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Cover illustration: Male *Crocothemis erythraea*.
Photograph by Andreas Chovanec.

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Authors are asked to study these instructions with care and to prepare their manuscripts accordingly, in order to avoid unnecessary delay in the editing of their manuscripts.

- Word-processed manuscripts should be submitted by e-mail, using Arial type face and font size 12.
 - o The following terms are used: 'exuvia' for cast skin (plural: 'exuviae'); 'larva' (instead of 'naiad' or 'nymph'); 'prolarva' to designate the first larval instar.
 - o Dates in the text should be expressed in the form '24 July 2020'.
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 - Journal titles should be written out in full and be in italics; the volume number in bold. Book titles should also be in italics and the number of pages included. Note the use of '&' rather than 'and' where there are two or more authors.
 - If websites are used these should be cited in the text as for references and be listed alphabetically after the references at the end of the article in the following form:
 - Pitsford Hall Weather Station. 2012. www.northantsweather.org.uk (accessed 30 July 2012).
 - o Figures, plates & tables should be referred to in the text in the form (Fig. 1), (Plate 1), (Table 1).
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 - o Footnotes should be avoided.
- Figures, plates and tables should be presented on separate, unnumbered pages, **not** embedded in the text.
 - o Figures and plates should be submitted as .jpg or .tiff files; tables using MS Word.
 - o Legends for figures, plates and tables should be presented together in sequence on separate pages.
 - Each legend should allow the content of the figure/plate/table to be understood fully without reference to the text.
- Video links can be included. They should be referenced in the text and listed separately as 'Video link(s)' after the references.
- Please contact the Journal Editor if any further help is needed.

Obituary: Jill Silsby (1925 – 2023)

PAM TAYLOR

Potter Heigham, Norfolk

The BDS has been informed that Jill Silsby sadly passed away in March 2023; she was 98 years old. Jill was a prominent figure in the early days of the BDS. She served first as both publicity officer and fund-raising officer, later taking on the additional responsibility of BDS Secretary from 1987 to 1994. In 1992 Jill even took on a fourth role, that of SIO (Societas Internationalis Odonatologica) contact, replacing Peter Mill in that position. Jill's late husband Ronnie didn't escape either. He served as BDS Treasurer from 1989 to 1996.

Dragonflies became Jill's life and she travelled extensively to most parts of the world to study and record both them and their behaviour in their natural habitats. This resulted, after twenty years of study, in a comprehensive book entitled *Dragonflies of the World*. This easy to read and beautifully illustrated book, with over three hundred photographs was published in 2001. It covered the evolution, ecology, behaviour, physiology and taxonomy of dragonflies, and included additional contributions from several of the world's leading odonatologists. In 2004, one of these leading scientists, Klaas-Douwe Dijkstra, described and named a new species of dragonfly from Uganda in Jill's honour. *Idomacromia jillianae* (Jill's Shadowcruiser) is endemic to Uganda and Jill was proud to have such a dragonfly named after her.

As one of the planet's most enthusiast dragonfly advocates Jill, in 1997, was a founding member of the Worldwide Dragonfly Association (WDA). Over time she served as both honorary secretary and treasurer of this organisation. Furthermore, she edited their newsletter (later Journal) Agrion for ten years, as she earlier had for the BDS newsletter. Bill Wain, who succeeded Jill as BDS secretary in 1995, recalls how Jill was a formidable lady. He initially met her on his first BDS field meeting at Pangbourne, beside the River Thames. Jill was the meeting leader and she insisted that everyone saw or found an emerging Common Clubtail *Gomphus vulgatissimus* before the end of the day. It wasn't actually difficult to achieve, because there were lots crawling across the footpath to reach a safe plant stem on which they could harden off.

My own best recollection of Jill is from August 1995 when I received a phone call from her to say hundreds of migrant dragonflies had arrived in Great Yarmouth cemetery. She went on to insist that I go and check out this news for myself. Quite how Jill heard about these migrants down in Surrey before I did,



Plate 1. Jill in the Arabian Desert 1977



Plate 2. Jill at a Christening 2007

living only twelve miles from the site, I'll never know. However, following her instructions I duly made my way to Great Yarmouth and she certainly hadn't been exaggerating. When I entered the cemetery there were indeed hundreds of Yellow-winged Darters *Sympetrum flaveolum* present, together with a handful of other migrant species. It seemed that every gravestone, railing and bush was decorated by these beautiful insects and their 'stained glass' yellow wings.

Jill Silsby really was a driving force in the early days of both the BDS and the WDA. She did a great deal to grow both organisations and enthuse people worldwide about the wonder of our beloved dragonflies. In recognition of her outstanding contribution to dragonfly knowledge and conservation both in Britain and the world, Jill was awarded Honorary Membership of the BDS. She will be missed.

Received and accepted 19 January 2024

An example of successfully merging dragonfly conservation with tourism: Odonata at a large artificial swimming pond in Styria (Austria)

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Abstract

In 2023, the odonate fauna of the man-made Gruber-Pond in Pöllau (Styria Province, Austria) was investigated. Records of preliminary studies in 2021 and 2022 were also included in the results. The investigation of this 'swimming biotope' of 4.000 m² revealed a total of 22 odonate species, with 18 of them certainly, probably, or possibly breeding. Five of the breeding species are listed in the Red List of endangered Odonata for Styria. Most remarkable is the record of a large population of the 'endangered' *Coenagrion scitulum* (Dainty Damselfly). The pond is characterised by an open water zone (approximately 2/3 of the total area) and a zone densely vegetated by reed and floating-leaved macrophytes (1/3 of the total area). Littoral zones are open (1/3 of the shoreline), sparsely vegetated (1/3 of the shoreline), and densely vegetated (1/3 of the shoreline). The resulting structural heterogeneity is reflected by the occurrence of odonate species in a wide variety of ecological guilds.

Introduction

Over exploitation of water resources, accompanied by reduced water supply due to climate change impacts, leads to a lowered availability of Odonata habitats (Hassall & Thompson, 2008; Hassall, 2015). Thus, secondary water bodies may play an essential role in compensating for habitat loss and isolation. In this connection, the creation of ponds represents one of the most widespread measures for dragonfly conservation (e.g. Moore, 1991; Chovanec & Raab, 1997; Chovanec, 1998; Blyth, 2014; Buczyński, 2015; Maynou *et al.*, 2017; De Paz *et al.*, 2021). The study presented in this paper deals with the odonate fauna of a large artificial, near-natural swimming pond, which has been constructed to support both nature conservation and recreation.

Site description

In 1999, the Gruber-Pond was constructed for both conservation and recreation (bathing/swimming) by the Gruber Hotel and Restaurant and by the 'Nature Park Pöllau Valley', the regional tourism and nature management agency. The pond (15°48'51"E, 47°18'43"N) is situated at an altitude of 459 m a.s.l. in Pöllau, a village with 6.000 inhabitants (political district Hartberg/Fürstenfeld). This district is located in the eastern region of the Styria Province in the east of Austria (Fig. 1). The region of Pöllau belongs to the Austrian aquatic bioregion Eastern Ridges and Lowlands within the Hungarian Lowlands ecoregion (Illies, 1978; Wimmer *et al.*, 2012). The water body is oval and has an area of 4.000 m², with a maximum length of about 100 m and a maximum width of 45 m. The main axis is oriented northwest/southeast (Fig. 2).

The southeastern part of the pond is characterised by floating-leaf plants, in particular *Nuphar lutea* (Yellow Water-lily), *Nymphaea alba* (White Water-lily) and *Nymphoides peltata* (Fringed Water-lily), and emergent plants, in particular *Carex* spp. (sedges), *Pontederia lanceolata* (Pickerelweed), *Iris pseudacorus* (Yellow Iris), *Lythrum salicaria* (Purple Loosestrife) and *Typha latifolia* (Bulrush). This area is totally excluded from bathing and swimming (Plate 1) and accounts for approximately one third of the pond's surface and of the total shoreline length. The northeastern part of the shore is less densely vegetated by emergent plants (Plate 2). Here bathers can reach the water by using a swimming pier. This part of the pond also comprises one third of the total length of the shore. The remaining third of the shore, situated in the western part of the pond, is not vegetated, is characterised by a gravel substrate and is used as a bathing and swimming shore (Plate 2). All littoral zones are shallow with a maximum depth of about 50 cm. A wooden platform, which is occasionally used for wedding ceremonies, separates the open water area from the vegetated area. The pond, together with its surrounding sunbathing lawn, is highly exposed to the sun. The hinterland of the water body is dominated by forest, agriculture, housing and the riparian vegetation of a cool, fast-flowing, and well-oxygenated river ('Pöllauer Saifen'), which is situated at a distance of about 30 m from the pond (Fig. 2). There is no hydrological connection between the two water bodies.

Method

In order to cover winter-, spring-, summer-, and autumn-species, eight field trips were carried out in 2023 (18 March, 22 May, 10 June, 17 June, 18 June, 9 July, 23 July and 19 August). Records were also made during site visits on 16 July 2021 and 28-29 July 2022. Each field trip took between two and three hours and was carried out in warm and sunny weather conditions with no or only gentle



Figure 1. Map of Austria with its capital Vienna (star), the capitals of the federal provinces (in parentheses), the neighbouring countries (in italics) and the location of Pöllau (red dot); height scale in m a.s.l. (source: <https://commons.wikimedia.org/wiki/>).



Figure 2. Aerial photograph of the Gruber-Pond with its hinterland (source: <https://www.google.com/maps/>).

wind, between 10:00 and 14:00 CEST (Central European Summer Time). The whole shoreline was surveyed by walking around the pond four times. Surveys concentrated on the detection of teneral, juvenile, and adult odonates and on the observation of reproductive behaviour (mating, tandems, egg deposition). Specimens were identified by sight or from photographs. If individuals had to be caught with a hand net, they were immediately released after identification. A systematic search for exuviae was not carried out but, if found, they were sampled and their species determined.

The numbers of adults recorded per 100 m of shoreline were allocated into a five-class abundance system, in which the different spatial requirements of odonate families were considered (Table 1; Chovanec *et al.*, 2015; Chovanec, 2022a). The abundance data for each species was determined by the largest number of individuals recorded on any one occasion during the investigation period and allotted to one of the five classes. The chronological development of the numbers of individuals was derived from the abundance classes assigned at the different site visits.



Plate 1. The Gruber-Pond showing the densely vegetated area in the southeast region. In the background on the left the swimming pier indicated by an arrow can be seen, 23 July 2023.

Table 1. Allocation of numbers of adult specimens/100 m to abundance classes (I–V).

	Abundance class				
	I Single	II Rare	III Frequent	IV Abundant	V Extra abundant
Zygoptera without Calopterygidae	1	2-10	11-25	26-50	>50
Calopterygidae and Libellulidae	1	2-5	6-10	11-25	>25
Anisoptera without Libellulidae	1	2	3-5	6-10	>10



Plate 2. The Gruber-Pond showing the sparsely vegetated eastern shore with the swimming pier, the open western shore and the large open water area, 23 July 2023.

Following Chovanec (2022a), several criteria were considered to determine certain, probable, or possible evidence of breeding” (see also Schmidt, 1985; Moore & Corbet, 1990; Moore, 1991; Raebel *et al.*, 2010; Wildermuth, 2010; Bried *et al.*, 2015).

- **Certain Breeding** - records of exuviae and/or teneral.
- **Probable Breeding** - observations of reproductive behaviour and/or adults in abundance class $\geq$ III.
- **Possible Breeding** - records of adults at least at two surveys in abundance class I or II but with no reproductive behaviour observed.

In particular, classification of a species as ‘possibly breeding’ was carefully scrutinised if their ecological requirements were at variance with this classification.

The ecological requirements of each species occurring in the Austrian aquatic bioregion ‘Eastern Ridges and Lowlands’ were assessed following Chovanec *et al.* (2015): Species traits were defined by several habitat parameters: fast flowing upstream section, slow-flowing down stream section, flow velocity, standing water, temporary water, size of water body, open water, open banks, submerged macrophytes, reed, and riparian trees. On the basis of the species-specific configurations of these habitat parameters, cluster analysis revealed associations with seven different habitat types:

- **A1** – association with open waters
- **A2** – association with sparsely vegetated banks
- **A3** – association with reed and riparian trees
- **A4** – association with reed and submerged macrophytes
- **A5** – association with temporary waters
- **A6** – association with fast-flowing water and upstream river sections
- **A7** – association with slow-flowing water and downstream river sections

As each species is allocated to only one ecological association, this system is a rather coarse definition of ecological guilds, not entirely reflecting the ecological plasticity of many species. On the one hand, some flowing water species in group A7 (e.g. *Platycnemis pennipes* (White-legged Damselfly), *Orthetrum brunneum* (Southern Skimmer) and *O. coerulescens* (Keeld Skimmer)) also occur in standing waters. Conversely, species with standing water associations can also be found breeding in slow running water (e. g. *Ischnura elegans* (Blue-tailed Damselfly)). *Sympetrum sanguineum* (Ruddy Darter), belonging to A5,

also colonises permanent waters. Information on threats to species were taken from the Styrian Red List of endangered Odonata (Holzinger *et al.*, 2021).

Results

The inventory of species recorded at the Gruber-Pond, with information on abundances, breeding, assignment to ecological groups and conservation classification according to the Red List were determined (Table 2). Detailed results referring to each site visit were also recorded (Tables 3, 4). The survey revealed 22 odonate species (nine damselflies and 13 dragonflies), 18 of which were certainly, probably, or possibly breeding. In seven species, evidence of breeding was confirmed by the presence of exuviae and teneralis.

Twelve species appeared in high abundances; of these, three species were classified in abundance class III, three in abundance class IV and six species in class V. Four of the breeding species are classified as 'Near Threatened' - *Sympecma fusca* (Common Winter Damselfly) (Plate 3), *Cordulia aenea* (Downy Emerald), *Libellula quadrimaculata* (Four-spotted Chaser) and *Orthetrum brunneum* (Plate 4). *Coenagrion scitulum* (Dainty Damselfly) (also breeding) (Plate 5) is classified as 'Vulnerable'. Exuviae were found of both *S. fusca* (one) and *L. quadrimaculata*.

All ecological groups defined for standing waters (A1–A5) were represented by at least one breeding species. Three breeding species are characteristic of open water areas (A1) *Enallagma cyathigerum* (Common Blue Damselfly), *Anax imperator* (Emperor Dragonfly) and *Cordulia aenea* (Downy Emerald)), two breeding species are associated with sparsely vegetated banks (A2) (*Orthetrum cancellatum* (Black-tailed Skimmer) (Plate 6) and *Sympetrum striolatum* (Common Darter)), three breeding species with reed and riparian trees (A3) (*Sympecma fusca*, *Pyrrhosoma nymphula* (Large Red Damselfly) and *Aeshna cyanea* (Southern Hawker)), seven breeding species are associated with reed and submerged macrophytes (A4) (e. g. *Lestes sponsa* (Common Emerald Damselfly), *Coenagrion puella* (Azure Damselfly) (Plate 7), *Crocothemis erythraea* (Scarlet Darter) (Plate 8) and *L. quadrimaculata*, while ecological association A5 was represented by *Sympetrum sanguineum*. At least one species belonging to each of the ecological categories A1, A2, A3, and A4 was 'extremely abundant' (abundance class V). Two species typically associated with slow-flowing rivers (A7) (*Platycnemis pennipes* and *O. brunneum*) were probably breeding at the Gruber-Pond.

The chronology of observations of mature individuals showing sexual and/or reproductive activities (Table 3) allows a coarse classification into winter-,

Table 2. Odonata species recorded at the Gruber-Pond. A1–A7: Assoc., associations with A1 – open waters, A2 – sparsely vegetated banks, A3 – reed and riparian trees, A4 – reed and submerged macrophytes, A5 – temporary waters, A6 – fast-flowing water and A7 – slow-flowing water; RL, Red List of endangered Odonata for Styria: LC, Least Concern; NT, Near Threatened; V, Vulnerable; Ab.C., Abundance Class I–V (see Table 1); Breed., Breeding *** certain, ** probable, * possible.

		Assoc.	RL	Ab.C.	Breed.
Damselflies					
<i>Lestes sponsa</i>	Emerald Damselfly	A4	LC	V	**
<i>Sympecma fusca</i>	Common Winter Damsel	A3	NT	V	***
<i>Calopteryx virgo</i>	Beautiful Demoiselle	A6	NT	I	
<i>Platycnemis pennipes</i>	White-legged Damselfly	A7	LC	II	**
<i>Coenagrion puella</i>	Azure Damselfly	A4	LC	V	***
<i>Coenagrion scitulum</i>	Dainty Damselfly	A4	VU	IV	**
<i>Enallagma cyathigerum</i>	Common Blue Damselfly	A1	LC	V	***
<i>Ischnura elegans</i>	Blue-tailed Damselfly	A4	LC	III	***
<i>Pyrrhosoma nymphula</i>	Large Red Damselfly	A3	LC	I	*
Dragonflies					
<i>Aeshna cyanea</i>	Southern Hawker	A3	LC	II	*
<i>Anax imperator</i>	Emperor Dragonfly	A1	LC	V	***
<i>Onychogomphus forcipatus</i>	Small Pincertail	A7	VU	II	
<i>Cordulia aenea</i>	Downy Emerald	A1	NT	III	**
<i>Crocothemis erythraea</i>	Scarlet Darter	A4	LC	II	**
<i>Libellula depressa</i>	Broad-bodied Chaser	A2	LC	I	
<i>Libellula quadrimaculata</i>	Four-spotted Chaser	A4	NT	IV	***
<i>Orthetrum albistylum</i>	White-tailed Skimmer	A2	NT	I	
<i>Orthetrum brunneum</i>	Southern Skimmer	A7	NT	II	**
<i>Orthetrum cancellatum</i>	Black-tailed Skimmer	A2	LC	IV	**
<i>Sympetrum sanguineum</i>	Ruddy Darter	A5	LC	III	**
<i>Sympetrum striolatum</i>	Common Darter	A2	LC	V	***
<i>Sympetrum vulgatum</i>	Vagrant Darter	A4	LC	II	**

Table 3. Odonata recorded at the Gruber-Pond (Styria, Austria) in 2023 in order of chronological appearance. I–V, Abundance classes of adults (see Table 1); E, exuvia(e) found; T, teneral(s) found; R, observation of reproductive behaviour (copulae and/or tandems and/or egg deposition).

	18	22	10	17	18	9	23	19
	Mar.	May	June	June	June	July	July	Aug.
	2023	2023	2023	2023	2023	2023	2023	2023
<i>Sympecma fusca</i>	II	V/R	II	II	I		E	
<i>Libellula depressa</i>		I						
<i>Pyrrhosoma nymphula</i>		I	I					
<i>Cordulia aenea</i>		III	I		II		I	
<i>Libellula quadrimaculata</i>		II	IV/ETR	IV/E	IV/TR	IV/R	III	
<i>Coenagrion puella</i>		II/R	III/ETR	IV/ER	IV/R	V/R	V/R	IV/R
<i>Ischnura elegans</i>		II	III/ET	II		II	III	II/E
<i>Calopteryx virgo</i>			I			I	I	I
<i>Enallagma cyathigerum</i>			III	IV/ER	V/R	IV/R	V/R	IV/R
<i>Anax imperator</i>			IV/ER	V/ER	V/R	V/R	V/R	IV
<i>Coenagrion scitulum</i>				I	II/R	IV/R	III/R	
<i>Orthetrum cancellatum</i>				II	III/R	IV/R	III	II/R
<i>Sympetrum striolatum</i>				ET	T	ET	ET	V/R
<i>Platycnemis pennipes</i>					I		I	II/R
<i>Orthetrum albistylum</i>						I		
<i>Onychogomphus forcipatus</i>						II		
<i>Orthetrum brunneum</i>						II/R	II/R	
<i>Lestes sponsa</i>						II	V/R	IV/R
<i>Crocothemis erythraea</i>						II/R	II	II
<i>Sympetrum sanguineum</i>						II	III	III/R
<i>Aeshna cyanea</i>								II
<i>Sympetrum vulgatum</i>								II/R

Table 4. Records (in systematic order) made in July 2021, 2022, and 2023. I–V, Abundance classes of adults (see Table 1); E, exuvia(e) found; T, teneral(s) found; R, observation of reproductive behaviour (copulae and/or tandems and/or egg deposition).

	16 July 2021	28-29 July 2022	9 July 2023	23 July 2023
<i>Lestes sponsa</i>	I	II	II	V/R
<i>Sympecma fusca</i>				E
<i>Calopteryx virgo</i>			I	I
<i>Platycnemis pennipes</i>		II/R		I
<i>Coenagrion puella</i>	II/R	II/R	V/R	V/R
<i>Coenagrion scitulum</i>			IV/R	III/R
<i>Enallagma cyathigerum</i>	III	III/R	IV/R	V/R
<i>Ischnura elegans</i>	I	II	II	III
<i>Aeshna cyanea</i>		I		
<i>Anax imperator</i>	II	III/R	V/R	V/R
<i>Onychogomphus forcipatus</i>			II	
<i>Cordulia aenea</i>				I
<i>Crocothemis erythraea</i>	II	II	II/R	II
<i>Libellula quadrimaculata</i>	III/R	II	IV/R	III
<i>Orthetrum albistylum</i>			I	
<i>Orthetrum brunneum</i>		II	II/R	II/R
<i>Orthetrum cancellatum</i>	II	II	IV/R	III
<i>Sympetrum sanguineum</i>		II	II	III
<i>Sympetrum striolatum</i>			ET	ET



Plate 3. Mating pair of *Sympecma fusca*, 22 May 2023.



Plate 4. *Orthetrum brunneum* (male), typically perching on gravel, 28 July 2022. As in the male *O. cancellatum* depicted on Plate 6, this specimen shows the four-leg perching, which is characteristic of *Libellula* spp. and *Orthetrum* spp. (Chovanec, 2018).



Plate 5. *Coenagrion scitulum* in the tandem position, 18 June 2023.



Plate 6. Strong thoracic pruinescence in *Orthetrum cancellatum* (male), typically perching on gravel (see Chovanec, 2021, 2023a), 19 August 2023.



Plate 7. Mating *Coenagrion puella*, 18 June 2023. Both individuals are infested by larvae of the water mite *Arrenurus* sp. The arrow indicates a terrestrial mite attached to the left hind leg of the female (see also Wildermuth et al., 2015).



Plate 8. *Crocothemis erythraea* (male), 16 July 2021.

spring-, early summer-, and high summer/autumn-species. Apart from the winter-species *S. fusca*, the data show a cluster of spring-species, with first records in May consisting of *Libellula depressa* (Broad-bodied Chaser), *P. nymphula*, *C. aenea*, *L. quadrimaculata*, *C. puella* and the first generation of *Ischnura elegans*. The group consisting of *E. cyathigerum*, *Anax imperator*, *C. scitulum*, *O. cancellatum* and *P. pennipes*, which first appeared in June, can be classified as early summer-species. This phenological group is followed by high summer-autumn-species with the first adults recorded in July or later, comprising *S. striolatum*, *O. brunneum*, *L. sponsa*, *C. erythraea*, *S. sanguineum*, *A. cyanea*, *Sympetrum vulgatum* and the second generation of *I. elegans*. Exuviae of *S. striolatum* were found in June, July and August, while those of *I. elegans* were found in June and again in August. The most obvious differences between the observations made in July 2023 and those made in July 2021 and July 2022 are the absence of records of *C. scitulum* and *S. striolatum* in those two years and of the presence of exuviae and teneral of *S. striolatum*, followed by a large number of adults, in August in 2023 (Table 4). An interspecific tandem between a male *S. sanguineum* and a female *S. striolatum* was observed on 19 August 2023.

Discussion

The number of odonate species recorded at the Gruber-Pond corresponds to 28% of the Austrian and to 34% of the Styrian species. The high numbers of species and of individuals occurring at this man-made pond can be explained by several factors. The large size of the pond allows a wide variety of habitat. Management measures are regularly carried out to prevent the dominance of single plant species and the expansion of macrophytes into the bathing area and to the open shore, thus guaranteeing a balanced availability of the different habitat types over time and thus a constantly high number of species (see also Janssen *et al.*, 2018; Kietzka *et al.*, 2021). In contrast, Chovanec (2023b) showed a decrease in the number of breeding odonate species recorded at a rapidly overgrown small wetland. The Gruber-Pond and its sunbathing lawn are sunny and the pond's hinterland provides enough near-natural space, e.g. for shelter, maturation and hunting (see also Moore, 1991; Yamaguchi, 1975; Goertzen & Suhling, 2003; Kadoya *et al.*, 2004; Raebel *et al.* 2012; Simaika *et al.*, 2016; Vilenica *et al.* 2020; Deacon *et al.*, 2023). As indicated by the large number of species listed in the Red List for Styria, the pond provides a suitable habitat not only for generalist and common species but also for specialist and endangered species (Steytler & Samways, 1995; Pinilla-Rosa *et al.*, 2023).

The presence of odonate species occupying several ecological guilds (associations) indicates the availability of various habitat types, providing different

ecological niches. As well as the breeding species *Orthetrum cancellatum* and *Sympetrum striolatum*, the non-breeding *Libellula depressa* and *Orthetrum albistylum*, are 'pioneer species' (A2), preferring open or sparsely vegetated banks (Chovanec *et al.*, 2015). Apart from the fast-flowing upstream riverine species, each ecological guild is represented by at least one breeding species. *Platycnemis pennipes* and *Orthetrum brunneum* (A7), which are associated with slow-flowing rivers, also breed in suitable standing waters and probably breed at the Gruber-Pond. Although single individuals of the riverine species *Calopteryx virgo* (A6) were observed on four separate occasions, the species was not classified as possibly breeding due to the absence of its ecological requirements at the Gruber Pond. Specimens of *Calopteryx virgo* were visitors from the nearby fast-flowing Pöllauer Saifen river, where the species occurs in high abundance (Chovanec, 2023c). *Onychogomphus forcipatus* (A7) prefers rivers but may also successfully breed in lakes and even in small gravel pits (Weihrauch, 1998, 2001; Wildermuth & Martens, 2019). As two males of this species were observed on only one visit to the Gruber-Pond, *O. forcipatus* was classified as not breeding at this site. This species is a quite common and widespread dragonfly in most of Europe. In the north, its range extends to southern Fennoscandia (Dijkstra *et al.*, 2020). Its larvae inhabit sediments of sand and fine gravel (Suhling & Müller, 1996). As in the case of *C. virgo*, these specimens probably came from a large population inhabiting the Pöllauer Saifen river (Chovanec, 2023c).

The records of *Coenagrion scitulum* in abundance class IV should be highlighted as this species usually occurs in small numbers in Austria (Chovanec & Schaufler, 2023). In the year 1971, only one record of this species was recorded for Styria (Stark, 1971). Higher temperatures due to climate change have favoured the expansion of *C. scitulum* in Austria and throughout Europe (Dijkstra *et al.*, 2020; Chovanec & Schaufler, 2023). *Coenagrion scitulum* was found only in 2023 at the Gruber-Pond (Table 4). However, in 2022, the date of the site visit was probably too late to find this species since its flight period often finishes at the end of July (Chovanec & Schaufler, 2023). In 2021, the species was not recorded at the pond but possibly may have been overlooked due to low numbers of individuals.

Some decades ago, Central Europe represented the northern border of the distribution of two Mediterranean species, *Crocothemis erythraea* and *O. brunneum* (Askew, 1988). Today, both species have significantly expanded their ranges (Ott, 2010; Wildermuth & Martens, 2019; Dijkstra *et al.*, 2020) and are now common in the lowlands of Austria and breed at the Gruber-Pond. In the UK, where it was first recorded in 1995, *C. erythraea* is a rare migrant, with most records from the Channel Islands and the south of England (Parr, 2020, 2021). *Orthetrum brunneum* is a pioneer species preferring standing waters and slow

flowing rivers with little vegetation in their early successional stages (Chovanec, 2018, 2023b).

The records of *Ischnura elegans* as late as August in 2023 and the finding of an exuvia of the species on 19 August suggest a second generation in this year. Bivoltine development is fairly common in *Ischnura* ssp. in low altitudes in Central Europe and is favoured by higher temperatures due to climate change (Inden-Lohmar, 1997; Chovanec, 2023b).

A few specimens of *Sympecma fusca* were recorded on 18 March 2023, the maximum abundance (abundance class V) was reached in May and the flight period lasted until the second week of June. An exuvia found on 23 July confirmed the successful development of the 2023/2024 generation. This species is found in southern and central Europe, extending as far north as southern Sweden and reaching into central Asia (Dijkstra *et al.*, 2020). It overwinters as an adult, preferably in the stalks of dried grass. It was seen in Britain in 2008 (Parr, 2009). Most pairing occurs in this species in April and May. Development takes between two and three months in the aquatic stage.

During the visits on 17 June, 18 June, 9 July and 23 July 2023, exuviae and teneral adults of *S. striolatum* were found. The maturation period is defined as the time between records of the first teneral adults and the first adults at a water body. As no mature adults were recorded until 19 August, the maturation period lasted at least five weeks in 2023. According to the literature, in *S. striolatum* this period typically lasts between three and six weeks but, in hot summers, it can be extended to eight weeks (Sternberg, 2000; Horne, 2012; Wildermuth & Martens, 2019). Heterospecific pairing attempts, particularly between *Sympetrum* spp., are well documented (Bick & Bick, 1981; Corbet, 1999; Chovanec, 2017) and an interspecific tandem between a male *Sympetrum sanguineum* and a female *S. striolatum* was recorded in the current study. In contrast to *S. sanguineum* (abundance class III), *S. striolatum* occurred in class V at the pond. The higher availability of *S. striolatum* females may have had a stimulating effect on the male of *S. sanguineum* to grasp a female of rather similar appearance (Chovanec, 2022b). The opportunistic mating behaviour of *Sympetrum* spp. males is discussed by Corbet (1999).

Detailed phenological patterns can be extracted from sampling designs with high numbers of site visits (e. g. Chovanec, 2023b) with systematic sampling of exuviae included. The present study allowed only a rough assessment of phenological groups, primarily based on the records of adults and reproductive activities (Schmidt, 1985). However, the results are, to a large extent, in line with those of other data on Odonata phenology (Schmidt, 1985; Moore, 1991; Chwala & Waringer, 1996; Laister, 1996; Chovanec, 1998; 2023b).

Unlike most other animal groups, odonates provide the opportunity to observe adult behavioural patterns without large effort from the observer. Therefore, odonates can play an important role in environmental education, nature awareness projects and ecotourism (Primack *et al.*, 2000; Suh & Samways, 2001; Lemelin, 2007, 2009; Kietzka *et al.*, 2021, Dillon *et al.*, 2023). Due to its accessibility and the high number of species belonging to different ecological guilds, the Gruber Pond provides a suitable site for such programmes. On 10 June 2023, a first step towards this was carried out with a field trip to the pond as part of a one-day seminar on Odonata held by the author and organised by the Nature Protection Academy of Styria. The installation of information boards dealing with the dragonflies appearing at the pond and their ecology is recommended.

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References

- Askew, R.R. 1988. *The Dragonflies of Europe*. Harley Books, Colchester, UK. 291 pp.
- Bick, G.H. & Bick, J.C. 1981. Heterospecific pairing among Odonata. *Odonatologica* **10**: 259-270.
- Blyth, C. 2014. Colonisation of a new pond: new habitat for *Coenagrion hastulatum* (Charpentier) (the Northern Damselfly) and other odonate species at a site in Aberdeenshire. *Journal of the British Dragonfly Society* **30**: 1-8.
- Bried, J.T., Dillon, A.M., Hager, B.J., Patten, M.A. & Luttbeg, B. 2015. Criteria to infer local species residency in standardized adult dragonfly surveys. *Freshwater Science* **34**: 1105-1113.
- Buczyński, P. 2015. *Dragonflies (Odonata) of anthropogenic waters in middle-eastern Poland*. Gutgraf, Olsztyn. 272pp.
- Chovanec, A. 1998. The composition of the dragonfly community (Insecta: Odonata) of a small artificial pond: seasonal variations and aspects of bioindication. *Lauterbornia* **32**: 1-14.
- Chovanec, A. 2017. Interspezifische Paarungsversuche unterschiedlicher Libellenarten (Odonata). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* **68**: 91-94.

- Chovanec, A. 2018. Beobachtungen zum Sitzverhalten des Südlichen Blaupfeils (*Orthetrum brunneum*) und anderer Libellulinae (Odonata: Libellulidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* **70**: 9-18.
- Chovanec, A. 2021. Variationen der Bereifung beim Großen Blaupfeil, *Orthetrum cancellatum* (Linnaeus, 1758) (Odonata: Libellulidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* **73**: 1-17.
- Chovanec, A. 2022a. The assessment of the dragonfly fauna (Insecta: Odonata) as a tool for the detailed typological characterisation of running waters. *Acta ZooBot Austria* **158**: 129-147.
- Chovanec, A. 2022b. Erstmalige Dokumentation eines Paarungsversuches zwischen einem Männchen von *Orthetrum brunneum* und einem Weibchen von *Orthetrum albistylum* (Odonata: Libellulidae). *Mercuriale* **22**: 71-82.
- Chovanec, A. 2023a. Studying pruinescence in males of Black-tailed Skimmer and Keeled Skimmer. *Dragonfly News* **83**: 31.
- Chovanec, A. 2023b. Succession of the Odonata fauna at a small wetland in an overflow and seepage reservoir: results of a six year study. *Reports of the International Dragonfly Fund* **182**: 1-62.
- Chovanec, A. 2023c: *Libellen in Pöllau (Oststeiermark)*. Unpublished Project Report commissioned by the Naturpark Pöllauer Tal, Pöllau, Austria. 47 pp.
- Chovanec, A. & Raab, R. 1997. Dragonflies (Odonata, Insecta) and the ecological status of newly created wetlands - examples for long-term bioindication programmes. *Limnologia* **27**: 381-392.
- Chovanec, A. & Schaufler, K. 2023. Zwei individuenreiche Vorkommen von *Coenagrion scitulum* (Rambur, 1842) (Odonata: Coenagrionidae) in Niederösterreich, mit erstmaliger Dokumentation des Befalls durch *Limnochares aquatica* (Linnaeus, 1758) (Acari: Limnocharidae) sowie eines homospezifischen Triple-Tandems. *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* **75**: 145-165.
- Chovanec, A., Schindler, M., Waringer, J. & Wimmer, R. 2015. The Dragonfly Association Index (Insecta: Odonata) – a tool for the type-specific assessment of lowland rivers. *River Research and Applications* **31**: 627-638.
- Chwala, E. & Waringer, J. 1996. Association patterns and habitat selection of dragonflies (Insecta: Odonata) at different types of Danubian backwaters at Vienna, Austria. *Archiv für Hydrobiologie Supplement* **115** / *Large Rivers* **11**: 45-60.
- Corbet, P. 1999. *Dragonflies – Behaviour and Ecology of Odonata*. Harley Books, Colchester. 829 pp.
- Deacon, C., Samways M.J. & Pryke, J.S. 2023. Interplay between pond size and matrix extent drives odonate diversity patterns in a fragmented landscape. *Biodiversity and Conservation* **32**: 4767-4785.
- De Paz, V., Baños-Picón, L., Rosas-Ramos, N., Tobajas, E., Tormos, J. & Asís, J.D. 2021. The role of artificial ponds in maintaining dragonfly populations in an intensified farmland landscape. A case of study in Zamora, Spain. *Journal of Natural History* **54**: 37-38, 2439-2454.
- Dijkstra, K.-D.B., Schröter, A. & Lewington, R. 2020. *Field guide to the dragonflies of*

- Britain and Europe. Second Edition. Bloomsbury Wildlife, London. 336 pp.
- Dillon, A., Simaika, J., Clausnitzer, V., Thompson, A., White, E., Montes-Fontalvo, J., Goforth, C. & Khelifa, R. 2023. *Bridging people and nature through Odonata*. In: *Dragonflies and Damselflies. Second Edition* (eds. A. Córdoba-Aguilar, C.D. Beatty & J.T. Bried). Oxford, University Press. 413-426.
- Goertzen, D. & Suhling, F. 2013. Promoting dragonfly diversity in cities: major determinants and implications for urban pond design. *Journal of Insect Conservation* **17**: 399-409.
- Hassall, C. 2015. Odonata as candidate macroecological barometers for global climate change. *Freshwater Science* **34**: 1040-1049.
- Hassall, C. & Thompson, D.J. 2008. The impacts of environmental warming on Odonata: a review. *International Journal of Odonatology* **11**: 131-153.
- Holzinger, W.E., Kerschbaumsteiner, H. & Komposch B. 2021. *Libellen (Odonata)*. In: *Rote Listen der Tiere der Steiermark, Teil 2B Tiergruppenbearbeitungen* (Ökoteam). Unpublished Project Report commissioned by the Österreichische Naturschutzjugend Landesgruppe Steiermark. Financed by the Province of Styria and die European Union, Programme LE **14-20**: 55-69.
- Horne, J. 2012. Emergence, maturation time and oviposition in the Common Darter *Sympetrum striolatum* (Charpentier). *Journal of the British Dragonfly Society* **28**: 66-74.
- Ilies, J. 1978. *Limnofauna Europaea*. Fischer, Stuttgart. 552 pp.
- Inden-Lohmar, C. 1997. Nachweis einer zweiten Jahresgeneration von *Ischnura elegans* (Vander Linden) und *I. pumilio* (Charpentier) in Mitteleuropa (Zygoptera: Coenagrionidae). *Libellula* **16**: 1-15.
- Janssen, A., Hunger, H., Konold, W., Pufal, G. & Staab, M. 2018. Simple pond restoration measures increase dragonfly (Insecta: Odonata) diversity. *Biodiversity and Conservation* **27**: 2311-2328.
- Kadoya, T., Suda, S. & Washitani, I. 2004. Dragonfly species richness on man-made ponds: effects of pond size and pond age on newly established assemblages. *Ecological Research* **19**: 461-467.
- Kietzka, G.J., Pryke, J.S., Gaigher, R. & Samways, M.J. 2021. 32 years of essential management to retain value of an urban dragonfly awareness pond. *Urban Ecosystems* **24**: 1295-1304.
- Laister, G. 1996. Bestand, Gefährdung und Ökologie der Libellenfauna der Großstadt Linz. *Naturkundliches Jahrbuch der Stadt Linz* **40/41**: 9-305.
- Lemelin, R.H. 2007. Finding beauty in the dragon: the role of dragonflies in recreation and tourism. *Journal of Ecotourism* **6**: 139-145.
- Lemelin, R.H. 2009. Goodwill hunting: dragon hunters, dragonflies and leisure. *Current Issues in Tourism* **12**: 235-253.
- Maynou, X., Martín, R. & Aranda, D. 2017. The role of small secondary biotopes in a highly fragmented landscape as habitat and connectivity providers for dragonflies (Insecta: Odonata). *Journal of Insect Conservation* **21**: 517-530.
- Moore, N.W. 1991. The development of dragonfly communities and the consequences

- of territorial behaviour: a 27 year study on small ponds at Woodwalton Fen, Cambridgeshire, United Kingdom. *Odonatologica* **20**: 203-231.
- Moore, N.W. & Corbet, P.S. 1990. Guidelines for monitoring dragonfly populations. *Journal of the British Dragonfly Society* **6**: 21-23.
- Ott, J. 2010. Dragonflies and climatic change – recent trends in Germany and Europe. *BioRisk* **5**: 253-286.
- Parr, A.J. 2009. Migrant and dispersive dragonflies in Britain during 2008. *Journal of the British Dragonfly Society* **25**: 94-99.
- Parr, A.J. 2020. Migrant and dispersive dragonflies in Britain during 2019. *Journal of the British Dragonfly Society* **36**: 67-83.
- Parr, A.J. 2021. Migrant and dispersive dragonflies in Britain during 2020. *Journal of the British Dragonfly Society* **37**: 69-81.
- Pinilla-Rosa, M., García-Saúco, G., Santiago, A., Ferrandis, P. & Méndez, M. 2023. Can botanic gardens serve as refuges for taxonomic and functional diversity of Odonata? The case of the botanic garden of Castilla–La Mancha (Spain). *Limnology* **24**: 37-50.
- Primack, R., Kabori, H. & Mori, S. 2000. Dragonfly pond restoration promotes conservation awareness in Japan. *Conservation Biology* **14**: 1553-1554.
- Raebel, E.M., Merckx, T., Feber, R.E., Riordan, P., Macdonald, D.W. & Thompson, D.J. 2012. Identifying high-quality pond habitats for Odonata in lowland England: implications for agri-environment schemes. *Insect Conservation and Diversity* **5**: 422-432.
- Raebel, E.M., Merckx, T., Riordan, P., Macdonald, D.W. & Thompson, D.J. 2010. The dragonfly delusion: why it is essential to sample exuviae to avoid biased surveys. *Journal of Insect Conservation* **14**: 523-533.
- Schmidt, E.G. 1985. Habitat inventarization, characterization and bioindication by a “Representative Spectrum of Odonata Species (RSO)”. *Odonatologica* **14**: 127-133.
- Simaika, J.P., Samways, M.J. & Frenzel, P.P. 2016. Artificial ponds increase local dragonfly diversity in a global biodiversity hotspot. *Biodiversity and Conservation* **25**: 1921-1935.
- Stark, W. 1971. Faunistische Nachrichten aus Steiermark (XVI/8): Bemerkenswerte Libellenfunde (Insecta, Odonata). *Mitteilungen des naturwissenschaftlichen Vereins für Steiermark* **100**: 450-453.
- Sternberg, K. 2000. *Sympetrum striolatum* (Charpentier, 1840) Große Heidelibelle. In: *Die Libellen Baden-Württembergs. Band 2* (eds. K. Sternberg & R. Buchwald). Ulmer, Stuttgart. pp 602-616.
- Steytler, N.S. & Samways, M.J. 1995. Biotope selection by adult male dragonflies (Odonata) at an artificial lake created for insect conservation in South Africa. *Biological Conservation* **72**: 381-386.
- Suh, A.N. & Samways, M.J. 2001. Development of a dragonfly awareness trail in an African botanical garden. *Biological Conservation* **100**: 345-353.
- Suhling, F. & Müller, O. 1996. *Die Flußjungfern Europas*. Die Neue Brehm-Bücherei Bd. 628, Westarp Wissenschaften, Magdeburg. 237 pp.
- Vilenica, M., Pozojević, I., Vučković, N. & Mihaljević, Z. 2020. How suitable are man-made water bodies as habitats for Odonata? *Knowledge & Management of Aquatic Ecosystems* **421**: 13.

- Weihrauch, F. 1998. Die Entwicklung von *Gomphus vulgatissimus* (L.) in Kiesgrubengewässern: seltene Ausnahme oder lediglich übersehen? (Anisoptera: Gomphidae). *Libellula* **17**: 149-161.
- Weihrauch, F. 2001. Entwicklung von *Onychogomphus f. forcipatus* in einem Kleingewässer (Odonata: Gomphidae). *Libellula* **20**: 149-154.
- Wildermuth, H. 2010. Monitoring the effects of conservation actions in agricultural and urbanized landscapes – also useful for assessing climate change? *BioRisk* 5: 175-192.
- Wildermuth, H. & Martens, A. 2019. *Die Libellen Europas. Alle Arten von den Azoren bis zum Ural im Porträt*. Quelle & Meyer, Wiebelsheim. 958 pp.
- Wildermuth, H., Roland, H.-J. & Hein, A.T. 2015. Landmilben als Libellenparasiten – bisher bekanntes Wirtsspektrum in Europa (Acari: Prostigmata; Odonata). *Libellula* **34**: 103-115.
- Wimmer, R., Wintersberger, H. & Parthl, G. 2012. *Hydromorphologische Leitbilder – Fließgewässertypisierung in Österreich*. Federal Ministry of Agriculture and Forestry, Environment and Water Management, Vienna. 4 Volumes 44+160+30+39 pp.
- Yamaguchi, M. 1975. The Odonate fauna established at an artificially prepared pond in Heirinji Temple Forest. *Tombo* **XVIII**: 21-22.

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An investigation of dragonfly larval development time using newly-created garden ponds

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Summary

Final stage larval exuviae of 57 *Pyrrhosomsa nymphula* (Large Red Damselfly) and 11 *Libellula depressa* (Broad-bodied Chaser) were recorded during spring 2023 at six garden ponds from different addresses in St Albans, Hertfordshire. As all the ponds had been newly created since November 2021, it was possible to demonstrate that both species had completed larval development within one-year, rather than the two-years often quoted in the literature. This suggests an accelerated developmental rate in response to climate warming.

Introduction

Dragonflies are known to accelerate their larval development rate and generation times as temperature increases (Corbet, 1999). For example, species such as *Ischnura elegans* (Blue-tailed Damselfly), which typically completes a generation in one year in southern England, may take two years to complete development in Scotland, whereas in southern Europe it may have two generations (or more) in a single year (Brooks *et al.*, 2014; Dijkstra *et al.*, 2020). In the present conditions of continuing climate-warming we might expect some species in Britain to reduce their generation times from two years to one year. This can be difficult to demonstrate but one way to do this is to record dragonfly species emerging from newly-created ponds during the pond's second summer.

Methods

In St Albans, Hertfordshire, the Herts & Middx Wildlife Trust have been encouraging householders to dig ponds in their gardens (Plates 1 & 2). A neighbourhood WhatsApp group was set up by Nadia Bishara to include people who had dug garden ponds between November 2021 and November 2022 and to record the dragonflies emerging from their ponds during 2023. Any such dragonflies must have developed from eggs laid in 2022 and completed their life cycle within one year. Including the author, there were six people with



Plate 1. Pond 1 from which six *Pyrrhosoma nymphula* and three *Libellula depressa* emerged after one year.

new ponds who took part in the project. Participants were asked to upload photographs of exuviae they found by their ponds, which the author then identified. In some cases, identifications were confirmed from exuviae collected from participant's ponds. It was particularly interesting to see if any individuals of *Pyrrhosoma nymphula* (Large Red Damselfly) or *Libellula depressa* (Broad-bodied Chaser) emerged after just one year, since both of these species are typically early colonisers of new garden ponds and might be expected to have a larval development time of two years (Brooks *et al.*, 2014). Participants confirmed that plants put into their newly created ponds were sourced from garden centres as small plugs and thus they were unlikely to have introduced any dragonfly larvae.



Plate 2. Pond 5 from which three *Pyrrhosoma nymphula* and three *Libellula depressa* emerged after one year.

Results

Both *Pyrrhosoma nymphula* and *Libellula depressa* were observed to oviposit into the author's pond during its first summer in 2022. From the six newly-created ponds in different parts of St Albans a total of 57 final stage larval exuviae of *P. nymphula* were recorded between 2 May 2023 and 12 June 2023, thus confirming a one-year development time for this species. From three of these ponds a total of 11 final stage larval exuviae of *L. depressa* were recorded between 24 May and 2 July 2023, confirming a one-year development time for this species as well (Table 1). From the author's pond the emergence of three Broad-bodied Chasers were recorded, but it was interesting to note the presence of at least two half-grown larvae of this species in late-summer 2023. These larvae must have hatched from eggs laid in 2022 but were insufficiently developed to emerge during 2023 and will presumably take at least two years to complete development.

Discussion

These results demonstrate that both *Pyrrhosoma nymphula* and *Libellula depressa* can complete larval development within one year in this part of south-east England, rather than the two years often quoted in the literature. This suggests an accelerated developmental rate in response to climate warming.

Table 1. Number of *Pyrrhosoma nymphula* and *Libellula depressa* emerging during summer 2022 from six ponds that had been dug since November 2021.

	<i>Pyrrhosoma nymphula</i>	<i>Libellula depressa</i>
Pond 1	6	3
Pond 2	18	0
Pond 3	2	5
Pond 4	20	0
Pond 5	3	3
Pond 6	8	0
TOTAL	57	11

The study also shows the benefits of engaging with local groups of wildlife enthusiasts through social media to participate in simple but informative citizen science projects. The participants were keen to engage in a science-based project with an easily understandable objective and they were pleased that their new ponds were of wider interest, and they were also interested to learn more about dragonflies. The project could be further expanded on a national basis using similar methods to establish the latitude at which the life cycle of *Pyrrhosoma nymphula* and *Libellula depressa* switches from one year to two years. Furthermore, if the study was continued as a rolling programme it might be possible to establish the rate of northward movement of this latitudinal boundary.

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References

Brooks, S.J., Cham, S. & Lewington, R. 2014. *Field Guide to the Dragonflies and Damselflies of Great Britain and Ireland*. 5th ed. Bloomsbury Wildlife, London. 192 pp.

- Corbet, P.S. 1999. *Dragonflies: Behaviour and Ecology of Odonata*. Harley Books Colchester. 829 pp.
- Dijkstra, K-D. B., Schroter, A. & Lewington, R. 2020. *Field Guide to the Dragonflies of Britain and Europe*. Bloomsbury Wildlife, London. 336 pp.

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Calopteryx virgo (Linnaeus), The Beautiful Demoiselle – a species with royal connections

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Summary

The names, both common and scientific, given to the damselfly species *Calopteryx virgo* in Sweden and England in the 18th or early 19th century are discussed. All are somehow linked to royalty, either originating from Carl Linnaeus' early admiration of the young princess Louisa Ulrika, or from the similarity of the dark-blue wing colour of male *C. virgo* to the plumage of a kingfisher or the Windsor uniform.

Introduction

Males of the striking *Calopteryx virgo* (Beautiful Demoiselle) are gorgeous insects, presenting a dazzling sight as they flutter and dance in sunny patches over clear, sandy-bottomed forest streams. Little wonder that this beautiful species (Plate 1) was the first odonate to be given common names. This occurred both in Sweden and in England as early as in the 18th century. Interestingly, these names were all linked to royalty in one way or another. Also, the scientific species epithet, *virgo* (Latin for 'virgin'), of this damselfly may have its origin in its author's early admiration of a Prussian princess, whose name is also immortalized in synonymous scientific names given both to *Calopteryx virgo* and also to the related *Calopteryx splendens* (Banded Demoiselle).

Nomenclatorial consequences of the admiration of Carl Linnaeus (Carl von Linné) for Louisa Ulrika, the Princess of Prussia

In the summer of 1744, great excitement gripped high and middle-class society in Sweden. On the 17th of July the Swedish Crown Prince Adolf Fredrik was married *per procura* (i.e. with the groom absent) to Louisa Ulrika (Lovisa Ulrika in Swedish), Princess of Prussia in Berlin (Plate 2). A few weeks later the beautiful and accomplished, 24 year-old princess arrived in Sweden to meet



Plate 1. *Calopteryx virgo* (Beautiful Demoiselle) male as illustrated in Charpentier (1840).

her groom. Among those caught up in the fever of the occasion was the 37 year-old Carl Linnaeus, professor of medicine at Uppsala University (Plate 3). At that time, he was writing the manuscript of *Fauna svecica*, a synopsis of the 1357 animal species known to him from Sweden, published in 1746 (Linnaeus, 1746). He had not yet developed his system of binomial nomenclature, but each species was provided with a diagnosis of at most a dozen Latin words following the genus name. In addition, in the species accounts of 43 invertebrates (mostly butterflies and moths), Linnaeus also provided a so-called 'vulgar' name (the vulgo) intended for everyday use. Two types of dragonfly were dubbed 'Lovisa' and 'Ulrica' (Plate 4) in honour of the Princess. These 'species' represent respectively the male and female of *Calopteryx virgo* (Beautiful Demoiselle). This dedication was the first of its kind to an individual person in the animal names used by Linnaeus. It is noteworthy that, rather than selecting a butterfly species for his dedication, he chose this gorgeous and delicately charming demoiselle damselfly, which perhaps best embodies those qualities he admired in the princess.



Plate 2. Princess Louisa Ulrica of Prussia.



Plate 3. Carl Linnaeus as a young man.

757. **LIBELLULA** corpore cæruleo nitido; alis viridi-cærulefcentibus: apice fufcis: margine immaculatis.

Raj. inf. p. 50. n. 10. Libella media, corpore cæruleo, alis fere totis ex cæruleo nigricantibus.

Vulgo Lovifa.

Habitat ad Fluvios.

DESCR. Magnitudo, figura, color, locus & omnia, ut in præcedenti, ted alæ, quæ etiam puncto marginali carent, nigro-cærulefcentes: apice pallide fufcæ. *cauda* unguiculata.

758. **LIBELLULA** corpore viridi-cæruleo; alis subfufcis: puncto marginali albo.

Raj. inf. 51. n. 12. Libella media, corpore viridi, alis fulvefcentibus maculis parvis albis prope extremum angulum.

Vulgo Ulrica.

Habitat ad Fluvios.

DESCR. Mediæ eft magnitudinis. *Corpus* viridi-sericeum, nitidum, minime cæruleum. *Pedes* nigri. *Alæ* subfufcæ puncto marginali albicante oblongo; *Cauda* inermis.

Hæc præcedentis fæmina. *De Geer.*

Plate 4. The names Lovisa and Ulrica introduced in Linnaeus' *Fauna svecica* (1746).

In the second edition of *Fauna svecica* (Linnaeus, 1761) the names 'Lovisa' and 'Ulrica', along with the other 'vulgo' names, were omitted, since they had become redundant with the development of a universal Latinised binomial nomenclature, which Linnaeus used for all organisms in his 10th edition of *Systema naturæ* (Linnaeus, 1758), which now serves as the starting point for zoological nomenclature. In this publication, Linnaeus gave the binomial name *Libellula virgo* for the four 'forms' of the demoiselle damselflies which he had earlier recognized as separate species. However, his four forms included two distinct species, presently known as *Calopteryx virgo* and *C. splendens* (Banded Demoiselle). It is likely that the choice of the species epithet *virgo* was (at least partly) influenced by Linnaeus' early admiration for Louisa Ulrika, who had meanwhile (on 25 March 1751) become Queen consort of Sweden. This view is supported by the fact that in the 6th edition of *Systema naturæ* (Linnaeus, 1748), soon after the vulgo names honouring the princess had been introduced, Linnaeus applied the Swedish name 'Jungfrur' (= virgins) for the 'Libellula' forms which he later recognised as a single species *Libellula virgo*.

It might have been that the scientific name of the Banded Demoiselle was also honoured by being connected to Louisa Ulrika. In 1785, the French chemist Antoine François de Fourcroy (who was ennobled as the Comte de Fourcroy on the very day he died on 16 December 1809) introduced the name *Libellula ludovicea* (Fourcroy, 1785) for the same demoiselle species which the English entomologist and illustrator Moses Harris had described as *Libellula splendens* [= *Calopteryx splendens*] five years earlier in 1780 (Harris, 1776-1780).

Ludovica is the Latin counterpart of the name Louisa. Rather confusingly, in 1836, the English entomologist James Francis Stephens (Stephens, 1835-1837), described a species as *Calepteryx* [the original spelling of the genus name] *ludoviciana*, which, however, is just a synonym of *Calopteryx virgo*. Similarly, as with the epithet *ludovicea*, *ludoviciana* also relates in a convoluted way, to the Linnean vulgar name 'Lovisa'. For further details of the origin of these two names, see the recent publication (Hämäläinen & Fliedner (2022) on the etymology of the scientific names of demoiselle damselflies (Calopterygidae) of the world.

King's-fisher and King George – early English common names for the Demoiselles

In his book *An exposition of English insects* (Harris, 1776-1780), Moses Harris provided two of his new species, *Libellula splendens* [= *Calopteryx splendens*] and *Libellula splendeo* [= *Calopteryx virgo*] with an English name 'King's-fisher'. Harris wrote in his *splendeo* [*virgo*] account (published in 1780): "These and the former, on account of their brilliancy and richness of colours, are vulgarly called King's-fishers. They frequent little rivulets, or ditches of running water, that are over-shaded with bushes by bank-sides."

It is uncertain whether Harris himself coined this name or if it was already in use. In any case the striking blue glimpses of the fluttering males of these insects resemble the blue iridescence of *Alcedo atthis* (kingfisher) which share the same habitats. It is unclear why this colourful bird became known as the 'kingfisher' (originally King's fisher), but it has been speculated (Richter, undated website) that it may reflect the blue and orange colours in the tomb effigies of the English 12th century kings Henry II and Richard I at the Fontevraud Royal Abbey in France.

Somewhat later, the bluish winged *Calopteryx virgo* acquired another English vernacular name 'King George'. This name was an allusion to the dark-blue 'Windsor uniform' favoured by King George III (1738-1820), the colour of which resembled that of the male wings of this damselfly (Plate 5). This style of dress



Plate 5. King George III wearing the 'Windsor uniform'.

was introduced in 1777 and it was intended to be worn at Windsor only, but later the king wore it regularly in casual everyday use. Due to this, cartoonists such as James Gillray started to illustrate the king in this costume, making him instantly recognisable. This damselfly name may have originated in the 1790s or 1800s.

In his anonymously published *An illustrated handbook of British dragonflies* (Harcourt-Bath, 1890), William Harcourt-Bath wrote: "In France *C. virgo* and *splendens* have received the name of 'Demoiselles' or young ladies, while in our own country they are often called 'King George's' and 'Kingfishers' in allusion to their brilliancy and richness of colour." In 1900, in the introduction of his seminal book *British Dragonflies* (Odonata), William John Lucas wrote: "Such is the home of the gorgeous blue-winged 'Demoiselle' or 'King George' (*Calopteryx virgo*), without doubt the most resplendent of our Dragonflies, if not of all British insects. Handsome enough it looks in the cabinet; but to be seen at its best it must be watched as it flutters along the streams in the patches of

sunlight that filter through the foliage, and in which its colours vie with those of the kingfisher, whose lovely haunts it shares.” (Lucas, 1900). A few years later, in his well-known ‘country-side’ book *Hampshire days*, William Henry Hudson wrote on the dragonflies: “Is it not amazing that these familiar, large, showy, and striking-looking insects have no common specific names with us? The one exception known to me is the small beautiful *virgo* just spoken of, and this is called in books ‘Demoiselle’ and ‘King George’, but whether these names are used by the people anywhere or not, I am unable to say.” (Hudson, 1903).

I am not sure whether Lucas, (who did not provide common English names for other dragonfly species), was the first British author to call *Calopteryx virgo* a ‘demoiselle’. Later, Cynthia Longfield, who coined “popular” names for each species in her book *The Dragonflies of the British Isles* (Longfield, 1937) called *C. virgo* ‘The Demoiselle Agrion’, whereas *C. splendens* was called ‘The Banded Agrion’. None of Longfield’s names combining English words with a name in another language have survived, but many of her purely English common names became established and are used today. Before Longfield, an unknown person had already coined common names for all British dragonfly species, which were used in the cabinet labels in the insect collections of the Grosvenor Museum at Chester (Gabb, 1988). The two demoiselle species were labelled ‘Steel-blue Demoiselle’ (*C. virgo*) and ‘Blue-banded Demoiselle’ (*C. splendens*).

However, as pointed out by Norman Moore (Corbet, Longfield & Moore, 1960), none of the common English species names in use today are real vernacular ‘naturalist’s’ names: “Only one species of British dragonfly has acquired a naturalist’s name. It is *Agrion* [= *Calopteryx*] *virgo* which is sometimes called ‘King George’ – presumably a flattering but delightfully unsuitable allusion to George III. The French name ‘Demoiselle’ has largely replaced ‘King George’ in recent times, and also the other vernacular name of ‘Kingfisher’ mentioned by Harris in 1782.”

It remains to be determined when and where the amusing and witty insect name ‘King George’ was first introduced, and how widely it was used. The author has not been able to find any references to it from the major entomological books published in Britain in the first half of the 19th century. Neither does a Google search for ‘King George’ in connection with various dragonfly related terms help. The author hopes that some readers of this note can provide further information on the use of this ‘royal’ name.

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References

- Charpentier, T. de 1840. *Libellulinae Europaeae descriptae ac depictae*. Voss, Lipsiae. 180 pp., 48 plates excl.
- Corbet, P. S, Longfield, C. & Moore, N. W. 1960. *Dragonflies*. Collins, London. 260 pp., 24 plates excl.
- Gabb, R. 1988. English names for dragonflies. *Journal of the British Dragonfly Society* **4**: 19-21.
- Fourcroy, A. F. de. 1785. *Entomologia Parisiensis; sive, Catalogus insectorum quae in agro Parisiensi reperiuntur. (Pars prima & Pars secunda)*. Via et Aedibus Serpentineis, Paris. viii + 554 pp.
- [Harcourt-Bath, W.]. 1890. *An illustrated handbook of British dragonflies*. The Naturalists' Publishing Co., Birmingham. 98 pp. [Note. Author's name was given as: The editor of the "Naturalists' Gazette."].
- Hämäläinen, M. & Fliedner, H. 2022. Etymology of the scientific names of extant demoiselle damselflies (Odonata: Calopterygidae). *International Dragonfly Fund - Report* **174**: 1-175.
- Harris, M. 1776-1780. *An exposition of English insects, with curious observations and remarks, wherein each insect is particularly described; its parts and properties considered; the different sexes distinguished, and the natural history faithfully related*. Printed for the Author, London. 4 + 166 pp., 50 plates excl. [Note. Harris' new dragonfly species were described in 1780.].
- Hudson, W. H. 1903. *Hampshire days*. Longmans, Green and Co., London. xvi + 346 pp..
- Linnaeus, C. 1746. *Fauna svecica, sistens animalia Sveciae regni*. Laurentius Salvius, Stockholmiae. 29 + 411 pp.
- Linnaeus, C. 1748. *Systema naturae sistens regna tria naturae. Editio sexta, emendata et aucta*. Kiesewetter, Stockholmiae. 4 + 224 + 27 pp.
- Linnaeus, C. 1758. *Systema naturae per regna tria naturae. Tomus I. Editio decima, reformata*. Laurentius Salvius, Holmiae. 4 + 824 pp.
- Linnaeus, C. 1761. *Fauna svecica, sistens animalia Sveciae regni (Edition altera)*. Salvius, Stockholmiae. 49 + 579 pp., 2 plates excl.
- Longfield, C. 1937. *The dragonflies of the British Isles*. Frederick Warne & Co., London. 220 pp., 38 plates excl.
- Lucas, W. J. 1900. *British dragonflies (Odonata)*. L. Upcott Gill, London. xiv + 356 pp., 27 plates excl.
- Stephens J. F. 1835-1837. *Illustrations of British entomology; or, a synopsis of indigenous insects. Mandibulata*. Vol. 6. Baldwin & Cradock, London. 240 pp., 7 plates excl. [Note: The pages on dragonflies are dated 15 June 1836.].

Website

Richter, J. (undated). The Kingfisher: <https://www.scribd.com/document/30767423/The-Kingfisher-The-etymology-of-kingfisher-Alcedo-atthis>. accessed 10/12/2023.

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First proof of successful breeding by *Anax ephippiger* (Burmeister, 1839) (Vagrant Emperor) in Britain

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Introduction

Anax ephippiger (Vagrant Emperor) is a strongly migratory species, whose core range includes Africa, the Middle East and south-west Asia and, in recent years, the Mediterranean regions of southern Europe. The first British record dates back as far as February 1903 (Cham *et al*, 2014) but during the last decade or so it has become a much more frequent immigrant to northern Europe including the UK.

Methods and Results

In 2011, during a surge of sightings in the UK (Parr, 2012), a male and female of *Anax ephippiger* were seen by the author in tandem and ovipositing on both the 26 April and the 28 October at Hayle Kimbro Pool on the Lizard Peninsula in Cornwall (SW694169), the first-ever reported observations of breeding attempts in the UK. The October observation took place during an unsuccessful attempt to search for exuviae that may have provided proof of breeding had the April ovipositing been successful. Similar searches at this vast site in Spring 2012 were also unsuccessful.

During both 2018 & 2019 there were more reports of attempted breeding by the species, on the Lizard peninsula but once again subsequent searches for *A. ephippiger* exuviae were unsuccessful. However, it is interesting to note that in June 2019 both Belgium and the Netherlands had a very large influx of *A. ephippiger* which did result in successful breeding by the species, with more than 2000 exuviae being found at seven sites across the two countries between late August and the end of September 2019 (Manger & De Knijf, 2022).

On the 18 September 2023 Dougy Wright, the volunteer warden at Windmill Farm on the Lizard peninsula, led a guided walk around the reserve for a local conservation charity. During the walk he spotted a large dragonfly flying near the group that he immediately recognised from experience to be *A. ephippiger*

(Cornwall Wildlife Trust, 2023). However, as the dragonfly banked away, alongside the expected brown eyes, it appeared to have a red abdomen and a green and yellow thorax. This colouration caused some initial confusion as it did not conform with that of a mature *A. ephippiger* despite the insects jizz. However, an immediate internet search quickly revealed that this individual was a teneral/immature *A. ephippiger*, the first such sighting in Britain.

Given that the teneral/immature colouration does not last for long in odonates, the occurrence of this fresh specimen strongly suggested the possibility of a local emergence. With that in mind, and given the author's experience of searching for exuviae, Dougy Wright arranged for a meeting at Windmill Farm on the 22 September 2023 to conduct a search for exuviae around the Plantlife Pond (SW691149), the pool where *A. ephippiger* had been recorded in tandem and ovipositing in June 2023 (Tony Blunden, pers. com.)

Windmill Farm is jointly owned and managed by Cornwall Wildlife Trust and Cornwall Bird Watching and Preservation Society and is situated just 3.5 km north of the most southerly point on the British mainland. It is a Site of Special Scientific Interest and forms part of the Lizard Special Area of Conservation, (SAC).

The Plantlife Pond was created in 2006 and sits near the edge of an area of lowland heath where it adjoins an area of semi-improved pasture. Cattle graze the margins during the summer months and, as a result of their poaching, there is an extensive area of bare mud all the way around the edge of the pool. The Plantlife Pond is approximately 70 m long (running east to west) and 37 m wide at the eastern end. The western end comes to a point where the pool has an outflow pipe which is used to manage water levels during the winter months. It has a shallow saucer profile and is approximately 0.7 metres deep in the middle during the summer months. The ribbon of emergent vegetation around the water margins is dominated by *Eleocharis palustris* (Common Spike-rush), giving the habitat a very open appearance.

The search was conducted after overnight showers on a sunny morning with temperatures around 15°C to 16°C. It started at the eastern end of the pool and slowly moved around the margins in a clockwise direction. Along the southern margins of the pool two exuviae of *Anax imperator* (Emperor Dragonfly) were found on *E. palustris*, as well as six exuviae of *Sympetrum fonscolombii* (Red-veined Darter), four of the latter with the teneral insects still *in situ*, the first proof of successful breeding for *S. fonscolombii* at Windmill Farm. At the western end of the pond another large exuvia was located, also on *E. palustris*, about two metres into the water body. It was clearly the exuvia of an *Anax* species rather than an *Aeshna* species because of the eye shape forming a more or less



Plate 1. Dorsal view of the head of the exuvia of *Anax ephippiger* collected on 22 September 2023.

constant radius curve on the side of the head, giving the characteristic 'circular' head shape (Plate 1), rather than the teardrop shaped eyes of *Aeshna* sp., which give a non-circular head shape. It appeared to be slightly smaller than the two *A. imperator* exuviae already collected.

Its overall length was 44.5mm (Plate 2), which is at the upper end of the range for *A. ephippiger* (40 to 45mm) (Suhling *et al*, 2014) and the lower end of the range for *A. imperator* (45 to 56mm) (Cham, 2012). However, the labial mask (Plate 3) was significantly shorter than that of both *A. imperator* and *Anax parthenope* (Lesser Emperor) (Sasamoto *et al.*, 2022), giving it a much squatter appearance (*A. parthenope* has in the past successfully bred on the Lizard peninsula (Jones, 2000)). The labial mask measured 9mm long and 5mm wide at the widest point in comparison to the labial mask of the two *A. imperator* exuviae, which measured 11mm long and 6mm wide at their widest point. It was clearly an *A. ephippiger* exuvia. The absence of any ovipositor structure on the underside of abdominal segment 9 showed that it was a male.

Although we continued our search, we did not find any further exuviae that we suspected as being *A. ephippiger*.



Plate 2. Dorsal view of the exuvia of *Anax ephippiger* collected on 22 September 2023.



Plate 3. The labial mask of the exuvia of *Anax ephippiger* collected on 22 September 2023. The scale shows 1 mm divisions.

Discussion

Anax ephippiger has been proven to have bred successfully in Britain for the first time by the discovery of a male exuvia at Windmill Farm on the Lizard peninsula on the 22 September 2023. Current knowledge of the larval development time for *A. ephippiger* indicates that, on the African continent, larval development is likely to take in the region of 100 days (Dumont & Desmet, 1990), which strongly aligns with observations of the species ovipositing at Windmill Farm in mid-June 2023 (Tony Blunden pers. com.) and this subsequent emergence in September 2023. The Plantlife Pond is shallow and has a high degree of exposure to sunshine that would allow the rapid larval growth associated with species such as *A. ephippiger* and *Sympetrum fonscolombii*. Other similar sites on the Lizard peninsula where ovipositing *A. ephippiger* have been observed, such as Croft Pascoe Pool (SW7311997) & Hayle Kimbro Pool (SW694169) would also provide appropriate conditions. It therefore seems likely that, if further late spring/early summer ovipositing takes place locally, then more late summer emergences of *A. ephippiger* could occur in the future. However, since *A. ephippiger* is essentially a nomad, with newly emerged individuals leaving their natal area in the immediate post-teneral phase, permanent breeding populations in Britain are probably unfeasible.

Acknowledgements

My sincere thanks are due to Dougy Wright, for his timely invite to join him in searching for *Anax ephippiger* exuviae at Windmill and ultimately sharing in this significant discovery. My thanks are also due to Tony Blunden who shared his important observations of *A. ephippiger* ovipositing at Windmill Farm in 2023.

References

- Cham, S. 2012. *Field Guide to the larvae and exuviae of British Dragonflies. Damselflies (Zygoptera) and Dragonflies (Anisoptera)*. The British Dragonfly Society, Peterborough. 152 pp.
- Cham, S., Nelson, B, Parr, A., Prentice, S., Smallshire, D. & Taylor, P. (eds) 2014. *Atlas of Dragonflies in Britain and Ireland*. Biological Records Centre, Wallingford, Oxfordshire. 280 pp.
- Dumont, H.J. & Desmet, K. 1990. Trans-Sahara and trans-Mediterranean migratory activity of *Hemianax ephippiger* (Burmeister) in 1988 and 1989 (Anisoptera: Aeshnidae). *Odonatologica* **19**: 181-185.
- Jones, S.P. 2000. First proof of successful breeding by the Lesser Emperor *Anax*

- parthenope* (Selys) in Britain. *Journal of the British Dragonfly Society* **16**: 20-23.
- Manger, R. & De Knijf, G. 2022. Massale voortplanting van de Zadellibel (*Anax ephippiger*) in België en Nederland in de zomer van 2019. *Brachytron* **23**: 7-21.
- Parr, A.J., 2012. Migrant and dispersive dragonflies in Britain during 2011. *Journal of the British Dragonfly Society* **28**: 56-65.
- Sasamoto, A., Kotabe, A., Takuma, Y., Kawashima, I., Okude, G., & Futahashi, R. 2022. Description of larva of *Anax ephippiger* (Burmeister, 1839) from Japan, including changes and developments in external morphology (Odonata: Aeshnidae). *Tombo*, **65**: 28–37.
- Suhling, F., Müller, O. & Martens, A. 2014. The dragonfly larvae of Namibia (Odonata). *Libellula Supplement* **13**: 5-105.

Websites

- Cornwall Wildlife Trust. 2023: <https://www.cornwallwildlifetrust.org.uk/blog/rebecca-payne/first-uk-windmill-farm>. Accessed 08/11/2023.

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Accelerating range expansions of *Libellula depressa* Linnaeus (Broad-bodied Chaser) and *Calopteryx splendens* (Harris) (Banded Demoiselle) in Cumbria, 2000 – 2023

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Summary

Libellula depressa (Broad-bodied Chaser) and *Calopteryx splendens* (Banded Demoiselle) in Cumbria are currently near the north-western edges of their British ranges. Both have shown accelerating increases in range in the past quarter of a century, especially in the last decade. *Libellula depressa* has arrived as an incoming colonist, while *C. splendens* has a history of limited presence pre-2000, stretching back to at least 1937. The two species are ecologically very different and have shown different patterns of colonisation. It is presumed that climate change is the underlying factor in both their responses.

Introduction

Libellula depressa (Broad-bodied Chaser) and *Calopteryx splendens* (Banded Demoiselle) are currently the two Odonata species most actively undergoing range increases in Cumbria - which primarily comprises Watsonian Vice-Counties 69 and 70. Also, both species are listed by Olsen *et al.* (2022) as undergoing range expansions in continental Europe. They differ markedly in ecology and especially habitat requirements, *L. depressa* being a static-water species, while *C. splendens* is riverine. Both emerge relatively early in the flight season, in May/early June. As the males of both are highly conspicuous, they readily attract the attention of wildlife recorders and the public at large, many of the latter not regularly reporting dragonflies.

Methods

The range changes are presented in figures and maps to allow comparison of the two species. The figures are indicators of change in the geographical extent of the species rather than population sizes. As raw data include multiple records

from many sites, they are shown as the number of 2 x 2 km tetrads in which the species were recorded in each year. This helps to distinguish between growth in recording and genuine range changes. The maps illustrate the latest situations, based on records from 2023 submitted to the British Dragonfly Society via the standard online recording software *iRecord* or directly to the author. Nonetheless, the data presented here do not represent any comprehensive or organised surveys and to this extent are unbiased 'snapshots' tending, if anything, to under-represent the true extent of trends in both species.

The author is a County Dragonfly Recorder for the British Dragonfly Society and is thus aware of local developments on a regular basis. All records referred to in this paper are held in the Society's recording scheme (British Dragonfly Society, 2024) and many derive from his personal observations.

Range Expansions

Libellula depressa (Broad-bodied Chaser)

The latest dragonfly atlas for Britain (Cham *et al.*, 2014) documents the spread of this species: by 1990 it had reached the latitude of Manchester. In 1996, *Libellula depressa* in Cumbria was noted as "Vagrant and/or possible introduction; recorded at one west coast site 1984-6; single report for 1994" (Clarke, 1996). Fourteen years later, it was still showing almost no signs of the large-scale colonisation of the county that was soon to take place (Fig. 1).

Essentially, range expansion in Cumbria did not begin until c. 2009 and, at first, was mainly in the south of the county. It was not until the latter part of the following decade that a near exponential rise began, affecting for the first time a substantial part of the area. A map for pre-2000 would have been virtually devoid of records. The 56 tetrads recorded for 2023 (Plate 1) show that a wide geographical spread has now been attained. Oviposition has occurred at sites in many tetrads, especially where the presence of both sexes has made repeated mating possible. Excluding the coast, it is interesting that the majority of records are from areas out-with those shaded green on the map - which are below 100 metres a.s.l. and include the most intensively agricultural lowlands (which are also less accessible to recorders). The apparent 'cluster' of tetrads in the north of the county near its eastern border (arrowed in Plate 1) is puzzling. It is tempting to speculate that this might reflect arrivals from the east via the so-called 'Tyne Gap' at the northern edge of the Pennines. However, recording coverage just east of the Cumbria boundary is low and thus there is no evidence for this.

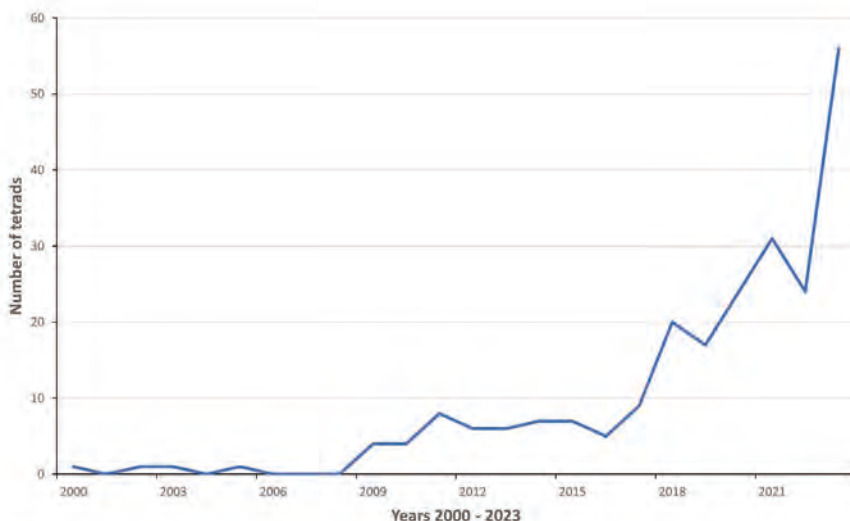
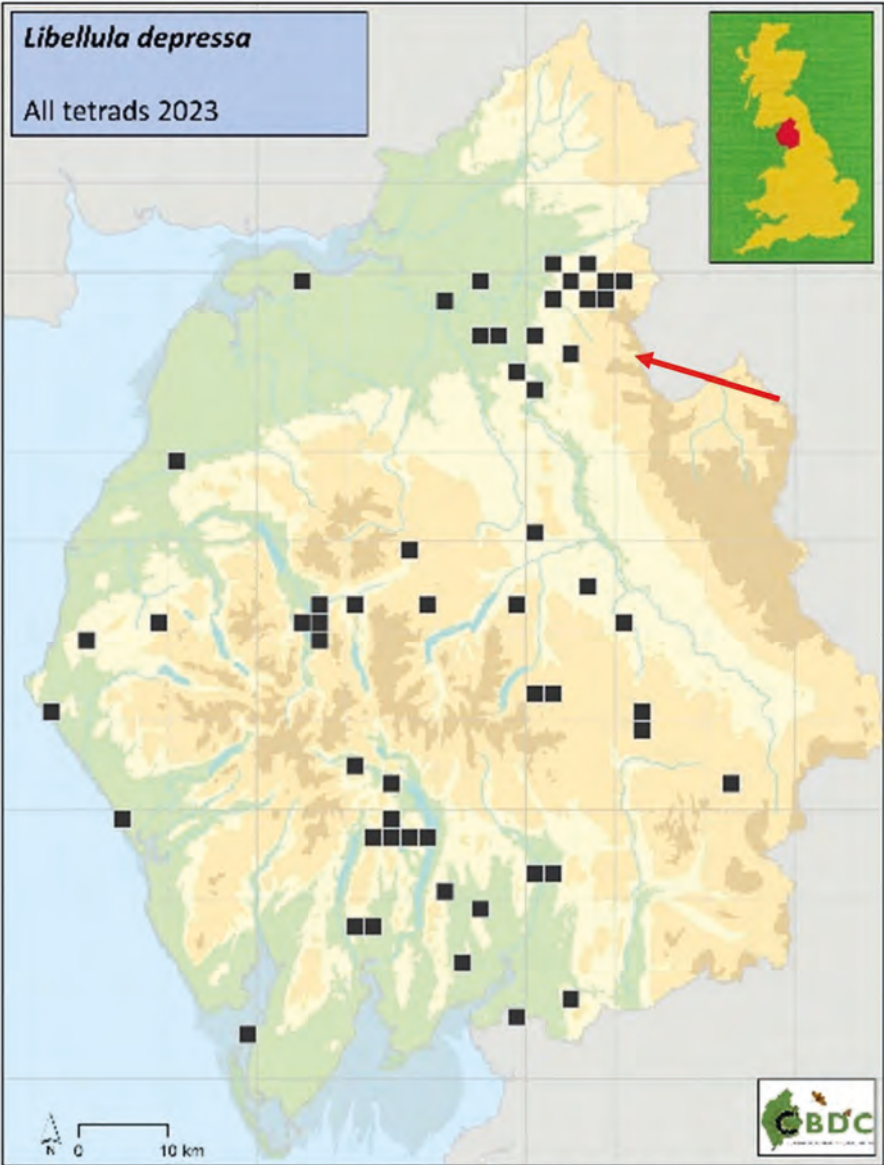


Figure 1. Records of *Libellula depressa* in Cumbria showing the number of recorded tetrads per annum 2000-2023. (n=232).

The species was reported in 2023 by some 50 observers and ranked fourth in the number of records per Odonata species in Cumbria for that year. At 6.5% of the 2023 Odonata records for the county, it was actually recorded more frequently than the related *Libellula quadrimaculata* (Four-spotted Chaser), which remains both more widespread and more abundant. The fine weather throughout much of the flight period of *L. depressa* and its frequent use of gardens and other man-made situations no doubt contributed to this situation.

Sites which produced records varied enormously, as might be expected of a generalist species. These included presence at early successional sites with bare margins, such as new ponds and flood resilience scrapes, which the species is well known to favour. The example illustrated (Plate 2) was created three years ago and is about 25m² in area; breeding activity has been recorded here and emergence in 2023 had begun on the exceptionally early date of 24 April and finally yielded at least 23 individuals. The flight period in Cumbria usually begins in early May and peaks in June. First and last dates for sightings of adults in 2023 were 24 April and 19 July.

Sightings at large coastal peatlands in both the south and the north of the county have been infrequent and the lack of breeding records, and records generally, from such sites suggests they are avoided by the species. Locations at which the species was seen included small pools in relatively upland sites



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Plate 1. Tetrads in which *Libellula depressa* was recorded in 2023. The arrow indicates the apparent ‘cluster’ of tetrads in the north of the county near its eastern border. (Contains O.S. data: Crown Copyright and database right, 2024).



Plate 2. *Libellula depressa* breeding pond close to sea level at Drigg (SD09). Photograph: Chris Arthur.



Plate 3. Pond in old limestone quarry near Crosby Ravensworth (NY61) at 300m a.s.l. A regular breeding site for *Libellula depressa* since 2021.

- such as Askham Fell (NY42) and near Crosby Ravensworth (NY61), both at c. 300 metres a.s.l. and with underlying limestone geology. The site in the last-mentioned area is a disused limestone quarry (Plate 3) and has been a breeding site for at least two seasons. It is shallow and bare-margined with extensive emergent *Eleocharis palustris* (Common Spike-rush) – and presumably has relatively base-rich water.

Calopteryx splendens (Banded Demoiselle)

Unlike the previous species, *Calopteryx splendens* is virtually confined to moderately slow-flowing lowland rivers and streams. The extent to which these have well-vegetated margins can be a key requirement of breeding sites. However, the occurrence of the species well away from typical breeding habitats has been a feature of recent years especially. The assessment in Clarke (1996) was: “Rare, Solway plain: main sites on River Waver, formerly River Eden (pre-1970) and possibly River Wampool; seen 1996 on these rivers. Vulnerable.” At that time, the species was known only from four hectads (10 x 10km squares) in the north of the area (Plate 4, red rectangle), on rivers discharging into the Solway Firth, where it had been present since at least 1937 (Day, 1943). In recent years, it has even been recorded along 3km of highly contorted meanders within upper limits of Spring tides on the River Wampool (pers. obs.).

The early twentieth century situation was discussed in more detail in Clarke (1999), where a detailed map of records up to 1999 was presented. It was felt at the time that sightings in the Solway area in 1996 were unusually extensive and that some sort of local dispersal movement had occurred.

Use of online recording did not become widespread until about 2015. This may explain some fluctuations in records, especially in earlier years, hence the use of a three-year moving average to better highlight the trend (Fig. 2). The situation is complicated by the concurrent range expansion being apparently from two directions. The northern populations are clearly expanding southwards, often upstream, especially along the north-flowing River Eden and its tributaries. This has been increasing progressively since 2000. Early, isolated occurrences in the south of the county are associated with years with exceptionally fine summers – 1995 and 2006. Records did not start to become annual in the south until after the latter year and the colonisation there is presumed to be from individuals moving north from Lancashire. Nonetheless, the impression is that most range expansion is driven from the north, sometimes crossing watersheds into previously unoccupied systems.

Many records in the past decade have been of single individuals of this riverine species dispersing widely beyond existing breeding habitats and areas, usually

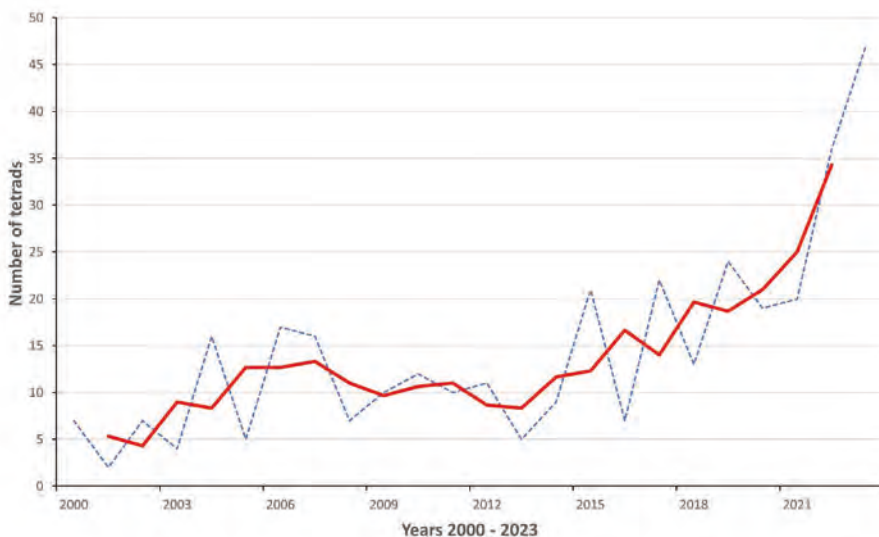
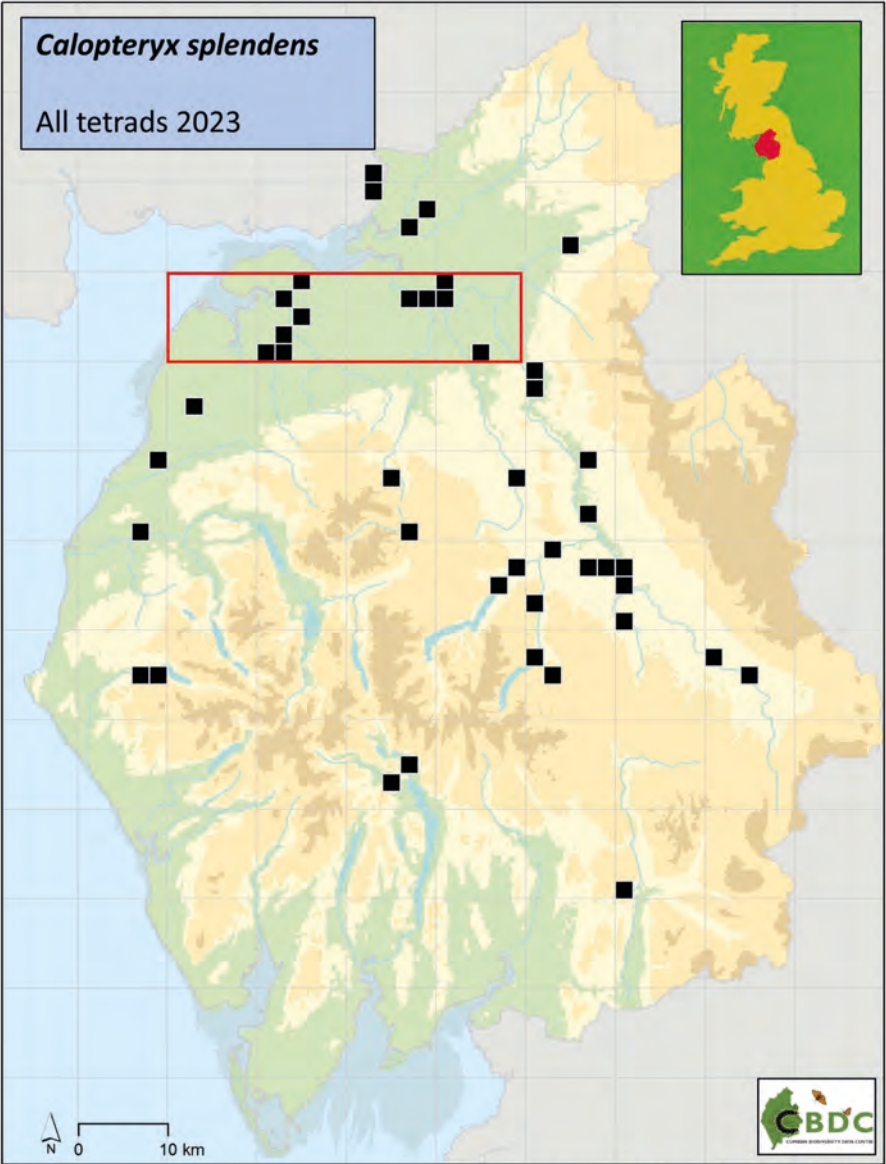


Figure 2. Records of *Calopteryx splendens* in Cumbria 2000 – 2023 showing the number of recorded tetrads per annum. Red trace = three-year running average. (n=347)

along water courses. The more conspicuous males form the basis of most records. Extreme examples of this dispersive behaviour have included single males on the upper River Irthing (NY67) in 2020 and at the head of Haweswater reservoir, in Mardale (NY41) in 2021. Both localities are upland and remote from possible breeding habitats - over 30km in the case of the first example. The river at the latter site lacked tall waterside vegetation, such as *Phalaris arundinacea* (Reed Canary-grass), typical of preferred sites, and had a gravelly/stoney bed.

Calopteryx splendens was recorded from 47 tetrads in 2023. The pattern of distribution differs markedly from that of *Libellula depressa*, most notably in the Solway lowlands and along the north-flowing River Eden. The tetrad records (Plate 4) undoubtedly under-represent some populations - notably those established on the River Derwent between Keswick and Workington since c. 2014 (Plate 5). The latter location is very representative of the usual habitats of *C. splendens* in the county – slow-flowing lowland rivers with unshaded banks and tall marginal vegetation. The species seems adept at colonising relatively short open stretches of this nature in otherwise tree-lined watercourses. First and last dates for sightings of adults in 2023 were 20 May and 8 August.

The occurrence of both *C. splendens* and *Calopteryx virgo* (Beautiful Demoiselle) at the same site is an interesting development, of which there are now several



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Plate 4. Tetrads in which *Calopteryx splendens* was recorded in 2023. Red rectangle indicates limits of records of established populations pre-2000. (Contains O.S. data: Crown Copyright and database right, 2024)



Plate 5. River Derwent near Isel (NY13) – a *Calopteryx splendens* site since at least 2013.

instances amongst the county records. A recent ongoing example has been that on the River Brathay near Skelwith Bridge (NY30) which, before c. 2019, was purely *C. virgo* territory (Clarke, 2019). Since that year, *C. splendens* has appeared (Plate 6) and in increasing numbers. Given that the two species have slightly different requirements, especially regarding water flow rates, this may tend to limit competition between them. However, adults inevitably share much the same habitat. In 2023, the two species appeared to be present in relatively similar abundance (pers. obs.), but the situation is new and remains dynamic.

Discussion

The recent survey by the British Dragonfly Society (Taylor *et al.*, 2021) included *C. splendens* and *C. virgo* discussed here amongst the 19 British Odonata species that have been increasing their national ranges. *Calopteryx splendens* had extended its range into Scotland by 2002 and, like many other species advancing north, at first moved much further in that direction on the eastern side of the UK than it did on the west (e.g. Lowdon, 2015). Both this species and *Libellula depressa* have since been recorded well north of the England-Scotland



Plate 6. *Calopteryx splendens* male with males of *Calopteryx virgo* in the background: River Brathay, Skelwith Bridge (NY30), June 2022.

border (e.g. Cham *et al.*, 2014). They already have isolated records north of the Highland Boundary Fault, with two very northerly records of *L. depressa* in 2023 being near Inverness and Wick - the latter at 58.4°N. As the larvae of *L. depressa* (and some other Odonata) can occasionally be accidentally transported with aquatic plants, some records can be problematic. The Wick occurrence was at a garden centre, which compounds the issue (Pat Batty, pers. comm.).

It is interesting that, at present, both species are increasing in Cumbria at the fastest known rates. Presumably, natural stabilisation points will be reached in the not-too-distant future. That these trends are occurring despite widely different ecological requirements of the two species suggests that an overarching climatic factor, such as temperature, is the stimulus. Interestingly, Brooks (2024) showed the *L. depressa* can now complete its life cycle in south-eastern England in a single year (instead of the usual two). He postulated that this may be one way the species responds to climatic warming.

The manner of spread of both species deserves comment. While *L. depressa* has clearly been progressing northwards within Cumbria during the years

in question, the noticeable grouping of tetrads referred to above (Plate 1) is unexplained. In contrast, *C. splendens* appears to be to some extent 'back-filling' from its former northern base (Plate 2). That the previously isolated outpost population of the species may in some senses have been 'pre-adapted' to have enabled this is an intriguing possibility.

Ward & Mill (2007) studied movements of adult *C. splendens* and showed that the great majority remained in close proximity to the study areas - individual males moved up to about 1.75 km and 0.75 km respectively, with females moving rather less far. Clearly, it is the exceptions that pioneer range expansions but the precise factors triggering this are still unresolved. The same authors (Ward & Mill, 2008) studied larvae experimentally, and showed that they can cling to the stony/pebbly substrates characteristic of some sub-optimal habitats in the absence of rich emergent vegetation of more typical lowland sites. This may be advantageous in some range expansion contexts.

Both species will encounter established Odonata in their respective breeding sites. The Cumbria records seem to suggest that *L. depressa* avoids some of the acidic sites favoured by many species. Several published sources concur with this tendency, though others, including Cham *et al.* (2014), cite apparently contrary situations. The situation with *Calopteryx* has already been mentioned. Svensson *et al.* (2018), studied the two species at over 100 locations in Fennoscandia. They found that situations where the two were present in similar abundance were much less frequent than those where one of the two was the more numerous. Their field and experimental studies examined various scenarios of the density and frequency of the two species and outcomes over time. They regarded *C. virgo* as the more dominant in inter-species conflicts.

It will be interesting to see whether these range expansions in Cumbria produce any evidence of the effects of inter-species interactions in the future.

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References

- Brooks, Steve. 2024. An investigation of dragonfly larval development time using newly-created garden ponds. *Journal of the British Dragonfly Society* **40**: 1-5.
- Cham, S., Nelson, B., Parr, A., Prentice, S., Smallshire, D. & Taylor P. 2014. *Atlas of Dragonflies in Britain and Ireland*. Field Studies Council, Telford. 280pp.
- Clarke, D. 1996. 'Dragonflies in Cumbria – a centenary review' in *Transactions of the Carlisle Natural History Society*, **12**: 27 - 38.
- Clarke, David. 1999. The outpost populations of the Banded Demoiselle (*Calopteryx splendens*) in the Solway Firth area, Cumbria: historical perspective and recent developments. *Journal of the British Dragonfly Society*, **15**: 33 - 38.
- Clarke, David. 2019. Bandeds on the move in Cumbria. *Dragonfly News*, **76**: 21.
- Day, F. H. 1943. Cumberland Odonata. *Entomologists' Monthly Magazine*, **79**: 43-44.
- Lowdon, J. 2015. The habitat requirements and changing distribution of *Calopteryx splendens* (Harris) within Northumberland. *Journal of the British Dragonfly Society* **31**: 1-13.
- Svensson, E.I., Gómez-Llano. M. A., Torres, A. R. & Bensch, H. M. 2018. Frequency dependence and ecological drift shape coexistence of species with similar niches. *The American Naturalist* **191**: 691-703.
- Taylor, P., Smallshire, D., Parr, A.J., Brooks, S.J., Cham, S.A., Colver, E.F., Harvey, M., Hepper, D., Isaac, N.J.B., Logie, M.W., McFerran, D., McKenna, F., Nelson, B. & Roy, D.B. 2021. *State of Dragonflies in Britain and Ireland 2021*. British Dragonfly Society, Old Weston, Huntingdon. 83 pp.
- Ward, L. & Mill, P. 2007. Long range movements by individuals as a vehicle for range expansion in *Calopteryx splendens* (Odonata: Zygoptera). *European Journal of Entomology*, **194**: 195-198.
- Ward, L. & Mill, P. 2008. Substrate selection in larval *Calopteryx splendens* (Harris) (Zygoptera: Calopterygidae). *Odonatologica*, **37**: 59-77.

Websites

- British Dragonfly Society 2024: <https://registry.nbnatlas.org/public/show/dp97> (accessed 1 February 2024).
- Olsen, K., Svenning, J. K. & Balslev, H. 2022. Climate change is driving shifts in dragonfly species richness across Europe via differential dynamics of taxonomic and biogeographic groups. *Diversity* 2022, **14**(12), 1066. 22 pp.
<https://doi.org/10.3390/d14121066>.

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