Odonatrix 21_2 (2025)

How climate warming appears to be affecting the odonate fauna of Gdynia (N Poland): results and observations from the 2024 season.

W jaki sposób ocieplenie klimatu zdaje się wpływać na faunę ważek w Gdyni: wyniki i obserwacje z sezonu 2024 r.

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Abstract: The paper presents interesting new records of dragonflies from the Gdynia district of Chwarzno-Wiczlino (N Poland) in 2024. The breeding of *Sympetrum fonscolombii* (Selys, 1840) was confirmed, and *Aeshna affinis* (Vander Linden, 1820) and *Erythromma viridulum* (Charpentier, 1840) were reported for the first time from Gdynia. In addition, *Sympetrum meridionale* (Selys, 1841) was recorded in the city for the third time. Six species listed as endangered in the European Red List of Dragonflies were recorded: *Lestes sponsa* (Hansemann, 1823), *Aeshna grandis* (Linnaeus, 1758), *Somatochlora metallica* (Vander Linden, 1825), *Sympetrum danae* (Sulzer, 1776), *S. pedemontanum* (Allioni, 1766) and *S. vulgatum* (Linnaeus, 1758). The apparent replacement of *S. vulgatum* by *S. striolatum* (Charpentier, 1840) and the probable northward and eastward range shifts of cold-adapted species of Siberian and West Siberian are analysed.

Key Words: Odonata, dragonflies, damselflies, Gdynia-Chwarzno, northern Poland, anthropogenic habitats, faunistics

Introduction

Up to 2023, 49 species of damselflies and dragonflies were recorded within the boundaries of the city of Gdynia (N Poland) (SENN 2024), which makes up 66.2% of the total number of species on the Polish checklist (74 species) (BERNARD et al. 2009, BUCZYŃSKI et al. 2019a). 39 of them (22 were confirmed or probable breeders) occurred in 2018-2023 at the sites explored in the present study, and included five southern species. The intention of the present study was to continue that earlier research with particular focus on southern species. It was planned to carry out regular monitoring of the odonate fauna, at a small number of water bodies throughout the 2024 season, within a very limited area (c. 1 km^2) in the Gdynia district of Chwarzno-Wiczlino. A further aim was to track the developing diversity of odonates in these water bodies, some of which were established only a few years ago.

Study area

The study area lies within the Sokółka, Fort Forest and Chwarzno-Polanki housing estates in the Gdynia district of Chwarzno-Wiczlino (Fig. 1). The third of these, the latest to be completed, is situated c. 1.5 km to the west of the other two (SENN 2024). The buildings on the estates are no more than five storeys high and stand quite far apart from each other. The

spaces between them have been landscaped with grassy areas, flower beds, shrubs and trees, as well as a number of small garden ponds. Physiogeographically, Chwarzno-Wiczlino lies in the East Pomeranian Lake District macroregion, within the borders of the Kashubian Lake District mesoregion (KISTOWSKI et al. 2021). During the period 1991-2020, the mean annual temperature in the Gdynia area was 9°C, the mean temperature in January was +1°C, in July it was 18°C, and the total annual precipitation was 600-650 mm. More recent (2021-2024) figures available for the Tri-City region (Gdańsk, Sopot, Gdynia) show that the mean annual temperature and the total annual precipitation in 2021-2024 were slightly higher than earlier. Moreover, the absolute maximum and minimum temperatures for January 2021-2024 varied rather widely year on year, (max. 6 – 15°C; min. -3 – -19°C), but the same parameters for the months of July in that period remained fairly constant (max. 30 – 32°C, min. 10 – 12°C). Precipitation in the months of January 2023 and 2024 (21 and 19 mm respectively) was less than the long-term average (50 mm). In turn, July 2021 and 2022 were much drier (68 and 63 mm respectively) than the long-term average (80 mm), rainfall in July 2023 was at about the average level (82 mm), but July 2024 was much wetter (126 mm) (INTERNET 1, 2).

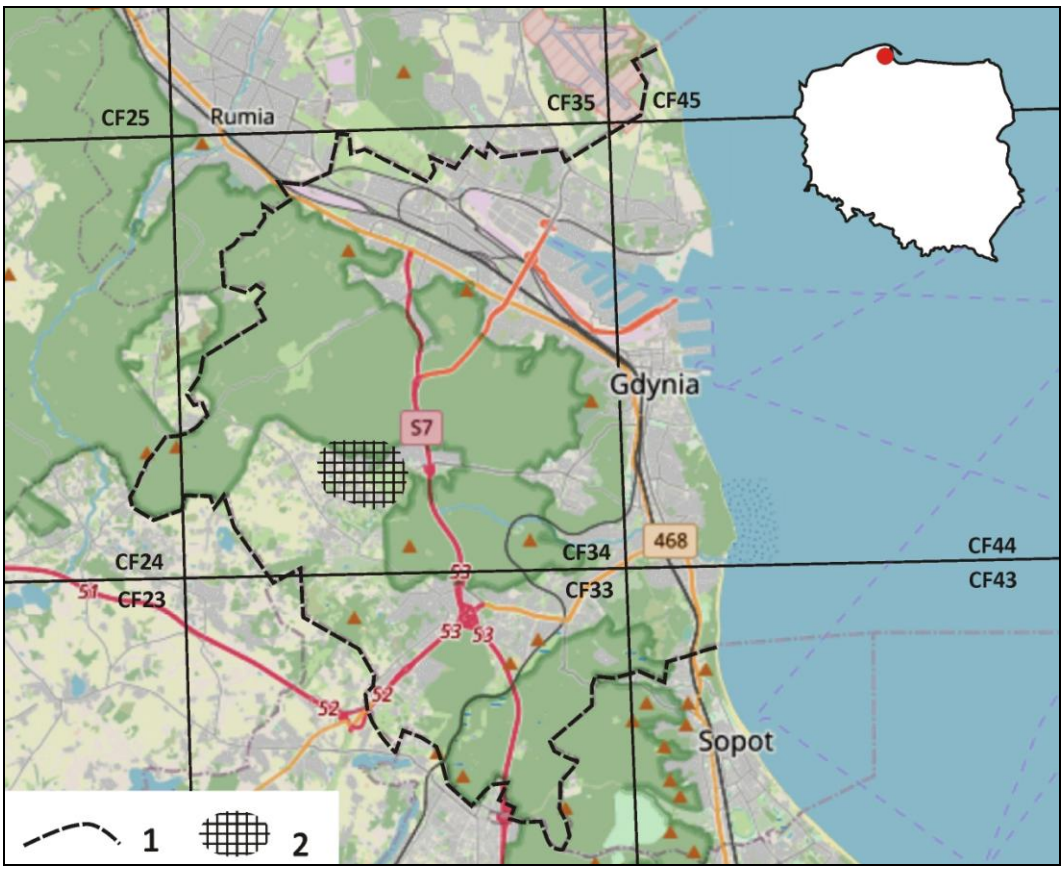

Fig. 1. Administrative boundary of Gdynia (1); study area (2). Figure by Ewa MIŁACZEWSKA.
Ryc. 1. Granice administracyjne miasta Gdyni (1); terenu badań (2). Ryc. Ewa MIŁACZEWSKA.
Source/ Źródło: https://gis.biomap.pl

Characteristics of the sites

The study encompassed four small water bodies and a group of garden ponds (sites **1-5,** Fig. 2-7) lying within an area of c. 1 km^2 on or near the above-mentioned estates. They are situated up to 1 km from the edge of the forests of the Tri-City Landscape Park (TLP) [Tri-

City: the conurbation of Gdańsk, Sopot and Gdynia]; all are supplied by rainwater. The description of each site includes its geographical coordinates (INTERNET 3), the relevant 10x10 km square in the UTM system, its height above sea level (INTERNET 4) and surface area (INTERNET 5). Sites **1-3** and **4** (in part) were described in detail by SENN (2024), there denoted as **1A-1D**. The present paper includes only the most important information, relating to the changes occurring in them in 2024. In the preceding autumn and winter, falls of rain and snow were fairly frequent, on occasion abundant, and during the spring and summer of 2024 there was ample rainfall, too. The ponds thus contained water for most of the time.

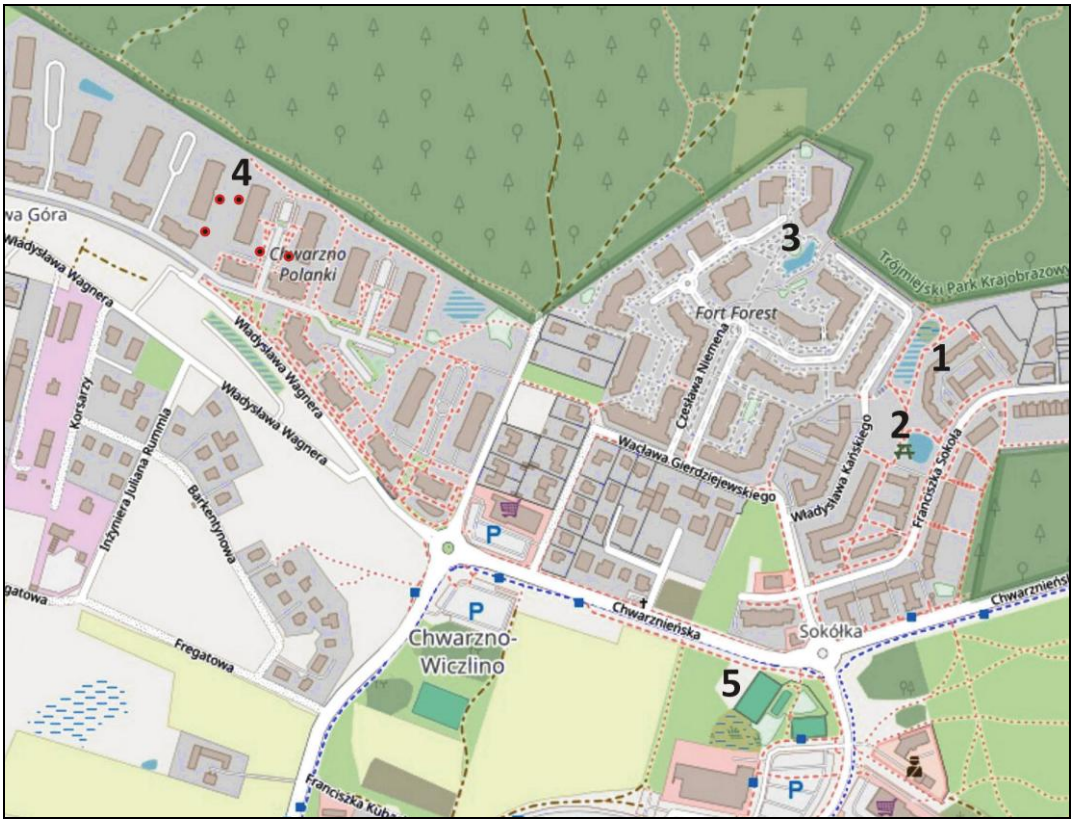

Fig. 2. Sites **1-5** (the red dots at site 4 indicate the positions of the garden ponds studied).
Ryc. 2. Stanowiska nr **1-5** (czerwone kropki przy stanowisku nr 4 oznaczają zbadane oczka ogrodowe).
Source/Źródło: https://gis.biomap.pl

1. Detention pond (dry pond) between the buildings of the Sokółka and Fort Forest estates (Figs. 2, 3).

Coordinates: N 54.500951, E 18.439951; UTM: CF34; 147 m a.s.l.

This pond (area – c. 840 m^2, av. depth – c. 25 cm) is situated in a natural depression near the southern edge of the TLP forests. It is fed by the excess of rainwater flowing in from the neighbouring retention pond (site **2**) and is 70-80 cm deep when full. Periods of drought in spring and summer, when the pond dries out completely, are occurring with greater frequency, as a result of which many parts of the pond bed have become covered with herbaceous vegetation and grasses. Even though precipitation between autumn 2023 and summer 2024 was quite abundant, the pond dried out twice for short periods – in mid-May and again in early June. The species composition of the vegetation growing in it has changed in comparison with earlier years (SENN 2024). Around one-third of its area is now covered by dense emergent vegetation, consisting mainly of *Phragmites australis* (CAV.) TRIN. ex STEUD.

and to a lesser extent of *Typha angustifolia* L. *Typha latifolia* L. used to grow here as well, but has been displaced by *Ph. australis*. The shoreline vegetation continues to consist mainly of clumps of *Juncus* sp. and *Carex* sp., but these, too, seem to be receding as the reedbed expands. In late June 2024, a plant with floating leaves – *Callitriche* sp. – appeared in this pond for the first time. The vegetation immediately adjacent to the pond includes shrubs, e.g. *Spiraea* sp., young trees like *Tilia* sp. and *Prunus* sp., as well as ruderal herbaceous plants and grasses. The banks of the pond were mown in autumn 2024 after an interval of two years.

Fig. 3. Site **1.** Photo: P. SENN.
Ryc. 3. Stanowisko nr **1.** Zdjęcie: P. SENN.

2. Retention pond on the Sokółka estate (Figs. 2, 4).

Coordinates: N 54.500141, E 18.440015; UTM: CF34; 147 m a.s.l.

This retention pond (area – c. 490 m^2), which used to be a field pond before the estate was built, receives surface run-off from the estate roads. Even though the water level falls during a hot summer, to my knowledge, it has never dried out. In contrast to the dry 2023 season, when patches of the pond bottom were exposed, it was quite high in autumn 2023 and throughout the spring and summer of 2024. There is no aquatic vegetation as such (the bottom of the pond was concreted over many years ago), but the roots of bankside herbaceous plants and grasses are accessible from the water, and the branches of a large *Salix alba* L. overhang the water. Young *Salix viminalis* L. bushes also grow along the water's edge.

Fig. 4. Site **2.** Photo: P. SENN.
Ryc. 4. Stanowisko nr **2.** Zdjęcie: P. SENN.

3. Retention pond on the Fort Forest estate (Figs. 2, 5).

Coordinates: N 54.501767, E 18.438309; UTM: CF34; 146 m a.s.l.

This pond (area – c. 460 m^2, av. depth – c. 1 m) was constructed some 7-8 years ago. Lying in a natural depression, close to the edge of the TLP forest, it receives the surface run-off from the roads and pavements on the estate. The vegetation consists principally of *Acorus calamus* L. and *Salix cinerea* L. in the deeper parts, and *Iris pseudacorus* L. in one corner, where the water is shallow. Mats of algae form in hot weather but disappear after heavy rain. In early June 2024, plants with floating leaves – *Potamogeton natans* L. – appeared for the first time in this pond and by September had spread quite profusely. Unlike 2023, the sandy-muddy bottom of the pond was never exposed in 2024. Apart from periods immediately after heavy rainfall (which can cause the water depth to change rapidly by as much as 50-60 cm), the water is usually quite transparent. The pond is inhabited by a small number of fish (species unknown) and by quite a large population (> 100 individuals) of *Lissotriton vulgaris* L. The aquatic insects, apart from odonates, include *Notonecta glauca* L., and members of Gerridae, Dytiscidae and Gyrinidae. There is no direct access to the water's edge. The life of this pond can be studied from a metal platform erected around one half of it, some 2 m above the water level, or from even higher up on the other half. Low shrubs grow around the pond, and the distance to the forest edge is at most 200 m. The basin in which the pond lies is lined with gabion retaining walls, with mosses overgrowing those parts that are regularly wetted.

Fig. 5. Site **3.** Photo: P. SENN.
Ryc. 5. Stanowisko nr **3.** Zdjęcie: P. SENN.

4. Five garden ponds between the blocks of flats near Wagnera St. on the Chwarzno-Polanki estate (Figs. 2, 6) (shown by the red dots on Fig. 2).

Coordinates: from N 54.502265, E 18.430000N to 54.501860, E 18.430644; UTM: CF34; 155 m a.s.l.

These ponds were established in 2022, a short distance away from the housing blocks. They are situated 500 – 550 m to the west of site **3** and up to 100 m from the TLP forest edge. All are c. 20 m^2 in area and up to 30 cm in depth. Some of the rainwater runoff from the roofs of the nearby buildings is channelled into them. To retard leakage into the substrate, the ponds have been lined with geomembrane. The vegetation consists mainly of *I. pseudacorus*, *T. latifolia* and *Lemna minor* L. Algal mats can also form in hot weather. Two of the ponds are as yet devoid of aquatic plants. Two of the ponds are surrounded by a pavement and garden shrubs, three by regularly mown grassy areas. Trees of various

species have been planted close by. The ponds are generally well-insolated. They all contain water after heavier rain but dry out at different rates.

Fig. 6. Site **4.** Photo: P. SENN.
Ryc. 6. Stanowisko nr **4.** Zdjęcie: P. SENN.

5. Periodic waterbody near the Chwarzno-Sokółka bus terminus (Figs. 2, 7).
Coordinates: N 54.497698, E 18.437387; UTM: CF34; 152 m a.s.l.

A semi-natural, shallow waterbody (area – c. 1300 m^2), which used to be part of a larger area of boggy terrain. Nowadays, it is squeezed in between a small shopping complex and a football pitch. It has existed in this form since 2017. There is water in this pond in spring and summer so long as there was abundant rain- and snowfall in the previous autumn and winter. In 2018-2019 water was present, aquatic plants thrived, and two odonate species were recorded: *Coenagrion puella* and *Libellula quadrimaculata*. But 2020-2023 were dry and the pond gradually dried out. However, plentiful precipitation in the autumn and winter of 2023-2024 restored the water, and the vegetation revived. As this pond dries out very slowly, water was present throughout the spring and most of the summer of 2024, only disappearing towards the end of August during a long, warm and dry spell. The emergent vegetation consists of extensive patches of *I. pseudacorus*, covering most of the water surface when fully developed, and a few clumps of *Alisma plantago-aquatica* L. The bankside vegetation consists mostly of *Salix caprea* L.*, S. cinerea*, *S. viminalis, Juncus* sp., *Lythrum salicaria* L. and *Bidens tripartita* L.

Fig. 7. Site **5.** Photo: P. SENN.
Ryc. 7. Stanowisko nr **5.** Zdjęcie: P. SENN.

Methods and materials

The study season lasted from 12 May to 23 September 2024. During this period, the five sites were monitored several times a week, sometimes daily, making a total of 92 monitoring sessions – 14 in May, 12 in June, 24 in July, 24 in August and 18 in September. Monitoring took place between 11:00 and 18:00 hrs, occasionally earlier or later, in calm, sunny weather, at temperatures of at least 18°C. Adult odonates were observed with the naked eye or through binoculars, odonates and sites were photographed, exuviae were collected on sight, and information was gathered on numbers and reproductive behaviour. The species recorded were classified according to their frequency of occurrence: frequent – recorded at all 5 sites, fairly frequent – at 3-4 sites, uncommon – at 1-2 sites. The occurrence and reproductive status of the species are listed in Table 1.

Results and discussion

This study yielded a total of 510 records of imagines and 14 exuviae of 27 species, 14 of which were confirmed or probable breeders. Among them were two species new to Gdynia – *Erythromma viridulum* (CHARPENTIER, 1840) and *Aeshna affinis* (VANDER LINDEN, 1820). The addition of these species brings the total number recorded within the city area to 51. This makes up 68.9% of the total number of odonates recorded to date in Poland (74 species) (BERNARD et al. 2009, BUCZYŃSKI et al. 2019a). The frequent species were *Ischnura elegans* (83 records, 63 of which at site **3**), *Coenagrion puella* (52), *Libellula depressa* (27) and *Sympetrum striolatum* (62), and the fairly frequent ones were *Aeshna cyanea* (60 records/4 sites), *Anax imperator* (50/4), *Somatochlora metallica* (28/3) and *Sympetrum sanguineum* (35/4) – all eurytopes. There were no records of strictly protected species, i.e. those listed in Annexes II and IV of the EU Habitats Directive (COUNCIL DIRECTIVE… 1992) and the Polish Directive regarding the Conservation of Animal Species (ROZPORZĄDZENIE… 2016).

At site **1** the odonate species composition was poorer and numbers were lower than in earlier years, whereas the corresponding figures for site **2** were much the same as before (SENN 2024). Site **3** was the most interesting one with 18 species, 12 of which were confirmed or probable breeders (see Table 1). The species composition – a total of 11, including pioneer species – recorded on the garden ponds at site **4** was typical of water bodies in the early stages of development, e.g. *Ischnura pumilio* and *Sympetrum striolatum*. Apart from *Lestes dryas*, all the species recorded at site **5** were common ones. The changes in the species composition of damselflies and dragonflies at these sites could have been due, apart from climate warming, to changes in the species composition of the plants growing in them, especially at sites **1** and **3** (see the site descriptions above; SENN 2024).

Below are discussed the southern species, two of which are new to Gdynia and taxa placed on the European Red List of Dragonflies & Damselflies (Odonata) (DE KNIJF et al. 2024).

Table 1. Dragonfly and damselfly (Odonata) species recorded in Gdynia-Chwarzno in 2024.
Column MA – maximum abundance (number of individuals) recorded at one site: a) 1; b) 2-10; c) 11-20; d) > 21. Column NR – number of records. EUR/EU27 – Species on European Red List (De Knijf et al. 2024): EN – endangered, VU – vulnerable, NT – near threatened. Symbols: ● – species breeding and developing in the habitats surveyed, reproduction confirmed by the finding of exuviae or teneral individuals; o – species probably breeding in the habitats surveyed, i.e. reproduction probable, as indicated by reproductive behaviour (tandems, copulation or oviposition); + – species present, i.e. adult(s) seen but no reproductive behaviour manifested (Buczyński et al. 2006, Bernard et al. 2009); * – southern species; ** – first record for Gdynia; † – STI – Species Temperature Index (°C) (after Termaat et al. 2019 – Supporting Information); the Siberian and West Siberian species are indicated in bold; ΣA – total number of species; ΣB – total number of confirmed and probable breeders.

Tabela 1. Gatunki ważek (Odonata) stwierdzone w Gdyni-Chwarznie w 2024 roku.
Kolumna MA – maksymalna stwierdzona liczebność (liczba osobników) na jednym stanowisku: a) 1; b) 2-10; c) 11-20; d) > 21. Kolumna NR – liczba obserwacji. EUR/EU27 – Gatunki uwzględnione na Czerwonej liście ważek Europy (EU) i Unii Europejskiej (UE) (De Knijf et al. 2024): EN – zagrożone, VU – gatunek narazony na wyginięcie, NT – bliski zagrożenia. Oznaczenia: ● – autochtoniczny, rozród potwierdzony przez obecność wylinek i/lub osobników teneralnych; o – prawdopodobnie autochtoniczny, rozród prawdopodobny na podstawie zachowań rozrodczych (tandemy, kopulacje, owipozycje); + – stwierdzony, obserwacje osobników dorosłych nie wykazujących zachowań rozrodczych (Buczyński et al. 2006, Bernard et al. 2009); * – gatunki południowe; ** – pierwsze stwierdzenie dla Gdyni;† – STI – Wskaźnik Temperatury dla Gatunków (°C) (wg Termaat et al. 2019 – Supporting Information); gatunki syberyjskie i zachodniosyberyjskie wyszczególniono tłustym drukiem; ΣA – liczba wszystkich gatunków; ΣB – liczba gatunków autochtonicznych i prawdopodobnie autochtonicznych.

No. Lp.	Species/Gatunek	Sites/Stanowiska					MA	NR	Phenology/Fenologia	EUR/ EU27	STI (°C)†
		1	2	3	4	5					
1.	*Calopteryx splendens* (Harris, 1782)			+			a	2	26 July – 5 Aug		9.391
2.	***Lestes dryas* Kirby 1890**					+	a	5	26 July – 9 Aug		**9.067**
3.	***L. sponsa* (Hansemann, 1823)**				+	+	b	5	15 July – 12 Aug	NT/NT	**7.572**
4.	*Chalcolestes viridis* (Vander Linden, 1825)	+		o			b	15	11 July – 21 Sept		10.616
5.	*Sympecma fusca* (Vander Linden, 1820)					+	a	1	14 May		10.848
6.	*Ischnura elegans* (Vander Linden, 1820)	o	+	●	+	+	d	83	13 May – 23 Sept		9.815
7.	*I. pumilio* (Charpentier, 1825)				+		b	3	7 – 27 Aug		10.454

No. Lp.	Species/Gatunek	Sites/Stanowiska					MA	NR	Phenology/Fenologia	EUR/ EU27	STI (°C)†
		1	2	3	4	5					
8.	***Enallagma cyathigerum* (CHARPENTIER, 1840)**	o					b	15	9 July – 11 Aug		**8.463**
9.	*Coenagrion puella* (LINNAEUS, 1758)	●	o	●	o	o	c	52	12 May – 6 Aug		9.297
10.	***Erythromma viridulum* (CHARPENTIER, 1840)**	+		o			b	5	9 – 23 Aug		10.644
1.	*Pyrrhosoma nymphula* (SULZER, 1776)		o	o			b	13	14 May – 2 June		8.815
12.	**/**Aeshna affinis* (VANDER LINDEN, 1820)**	+					a	1	6 July		10.877
13.	*Aeshna cyanea* (O.F. MÜLLER, 1764)	o	+	o	●		b	60	16 June – 23 Sept		8.813
14.	***A. grandis* (LINNAEUS, 1758)**	o		o			b	7	20 July – 2 Sept	VU/VU	**6.553**
15.	*A. mixta* LATREILLE, 1805			o			b	9	17 July – 16 Sept		10.251
16.	*Anax imperator* LEACH, 1815	o	+	●		+	b	50	29 May – 11 Aug		11.398
17.	***Cordulia aenea* (LINNAEUS, 1758)**	+					a	1	29 May		**7.348**
18.	***Somatochlora metallica* (VANDER LINDEN, 1825)**	+	+	+			b	28	26 May – 9 Aug	VU/VU	**6.412**
19.	*Libellula depressa* LINNAEUS, 1758	o	+	●	+	+	b	27	14 May – 29 July		9.670
20.	***L. quadrimaculata* LINNAEUS, 1758**	+				+	b	9	12 May – 9 July		**7.881**
21.	***Sympetrum danae* (SULZER, 1776)**	+		+	+		b	5	7 Aug – 8 Sept	EN/EN	**6.761**
22.	**S. fonscolombii* (SELYS, 1840)**	+		●!			a	2	14 Aug – 2 Sept		12.590
23.	**S. meridionale* (SELYS, 1841)**			+			a	1	21 Sept		11.990
24.	***S. pedemontanum* (ALLIONI, 1766)**				+		a	7	29 July – 27 Aug	NT/NT	**8.539**
25.	*S. sanguineum* (O.F. MÜLLER, 1764)	o		+	+	o	b	35	26 June – 21 Sept		9.326
26.	*S. striolatum* (CHARPENTIER, 1840)	o	+	o	●	+	b	62	11 July – 23 Sept		10.817
27.	***S. vulgatum* (LINNAEUS, 1758)**	+		+	+	+	b	7	6 Aug – 4 Sept	VU/VU	**7.750**
	ΣA:	**18**	**8**	**18**	**11**	**11**					
	ΣB:	**9**	**2**	**12**	**3**	**2**					

Species new to Gdynia

***Erythromma viridulum* (CHARPENTIER, 1840)** (Fig. 8).

Site **1**: 21 July 2024, 1 patrolling ♂; **3**: 9 – 23 July 2024, 1-2 territorial ♂♂, one tandem with oviposition. *E. viridulum* was recorded at site **3** some time after the first specimens of *P. natans* had appeared. Another record comes from a pond in the Ronald Reagan Park in Gdańsk-Przymorze (CF43), where a male of this species was photographed on 21 June 2018 (INTERNET 6).

Fig. 8. Male of *Erythromma viridulum*. Photo: P. SENN.
Ryc. 8. Samiec *Erythromma viridulum*. Zdjęcie: P. SENN.

The first record of *E. viridulum* from the Pomeranian Lake District comes from the 1980s, the second one from 2001 (MICHOŃSKI 2003). Historically, it was not mentioned by either LA BAUME (1908) or LE ROI (1911). The "Distribution Atlas of dragonflies (Odonata) in Poland" (BERNARD et al. 2009) shows a range of sites in the regions of Warmia and Masuria (NE Poland), for example, along the border with the Kaliningrad Oblast (Russia) (BUCZYŃSKI 2007), but none in northern Pomerania (N Poland), although its authors assumed that the latter region had almost certainly been colonized. Subsequently, *E. viridulum* was indeed reported from many sites in this region, like the islands of Wolin and Uznam (Usedom) in Western Pomerania (BUCZYŃSKI 2011) and the Słowiński National Park (JĘDRO et al. 2020). It was also recorded near Suwałki (BUCZYŃSKI et al. 2019b, MACKIEWICZ & TOŃCZYK 2019) and in Podlasie (KOBYŁECKI 2021), both regions in NE Poland. The expansion of this Mediterranean species is almost certainly due to climate warming, and its presence in the Gdynia-Chwarzno waterbodies could also have been due to their eutrophication (periodic mats of algae). As the species' distribution has expanded well to the north of the Polish Baltic coast, it ought to be present in any suitable habitat to the north, north-east and north-west of Poland. And this is indeed the case. *E. viridulum* has made similar northward and westward progress elsewhere in Europe. In England, it was first recorded in 1999, after which it rapidly colonized the south-east and the Isle of Wight. Currently, its distribution extends from Cornwall in the south-west to North Yorkshire in the north (at the same latitude as the southern Baltic Sea) (DIJKSTRA et al. 2020, SMALLSHIRE & SWASH 2020). *E. viridulum* has already spread over the whole of Germany (INTERNET 7) and is a confirmed breeder in Denmark (WILDERMUTH & MARTENS 2019). In Sweden, it was first recorded in 2004 in the south-west of the southern province of Skåne (BILLQVIST 2017, 2020) and has since spread eastwards and northwards to the provinces of Gotland and Uppland

(INTERNET 8). In 2019, a small population was discovered on the Courish Spit, the first record for the Kaliningrad Oblast (Russia) (SHAPOVAL et al. 2022). *E. viridulum* was first recorded in Lithuania in 2007, since when it has spread over almost the whole country and is now moderately frequent (GLIWA et al. 2019). In his paper on the potential odonate immigrants to Latvia, KALNIŅŠ (2011) stated that *E. viridulum* was one such species as it was already present in Lithuania. In fact, it was first recorded in Latvia in 2012 and is currently known from a small cluster of sites in central Latvia and a few isolated ones in the south-east and south-west of the country (KALNIŅŠ 2017). It has not yet been recorded in either Estonia (MARTIN 2013) or Finland (INTERNET 9).

***Aeshna affinis* (VANDER LINDEN, 1820)** (Fig. 9).

Site **1**: 6 July 2024 (c. 15:30 hrs), 1 mature ♂, appeared to be patrolling over one corner of the pond, overgrown with clumps of *Juncus* and *Carex*. On the day of the observation, this area was dry, and the hawker was flying over it continuously for about 15 minutes, hovering every so often. Given the characteristics of this periodically drying out pond (BERNARD et al. 2009, WILDERMUTH & MARTENS 2019), a check will need to be made in the coming years on whether this species has started to reproduce here. This record is probably the first one for Gdynia and to date the northernmost site of *A. affinis* in Poland.

Fig. 9. Male of *Aeshna affinis*. Photo: P. SENN.
Ryc. 9. Samiec *Aeshna affinis. Z*djęcie: P. SENN.

The "Distribution Atlas…" (BERNARD et al. 2009) shows no records of *A. affinis* north of around latitude 53°N but states that the species' occupancy is significantly expanding northwards and that it can be expected almost anywhere in the country, especially as it has already been sighted in Lithuania (see below). *A. affinis* has been recorded in other Polish cities – Kielce (GWARDIAN et al. 2015), Lublin (BUCZYŃSKI et al. 2020), Łódź (TOŃCZYK & PAKULNICKA 2004) and Warsaw (OŁDAK 2023). It has also been reported from the Suwałki area (BUCZYŃSKI & BUCZYŃSKA 2014), where breeding was confirmed in 2023 on the basis of an exuvia (TAŃCZUK et al. 2024), and the Podlasie region (BUCZYŃSKI et al. 2019b, KOBYŁECKI 2021), the last-mentioned author reporting a few ovipositing pairs at a site at latitude c. 53°N.

In the U.K., *A. affinis* has been fairly regularly sighted on the south-east coasts of England and since 2010 has been a confirmed breeder around the Thames Estuary (INTERNET 10). This species has been reported from all parts of Germany – it can turn up anywhere in that country although reproduction in the northern regions is probably still a rare occurrence (INTERNET 11). It has reached Denmark (WILDERMUTH & MARTENS 2019), southern

Sweden (principally Skåne and Öland, where it was first recorded in 2010-2011 – BILLQVIST 2017, 2020), and also Gotland (INTERNET 12) and southern Finland (INTERNET 13). The first record from Lithuania comes from 2003 (BERNARD 2005) and the handful of subsequent ones probably refer to migrants, the relevant sites being on the Baltic coast (GLIWA et al. 2019). To the south, *A. affinis* has been turning up on the Courish Spit (Kaliningrad Oblast, Russia) every year since 2010 (SHAPOVAL et al. 2022). This is another species regarded as a potential addition to the list of odonates of Latvia (KALNIŅŠ 2011). The first record from that country comes from 2016, when a dozen or so individuals were caught in a funnel trap for birds and bats on the Latvian coast, but since then there have been no further records (KALNIŅŠ 2017). Like the previous species, it has yet to be recorded in Estonia (MARTIN 2013).

Other southern species

***Sympetrum fonscolombii* (SELYS, 1840)** (Fig. 10).

Site. **1**: 14 August 2024, 1 juvenile ♂ of the second generation; **3**: 2 September 2024, 1 teneral ♂ of the second generation (a drop of water was still hanging from the end of its abdomen). It perched for quite a long time on a branch of a *Salix cinerea* bush, where it was photographed, before it took off on its virgin flight.

Fig. 10. Teneral male of *Sympetrum fonscolombii.* Photo: P. SENN.
Ryc. 10. Teneralny samiec *Sympetrum fonscolombii.* Zdjęcie: P. SENN.

This species had been recorded earlier at these sites: **1** – one ♂ at the end of May 2007; **1** and **3** – tandems with oviposition in June 2019. In 2024, no oviposition was seen to be taking place. This is probably the northernmost site in Poland where breeding of this species has been confirmed. Elsewhere in northern Poland, it was recorded in the vicinity of Sejny in 2017 (MACKIEWICZ & TOŃCZYK 2019) and in the Słowiński National Park in 2017-2018 (JĘDRO et al. 2020). Whether it reproduced in these areas is not known. There was a strong influx of this species to Poland in the spring of 2024, and there were subsequently a few records of second-generation individuals (P. BUCZYŃSKI, pers. comm.).

S. fonscolombii turns up as a migrant every year in Germany, where it reproduces, and larval survival of the winter has been proven in a few cases. The species is spreading across Germany and is very likely to become autochthonous throughout the country in the near future (INTERNET 14). LEMPERT (1997) reported a large-scale immigration of this species to Germany (and many other countries in Europe) as long ago as May-June 1996, and second-generation individuals were subsequently recorded in many parts of the

country, the northernmost such site being in Schleswig-Holstein (c. lat. 53°N). As these individuals were not seen again at the waterbodies where they emerged, the possibility was considered that many of them had migrated back towards the south (LEMPERT 1997). *S. fonscolombii* has also been recorded in Ireland, Scotland and Denmark (WILDERMUTH & MARTENS 2019). In Sweden, it was first recorded on Öland in 1997 (BILLQVIST 2017), where it may have reproduced temporarily in at least some years between 2011 and 2015 (BILLQVIST 2020). The latest records show that it has reached the province of Uppland (north of Stockholm) (16 records), and there are two records from as far north as the province of Västerbotten (lat. c. 63-64°N) (INTERNET 15). There are a handful of records from southern Finland, to which country this species is an irregular vagrant. An exceptional observation from Finland is that of an adult ♂ on 19.06.2019 from the island of Ulkokrunni in the Bay of Bothnia (biogeographical province – Oulu Ostrobothnia) near the town of Ii (lat. c. 65°N, around 1270 km to the north of Gdynia!) (INTERNET 16). In Latvia, this species still has to be regarded as a vagrant – there have been only a very few records to date; the first definitive one is from 2009, but the indications are that it will be recorded more often in the future, as its home range expands northwards (KALNIŅŠ 2017). It was first recorded in Lithuania in 2015 (GLIWA et al. 2019) and on the Courish Spit in the Kaliningrad Oblast (Russia) in 2007 (SHAPOVAL et al. 2022). BORISOV et al. (2020a) reported finds of *S. fonscolombii* as far north as 56°N in the European part of Russia. These authors stated that a second, indigenous generation of *S. fonscolombii* had been recorded in only two places in Russia – in the southern Urals and in the southern part of western Siberia, at latitudes 53°39' – 54°33'N. Post-teneral individuals were noted there from mid-August to mid-September, but breeding was quite likely farther north, where migratory individuals were not rare. The status of those second-generation individuals was not clear, but it some may have been migrating to the south. On the basis of stable isotope evidence, BORISOV et al. (2020b) demonstrated that this was in fact what could have been happening.

***Sympetrum meridionale* (SELYS, 1841)** (Fig. 11).

Site **3**: 21 September 2024, 1 ♂. This is the third record of this species in Gdynia – the other two are from Gdynia-Dąbrowa in late August 2018 (SENN 2019) and at site **4** at the end of September 2023 (SENN 2024). Except for one unpublished record from the Vistula Spit (BERNARD et al. 2009), these are the first records of *S. meridionale* on the Polish Baltic Coast.

Fig. 11. Male of *Sympetrum meridionale.* Photo: P. SENN.
Ryc. 11. Samiec *Sympetrum meridionale.* Zdjęcie: P. SENN.

The dozen or so records of this species on the Courish Spit in 2010-2016 (SHAPOVAL et al. 2022) suggest that it can occur anywhere on the Baltic coast or in north-eastern Poland. The individuals appearing on the Baltic coast are almost certainly migrants or vagrants. There have been a few records from Lithuania (GLIWA et al. 2019), but none as yet from Latvia, although it has been mentioned as a potential new species for that country (KALNIŅŠ 2011, 2017). In southern Germany it has been recorded regularly since 2005 (INTERNET 17). There are no records from anywhere in Scandinavia (WILDERMUTH & MARTENS 2019) or the UK (SMALLSHIRE & SWASH 2018).

Species on the European Red List of Dragonflies & Damselflies (Odonata) (DE KNIJF et al. 2024).
EUR – Europe as a whole, EU27 – the 27 member states of the European Union.

***Lestes sponsa* (HANSEMANN, 1823) –** EUR (NT)/EU27 (NT)

Site **4**: 15 July – 12 August 2024, 1-2 territorial ♂♂; **5**: 19 July 2024, 1 territorial ♂. SENN (2024) recorded this species at 9 of the 18 sites he explored, with abundances ranging from 2 to 10 individuals. During the present study *L. sponsa* was not found at site **1**, where previously it had been a probable breeder. One reason might be that the pond has become excessively overgrown with *Ph. australis* at the expense of smaller bankside aquatic plants like *Juncus* sp., on which oviposition had earlier been observed, although climate warming may also be responsible.

***Aeshna grandis* (LINNAEUS, 1758) –** EUR (VU)/EU27 (VU)

Site **1**: 24 July – 29 August 2024, 2 records of patrolling ♂♂,1 of an ovipositing ♀; **3**: 20 July – 2 September 2024, 3 records of ♀♀ laying eggs on dead leaves of *A. calamus*. This species is not abundant here, despite single individuals being recorded quite regularly.

***Somatochlora metallica* (VANDER LINDEN, 1825) –** EUR (VU)/EU27 (VU)

Site **1**: 12 – 24 July 2024, 8 records of patrolling ♂♂; **3**: 29 June – 9 August 2024, 19 records of patrolling ♂♂. This species, usually single individuals, is a frequent visitor to these sites. This seems rather surprising, however, as oviposition is possible only on site **1** (this was observed only once, in July 2019 – SENN 2024), when the water level is low and the sometimes-muddy bottom is exposed.

***Sympetrum danae* (SULZER, 1776) –** EUR (EN)/EU27 (EN)

Site **1**: 11 – 14 August 2024, 1 ♂, 2 ♀♀; **3**: 8 August 2024, 1 territorial ♂; **4**: 7 August 2024, ♂♂ – 2 territorial, 1 juvenile. In 2019 and 2020 there were 20 and 26 records, respectively, of this species at site **1** from July until September. In both years, breeding was confirmed on the basis of exuviae and teneral individuals, although no more than a few individuals were recorded at a time. *S. danae* colonizes water bodies in the early stages of succession and avoids dense emergent vegetation (KÜRY & KRIEG 2023); moreover, the larvae of this species prefer cooler waterbodies with low clumps of *Carex* sp. (A. TAŃCZUK, pers. comm.). The subsequent dramatic drop in the number of records here, as in the case of *L. sponsa*, could be due to the pond becoming overgrown with *Ph. australis.* Climate warming may well be playing a part, too.

***Sympetrum pedemontanum* (ALLIONI, 1766) –** EUR (NT)/EU27 (NT) (Fig. 12)

Site **4**: 29 July – 27 August 2024, 7 records of ♂ territorial behaviour. Earlier years (from 2012 to 2019) yielded just three records of single ♂♂ at site **1**. This is a migratory species and readily colonizes new water bodies (KÜRY & KRIEG 2023). Although no female was recorded, a check should be made at this site in 2025 to establish whether or not successful reproduction did indeed take place in 2024.

Fig. 12. *Sympetrum pedemontanum* (male). Photo: P. SENN.
Ryc. 12. *Sympetrum pedemontanum* (samiec). Zdjęcie: P. SENN.

***Sympetrum vulgatum* (LINNAEUS, 1758) –** EUR (VU)/EU27 (VU) (and comparison with ***Sympetrum striolatum* (CHARPENTIER, 1840))**

Site **1**: 11 August 2024, 1 territorial ♂; **3**: 18 – 26 August 2024, 2 territorial ♂♂; **4**: 8 August – 4 September 2024, patrolling ♂♂, tandem with oviposition; **5**: 6 August 2024, 1 territorial ♂. The numbers and frequency of *S. vulgatum* in this and the previous year dropped sharply in comparison with earlier years, when it was common (20-30 records from July to the end of September, mostly at site **1**) and was a confirmed breeder (exuviae and teneral individuals found) (SENN 2024).

S. vulgatum, hitherto the most frequently recorded darter here, seems to have been replaced by *S. striolatum*, which used to be rather rare here. Indeed, *S. striolatum*, a pioneer species preferring anthropogenic waters like those described here (WILDERMUTH & MARTENS 2019), has become the most common species of its genus in Gdynia-Chwarzno. It was recorded at all five sites, and breeding was confirmed at site **4**: a large number of teneral individuals were counted by one of these ponds and a number of exuviae were collected on another.

The "Distribution Atlas…" (BERNARD et al. 2009) shows far fewer records for *S. striolatum* – a warm-adapted Holomediterranean species – in the NE quarter of Poland, where its occupancy is localized and rare, than elsewhere in the country, and nationwide there are far fewer records of this species than of *S. vulgatum* – a cold-adapted Siberian species (DÉVAI 1976). Elsewhere in Europe, the status of the two species generally appears to be much the same: *S. striolatum* is common in the southern parts of the continent, whereas *S. vulgatum* is more often reported from the northern and eastern parts (KALKMAN et al. 2015a, 2015b). *S. striolatum* and *S. vulgatum* have roughly similar ecological requirements, but the latter prefers cooler waters. Moreover, the reproductive sites of the former are mostly below 600 m a.s.l., whereas those of the latter can be found up to 1400 m a.s.l. in the Alps (WILDERMUTH & MARTENS 2019).

In the UK, *S. striolatum* is common but *S. vulgatum* turns up only very occasionally as a vagrant (hence the English vernacular names of the species) (SMALLSHIRE & SWASH 2018). In Germany, *S. striolatum* occurs everywhere and is not endangered (INTERNET 18), whereas *S. vulgatum*, though present in the whole of Germany and is likewise not endangered, has sustained a reduction in numbers in some Länder, e.g. Hessen (INTERNET 19). In Sweden, *S. striolatum* appears to be fairly widespread and frequent in the southern 1/3 of the country as far north as the province of Uppland (north of Stockholm). There are some 20 records from each of the provinces adjacent to the Baltic Sea as far north as Västerbotten and one from the northernmost province of Norrbotten (latitude c. 65°N) (INTERNET 20). *S. vulgatum*, on the other hand, is common and widespread in the southern part of the country, but there are also more than 340 records from Västerbotten and 90 from Norrbotten (INTERNET 21). In Estonia, *S. striolatum* has been recorded only from areas in the west of the country, close to the Baltic coast, whereas records of *S. vulgatum* come mostly from those same coastal areas but also from the south-east (MARTIN 2013). In Latvia there are a few records of *S. striolatum* from sites scattered all over the country; its population is thought to be growing as the home range expands northwards. In contrast, *S. vulgatum* is widely distributed, with no significant factors adversely affecting the population, which is in fact growing (KALNIŅŠ 2017).

The first European Red List of Dragonflies (KALKMAN et al. 2010) generally reflected the situation at that time, whereby *S. striolatum* and *S. vulgatum* both had the status LC in Europe as a whole (EUR) and in the EU Member States (EU27), and population trends were stable. But drastic events must have taken place in the intervening years: the second such Red List (DE KNIJF et al. 2024) shows that *S. vulgatum* now has the status VU in both regions. It looks as if *S. vulgatum* is withdrawing from the areas it has hitherto inhabited and is being replaced by *S. striolatum*, a trend apparently taking place in Poland as well. Of course, it would be absurd, not to say irresponsible, to draw such a potentially wide-ranging conclusion from evidence acquired from such a small study area, but as something similar appears to have happened in the Lublin region, some 450 km to the south-east of Gdynia (P. BUCZYŃSKI, pers. comm.), it would be worth investigating the possible eastward/northward range shift of this species in this country. The higher temperatures brought about by climate warming are raising the temperature of the shallow waters into which both species lay their eggs, from which larvae may hatch too early, before the winter diapause, and die if exposed to winter temperatures (CORBET 2004), a process to which *S. vulgatum* seems to be more susceptible.

Conclusions

The generally northward range expansion of odonate species of Mediterranean origin (southern species) has been in progress since the 1980s, if not longer, and has been well documented. Among the earliest such species to spread northwards are the four reported in this paper: *E. viridulum*, *A. affinis*, *Sympetrum fonscolombii* and *S. meridionale* (OTT 2010). LEMPERT (1998) reported the first records of *E. viridulum* and the first evidence of reproduction by *S. fonscolombii* (exuviae) on Heligoland, at that time (summer 1997) the northernmost site of the former species and breeding record of the latter (latitude c. 54°N). This is almost the same latitude as Gdynia, so under favourable habitat and weather conditions, both species must have occurred in northern Poland and started to reproduce there in the

intervening 27 years. As all four species have been recorded much farther north, in Scandinavia, the Baltic states and the Kaliningrad Oblast of Russia, one can expect to come across them anywhere in northern Poland.

A different problem relates to cold-adapted species of Siberian and West Siberian origin (DÉVAI 1976, BERNARD et al. 2009). Not only *S. vulgatum*, but also the above-mentioned *L. sponsa*, *A. grandis*, *S. metallica*, *S. danae* and *S. pedemontanum*, all on the second Red List of Endangered Species (DE KNIJF et al. 2024), are of the same provenance. *Coenagrion lunulatum* (CHARPENTIER 1840), recorded over 100 years ago in Gdynia (LA BAUME 1908) but not confirmed again in this city (SENN 2024), is likewise of Siberian origin and its Red List status has changed from LC to VU. The status of other species recorded earlier in Gdynia (SENN 2024) and of the same origin has also deteriorated. They include *Coenagrion hastulatum* (LC → VU), *Aeshna juncea* (LC → EN), *Leucorrhinia dubia* (LC → VU), *L. rubicunda* (LC → VU) and *Sympetrum flaveolum* (LC → EN). Moreover, *S. danae* and *A. juncea*, along with *C. hastulatum*, *C. lunulatum*, *Leucorrhinia dubia* and *L. rubicunda*, have experienced declines of 50% and more during the decade 2014-2024 as a result of the fragmentation of their nutrient-poor habitats. *A. grandis* and *S. metallica* have been similarly affected, albeit to a lesser extent (DE KNIJF et al. 2024). Habitat fragmentation, eutrophication and desiccation, among other causes, have intensified as a result of recent climate warming and these factors are reinforcing each other.

TERMAAT et al. (2019) calculated the species-temperature index (STI) for 99 dragonfly species in 10 regions of Europe (though not including east-central European countries like Poland), based on the records underlying the distribution maps in the European atlas by BOUDOT & KALKMAN (2015). The STI of a species is the mean temperature (in °C) of the European part of the species' range (excluding Russia) and is taken as a proxy for the species' dependence on temperature. Since the annual mean temperature in the Gdynia area for the period 1991-2020 was 9°C and has risen slightly since then, the abundances of all the species recorded there with STI < 9°C, i.e. the cold-adapted Siberian and West Siberian ones discussed above, will very likely fall in the coming years, with the opposite happening to species with STI > 9°C, i.e. the warm-adapted southern species. The STI shows that the observed range expansions and contractions can to a large extent be explained by the preferred temperature of particular species, with climate warming possibly overriding other changes to their living environments. For cold-adapted species, therefore, higher temperatures alone may be responsible for their rapid declines (DE KNIJF et al. 2024, TERMAAT et al. 2019). In Sweden up to 2014, the occupancy indices of cold-adapted species (STI < 9.8°C) and of warm-adapted species (STI > 9.8°C) both increased, resulting in improved conditions for nearly all species (TERMAAT et al. 2019). Thus, two opposing processes appear to be taking place in parallel. As temperatures rise, southern species are moving into areas beyond their former northern limits and gradually replacing the cold-adapted species that have occupied them hitherto. The latter are retreating farther north from their present range, in order to remain within temperature limits that do not preclude reproduction. The same phenomena may be occurring in Poland and the Baltic states.

Annual mean temperatures are a reflection of the climate of an area, but maximum temperatures in the warmest and coolest months may also be playing a part. In fact it is extreme weather phenomena that ultimately govern the range limits of species. To quote from CORBET (2004): "… the survival of a species in marginal habitats may be determined more by the frequency of occasional catastrophic weather events than by average

conditions." As climate warming is such an all-embracing phenomenon, even regularly occurring above-"normal" temperatures in winter could be affecting the larval development of cold-adapted species not only in marginal habitats, but also in the core areas of their ranges.

Observers have tended to focus their attention on the exotic, southern species, whereas what is happening to common, cold-adapted species seems to have slipped under the radar. A survey among Polish odonatologists focusing on these species, with respect to their abundance and possible changes in their distributions/range boundaries, would undoubtedly shed some light on this problem.

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