental Monitoring have a very good potential and 12.4% – good.

Dam reservoirs and fish ponds are the crucial complement to the major surface waters system. Among c. 3,500 reservoirs, small local water bodies predominate. The largest is Włocławek Reservoir on Wisła (70 km^2 and 408,000,000 m^3). Some big reservoirs are located in lower parts of the mountains and on foothills. Fishponds are spread all over Poland, but there are regions, where they cover the vast areas – e.g. Lower Silesia or on the northern-east of the Sandomierz Basin. With regard to habitat and river conditions in Poland, ponds with carp predominate.

An environmental feature that is important for dragonflies is peatlands. More than 49,000 peatlands cover a total of 4.1% of the country's area. They are located mainly in the north (82%). Numerous peatlands also occur along the eastern border and locally in central Poland. Fens (low peatlands) predominate, while raised mires account for only 4.3% of all peatland sites and transitional mires for 2.6%.

Unfortunately, Poland's peatlands have long been subjected to strong anthropogenic pressure; only 10–30% of their original area has survived to the present day. Their degradation is currently being intensified by droughts associated with climate change.

Poland was originally a heavily forested country, with forests covering more than 90% of its territory. These were mainly mixed forests. However, this situation has been profoundly altered by human activity. Only a small remnant of natural forest survived in the form of the Białowieża Forest, although some forest areas in the Carpathians, the Świętokrzyskie Mountains region, and Roztocze also retain a near-natural character. Due to industrialization, agricultural expansion, and extensive exploitation during the World Wars, forest cover declined to only 20.8% by 1948. Today, it has increased to approximately 30%. Commercial forests strongly predominate, and extensive areas are planted with pine monocultures, although the proportion of deciduous forests has been increasing in recent decades. Forest distribution is highly uneven. The largest forested areas occur in the southeastern part of the country (especially in the Carpathians), in western and northern regions (particularly Lubusz Voivodeship and Pomerania), and locally along the eastern border.

Today, agricultural land dominates the Polish landscape, covering almost 52% of the country's area. Arable land accounts for 73.5% of all agricultural land, while meadows cover 14.3%. Cereals are the main crops, occupying more than 60% of the cultivated area, with wheat and rye being the most important. Among other crops, potatoes are the most widespread, covering about 12% of the cultivated area. The use of synthetic fertilizers and pesticides remains relatively low compared with other European countries, although some of these indicators have been steadily increasing, reflecting agricultural intensification and its growing impact on the environment, including dragonflies. The most intensive agriculture is found in northwestern and western Poland, particularly in the Wielkopolska region. In contrast, low-intensity and sometimes even extensive farming is characteristic mainly of southeastern Poland, as well as locally in Podlasie, northern Mazovia, and mountainous regions.

Poland has a temperate climate with transitional characteristics between maritime and continental types, with continental influences being particularly strong in the southeast. A distinct boundary between the hot-summer and cool-summer humid continental climate runs through the eastern part of the country and is marked by the January isotherm of – 3°C. Poland's climate is also highly variable, both from year to year and regionally. Climatic conditions differ across regions due to the country's considerable latitudinal and meridional extent, the influence of the Baltic Sea in the north, and the presence of mountains and uplands. Nevertheless, much of the country shares certain climatic characteristics, including relatively mild winters (average January air temperatures ranging from 0.5 to –3°C) and warm summers (average July temperatures of 18–19°C). Western and southwestern Poland are the warmest regions, while northeastern Poland is the coldest. A similar gradient characterizes the length of the growing season, which exceeds 240 days in the west, but is only about 190 days in the northeast. Average annual precipitation ranges from 450–550 mm in central Poland to more than 600 mm in the north and over 1,200 mm in mountainous and foothill regions.

As in many other countries, Poland's climate is changing. Compared with the 1980s, mean annual air temperatures have increased by more than 1.5°C. The greatest warming has occurred during the winter months. Total annual precipitation has remained relatively stable, but its annual distribution has changed. Together with increasing evaporation, this has altered the hydrological regime of rivers, resulting in progressively lower spring water levels due to the lack of spring snowmelt. It has also contributed to the drying of surface waters and peatlands. In recent decades, the disappearance of small permanent water bodies has become particularly noticeable. Increasingly large areas of the country are affected, either periodically or permanently, by hydrological drought.

The list of species

The list of dragonflies and damselflies recorded in Poland comprises 74 species (see below). In the past, incorrect records of *Coenagrion mercuriale* (Charpentier, 1840) and *Gomphus pulchellus* Selys, 1840 were noted.

There are some records of exotic species dragged with aquarium plants: *Ischnura senegalensis* (Rambur, 1842), *Pseudagrion microcephalum* (Rambur, 1842) and *Crocothemis servilia* (Drury, 1773) – yet unobserved in natural environment.

Zygoptera

Calopterygidae

Calopteryx splendens (Harris, 1771) – Banded Demoiselle

Calopteryx virgo (Linnaeus, 1758) – Beautiful Demoiselle

Lestidae

Lestes barbarus (Fabricius, 1798) – Migrant Spreadwing

Lestes dryas Kirby, 1890 – Robust Spreadwing

Lestes macrostigma (Eversmann, 1836) – Dark Spreadwing

Lestes sponsa (Hansemann, 1823) – Common Spreadwing

Lestes virens (Charpentier, 1825) – Small Spreadwing

Chalcolestes viridis (Vander Linden, 1825) – Western Willow Spreadwing

Sympecma fusca (Vander Linden, 1820) – Common Winter Damsel

Sympecma paedisca (Brauer, 1877) – Siberian Winter Damsel

Platycnemididae

Platycnemis pennipes (Pallas, 1771) – Blue Featherleg

Coenagrionidae

Ischnura elegans (Vander Linden, 1820) – Common Bluetail

Ischnura pumilio (Charpentier, 1825) – Small Bluetail

Enallagma cyathigerum (Charpentier, 1840) – Common Bluet

Coenagrion armatum (Charpentier, 1840) – Dark Bluet

Coenagrion hastulatum (Charpentier, 1825) – Spearhead Bluet

Coenagrion lunulatum (Charpentier, 1840) – Irish Bluet

Coenagrion ornatum (Selys, 1850) – Ornate Bluet

Coenagrion puella (Linnaeus, 1758) – Azure Bluet

Coenagrion pulchellum (Vander Linden, 1825) – Variable Bluet

Coenagrion scitulum (Rambur, 1842) – Dainty Bluet

Erythromma najas (Hansemann, 1823) – Large Redeye

Erythromma lindenii (Selys, 1840) – Blue-eye

Erythromma viridulum (Charpentier, 1840) – Small Redeye

Pyrrhosoma nymphula (Sulzer, 1776) – Large Red Damsel

Nehalennia speciosa (Charpentier, 1840) – Sedgling

Anisoptera

Aeshnidae

Brachytron pratense (O.F. Müller, 1764) – Hairy Hawker

Aeshna affinis Vander Linden, 1820 – Blue-eyed Hawker

Aeshna caerulea (Ström, 1783) – Azure Hawker

Aeshna cyanea (O.F. Müller, 1764) – Blue Hawker

Aeshna grandis (Linnaeus, 1758) – Brown Hawker

Aeshna juncea (Linnaeus, 1758) – Moorland Hawker

Aeshna mixta Latreille, 1805 – Migrant Hawker

Aeshna subarctica Walker, 1908 – Bog Hawker

Aeshna viridis Eversmann, 1836 – Green Hawker

Isoaeschna isoceles (O.F. Müller, 1767) – Green-eyed Hawker

Anax ephippiger (Burmeister, 1839) – Vagrant Emperor

Anax imperator Leach, 1815 – Blue Emperor

Anax parthenope (Selys, 1839) – Lesser Emperor

Gomphidae

Gomphus vulgatissimus (Linnaeus, 1758) – Common Clubtail

Stylurus flavipes (Charpentier, 1825) – River Clubtail

Onychogomphus forcipatus (Linnaeus, 1758) – Small Pincertail

Ophiogomphus cecilia (Fourcroy, 1785) – Green Snaketail

Cordulegastridae

Cordulegaster boltonii (Donovan, 1807) – Common Goldenring

Thecagaster bidentata (Selys, 1843) – Sombre Goldenring

Corduliidae

Cordulia aenea (Linnaeus, 1758) – Downy Emerald

Somatochlora alpestris (Selys, 1840) – Alpine Emerald

Somatochlora arctica (Zetterstedt, 1840) – Northern Emerald

Somatochlora flavomaculata (Vander Linden, 1825) – Yellow-spotted Emerald

Somatochlora metallica (Vander Linden, 1825) – Brilliant Emerald

Epitheca bimaculata (Charpentier, 1825) – Eurasian Baskettail

Libellulidae

Libellula depressa Linnaeus, 1758 – Broad-bodied Chaser

Libellula fulva O.F. Müller, 1765 – Blue Chaser

Libellula quadrimaculata Linnaeus, 1758 – Four-spotted Chaser

Orthetrum albistylum (Selys, 1848) – White-tailed Skimmer

Orthetrum brunneum (Fonscolombe, 1837) – Southern Skimmer

Orthetrum cancellatum (Linnaeus, 1758) – Black-tailed Skimmer

Orthetrum coerulescens (Fabricius, 1798) – Keeled Skimmer

Crocothemis erythraea (Brullé, 1832) – Broad Scarlet

Sympetrum danae (Sulzer, 1776) – Black Darter

Sympetrum depressiusculum (Selys, 1841) – Spotted Darter

Sympetrum flaveolum (Linnaeus, 1758) – Yellow-winged Darter

Sympetrum fonscolombii (Selys, 1840) – Red-veined Darter

Sympetrum meridionale (Selys, 1841) – Southern Darter

Sympetrum pedemontanum (Allioni, 1766) – Banded Darter

Sympetrum sanguineum (O.F. Müller, 1764) – Ruddy Darter

Sympetrum striolatum (Charpentier, 1840) – Common Darter

Sympetrum vulgatum (Linnaeus, 1758) – Vagrant Darter

Leucorrhinia albifrons (Burmeister, 1839) – Dark Whiteface

Leucorrhinia caudalis (Charpentier, 1840) – Lilypad Whiteface

Leucorrhinia dubia (Vander Linden, 1825) – Small Whiteface

Leucorrhinia pectoralis (Charpentier, 1825) – Yellow-spotted Whiteface

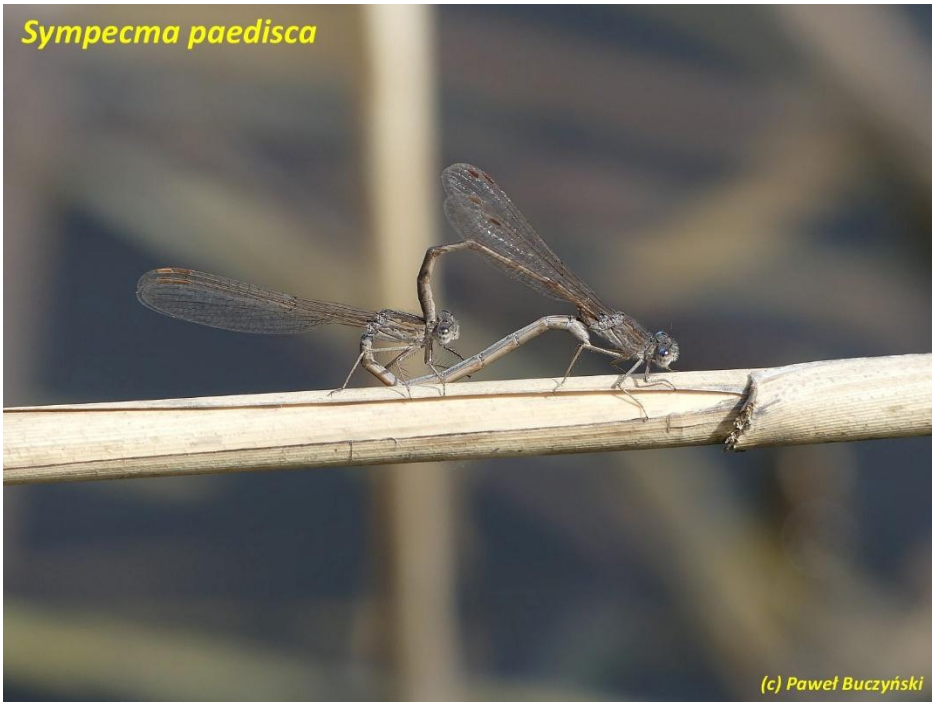
Leucorrhinia rubicunda (Linnaeus, 1758) – Ruby Whiteface

Pantala flavescens (Fabricius, 1798) – Wandering Glider

Characteristics of odonatofauna

There have been recorded 74 species of dragonflies in Poland so far, which is about a half of European species. The number and species composition of the national fauna are determined primarily by the country's location in the centre of Europe, the history of the Ice Age, the absence of barriers to dragonfly migration along the east–west axis, and their presence along the entire southern border.

In terms of present-day distribution patterns, almost the entire Polish dragonfly fauna consists of species with very extensive ranges, primarily Palaearctic and Western Palaearctic, and to a lesser extent Holarctic species. Only a few species have ranges extending partly into the Afrotropical or Palaeotropical regions (e.g. *Anax ephippiger*, *A. imperator*, *Crocothemis erythraea*, *Sympetrum fonscolombii*), or are even circumtropical (*Pantala flavescens*).



Poland lies too far east to host Western European endemic species whose ranges still extend into parts of Germany and the Czech Republic. In contrast, numerous Siberian species reached the country during the postglacial period. Among them, *Coenagrion armatum* reaches its western distribution limit in Poland; populations occurring in Germany and the Benelux countries are associated with Scandinavian populations. For most species of this group, however, such as *Sympecma paedisca*, *Coenagrion hastulatum*, *C. lunulatum*, *Nehalennia speciosa*, *Aeshna viridis*, or *Leucorrhinia* spp., Poland still represents a transitional area. At most, these species become rare in the south and southwest of the country, while the core of their ranges lies in the young-glacial lake districts and along the eastern border.

The formerly harsher climate, and probably also the mountain barriers along the southern border, long restricted the occurrence of species whose centres of distribution are located in warmer regions of the world. *Anax ephippiger* was first recorded in Poland in 1992, *Pantala flavescens* – in 2016, while *Crocothemis erythraea* had been observed only six times before 1990. Other species in this group were still rare across much of the country only about twenty years ago, with their more frequent occurrence being limited to southern and southeastern regions (which they may have colonized via Ukraine, bypassing the Carpathian arc from the east). Poland also marked the northern limits of their distribution ranges.

Particularly noteworthy are dragonflies with boreal-montane distributions, which occur in Poland as postglacial relicts associated withmountainous areas. *Aeshna caerulea* is known from only a few localities in the Sudetes and occurs exclusively at higher elevations above sea level (currently above 1,400 m).

In contrast, *Somatochlora alpestris* occurs throughout much of the Sudetes and in the higher parts of the Carpathians, and also descends to lower elevations; its lowest known localities are situated at approximately 650 m a.s.l.

As in many other regions of the world, the odonate fauna of Poland has been changing in response to climate change. The first signs of this phenomenon were recorded during the last decade of the twentieth century, and the process is now well advanced. It is manifested primarily by the expansion of numerous Mediterranean species (in the chorological sense of Dévai, 1976), as well as by changes in their ecology and biology. The most obvious effect has been the appearance of dragonfly species that had not previously been recorded in Poland. In other species, distribution boundaries have shifted, often by hundreds of kilometres: the entire territory of Poland has been colonized, the northernmost localities are now situated in the Baltic States and Russia (Kaliningrad Oblast), and in some cases even in southern Finland. Particularly spectacular expansions have been observed in *Aeshna affinis* and *Crocothemis erythraea*. Territorial expansion is accompanied by changes in habitat use. Initially, these species are usually restricted to the warmest water bodies, often of anthropogenic origin, such as small ponds

in surface-mining excavations (sand pits, gravel pits, quarries, and clay pits) or fish ponds. Over time, they expand into natural water bodies and even peatlands. At this stage, negative interactions may arise with native dragonflies, including species often regarded as conservation priorities, such as *Leucorrhinia* spp. and peatland-associated species of the genus *Aeshna*.

At the same time, the distribution of Siberian species *sensu lato* is changing. *Coenagrion armatum* has completely disappeared from western Poland (the last record dates back more than twenty years), is very rare in central Poland, and now persists mainly along the eastern border. Other dragonflies of this group likewise show range erosion from the west and south, becoming increasingly rare outside northern and eastern Poland. In some species, habitat requirements are also becoming more restricted, increasingly

limited to peatland waters. In recent years, the first signs of such range contraction have become apparent even in some regions of northern Poland.

The shift in the altitudinal distribution of *Aeshna caerulea* is probably related to climate warming and the resulting upward movement of the boundary of the subarctic climatic zone. Fifty to sixty years ago, this species occurred in the Sudetes from elevations as low as 830 m a.s.l. All of these lower-elevation populations have disappeared. Today, the only known locality in the Karkonosze Mountains lies at 1,430 m a.s.l.

Anthropopression on habitats is visible, negative impact of climatic changes is rising, yet vast areas of Poland are still in good condition and are refugia for valuable species. No species in Poland gone extinct so far. The red list included into "A distribution atlas of dragonflies (Odonata) in Poland" (2009) covers only seven species, including: five in categories of high risk (*Nehalennia speciosa* – EN, *Coenagrion armatum* – CR, *C. ornatum* – CR, *Aeshna caerulea* – CR, *Somatochlora arctica* – EN), one in category NT (*Somatochlora alpestris*) and one species as DD (*Orthetrum coerulescens*). Nowadays, the new list is being written which will be a little bit longer. In predictable future, only *Aeshna caerulea* may go extinct: scarce mountainous areas in Poland do not provide appropriate habitats. The situation may get worse since the species is moving further to the north to the boarder of subarctic climate.

At the same time, it is probable that *Gomphus pulchellus* Selys, 1840 may appear in south-western Poland – the species is in expansion to the east in Czech Republic and Germany.

In Poland there are 22 species which are endangered or near threatened species in the European Union: from category CR – none (out of two); EN – three (out of ten); VU – 9 (out of 18); NT – 9 (out of 19). For the majority of them, Polish populations are large and essential for the preservation of species.

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