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British Dragonfly Society

The aims of the **British Dragonfly Society** (BDS) are to promote and encourage the study and conservation of Odonata and their natural habitats, especially in the United Kingdom, and to raise public awareness of dragonflies.

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Cover illustration: Female *Coenagrion pulchellum*. Dark form - immature. Photograph by Steve Cham.

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Some notes on larval duration and voltinism in *Anax imperator* Leach (Emperor Dragonfly) in the Maltese Islands

Charles Gauci

28. Triq il-Kissier, Mosta, MST1822, Malta.

Summary

Anax imperator eggs hatched and the larvae reached F0 and emerged after as little as 80 days from a pond at Ghadira Nature Reserve, Malta (approximately 36°N) in 2023. Exuviae collected from four ponds at this reserve and from a number of reservoirs at other sites between 2020-23 indicate that the species is bivoltine in Malta.

Introduction

In the early 1990s, three small, shallow ponds were constructed at Ghadira Nature Reserve in Malta (35°58'N; 14°25'E) with the intension of making freshwater available to wildlife inhabiting the saline marshland. The reserve is administered by BirdLife Malta. The ponds immediately attracted dragonflies and seven species were found breeding annually while another two species were occasionally observed ovipositing. In 2019, permission was obtained to start collecting exuviae from the three ponds as well as from a fourth small, pre-fabricated one which had been added in 2017 (Gauci, 2020). During the first year, exuviae were collected twice weekly. In 2020, due to Covid-19, access to the reserve was initially prohibited and permission to collect exuviae was only granted at the end of May and restricted to one visit per week. In subsequent years visits continued on a once weekly basis.

Due to lack of control, the emergent vegetation in the ponds quickly spread and covered most of the water surface area, with the result that the number of exuviae found decreased significantly over the years (Fig.1). Some species, notably *Orthetrum cancellatum* (Black-tailed Skimmer) and *Sympetrum fonscolombii* (Red-veined Darter) deserted the ponds. In 2023 the pond at the northern side of the reserve, referred to as Pond 1 in Gauci (2020), dried out in mid-January. When all emergent vegetation and substrate were removed, the

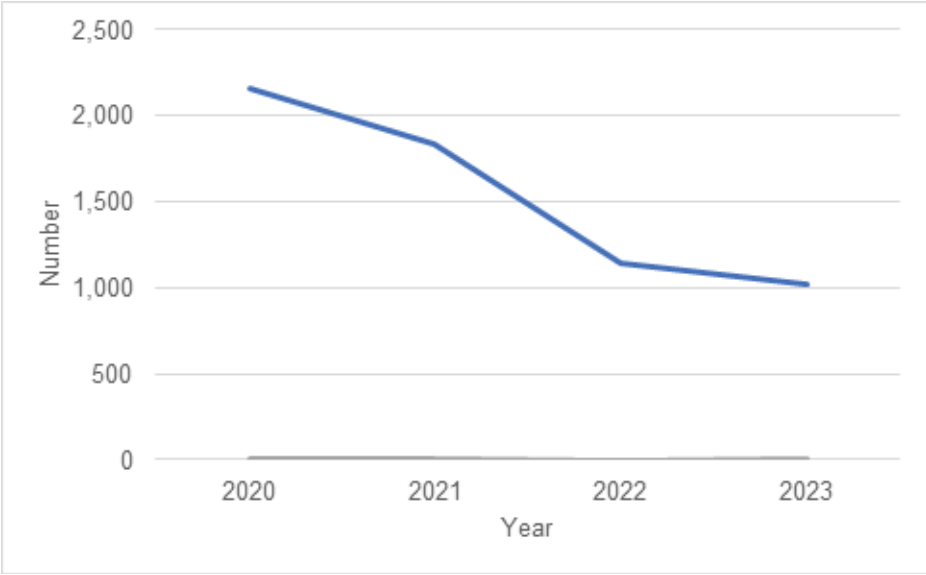


Figure 1. Total number of exuviae (all odonate species) collected from the four ponds at Ghadira Nature Reserve in 2020-23.

thin concrete bottom was found to have been damaged. The pond was repaired and re-filled with water in mid-February. A small patch of rushes was introduced at the north-east end and the concrete bottom was covered with a thin layer of fresh substrate (Plate 1).

Observations and Discussion

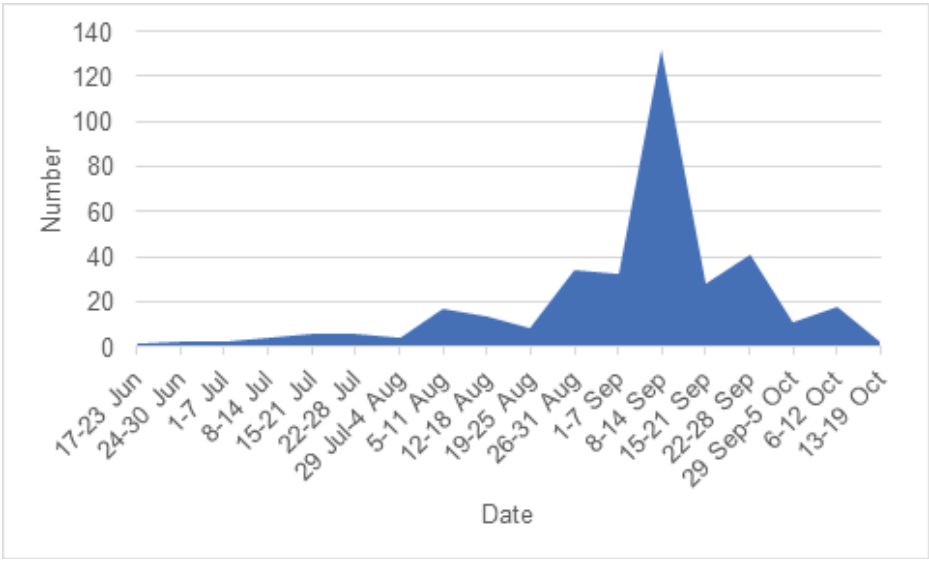
In 2023, collection started on 1 April, when the first exuviae of *Anax imperator* and *Crocothemis erythraea* (Scarlet Darter) were found at one of the ponds. The first exuviae (three *A. imperator* and one *C. erythraea*) at Pond 1 were found on 17 June, 123 days after the pond had been repaired and refilled, meaning that emerging imagos would have resulted from eggs laid earlier in the same year. No imago counts were carried out at the pond except when visits were made to collect exuviae. These visits lasted only 15-30 minutes and were mostly carried out early in the morning before most odonates were flying.

At other observation and exuviae collection sites in Malta, the first female *A. imperator* was noted ovipositing on 31 March. Assuming that the first oviposition at Pond 1 occurred at about the same time, the time between egg-laying and emergence for the first *A. imperator* exuviae found would be just 80 days. Such rapid growth is probably the result of a combination of factors – an abundant

Plate 1. The North pond (Pond 1) at Ghadira Nature Reserve.

food supply, warm temperatures and light. The abundant food supply likely consisted of *Discoglossus pictus* (Painted Frog) tadpoles and *Crocothemis erythraea* larvae. The latter started emerging in good numbers only after most *A. imperator* and *Orthetrum cancellatum* (which, with the removal of the vegetation choking the pond, had returned to oviposit) had emerged (Fig. 2).

In studies quoted by Corbet (1999), *A. imperator* is given as being univoltine between 36° 85'N and 52°50'N, bivoltine at 41°10'N, and semivoltine at 51°47'N. Corbet (1957) described *A. imperator* in England as being semivoltine and occasionally univoltine, the F0 larvae mostly spending their second winter in diapause. Philpott (1985) and Holmes & Randolph (1994) found the species to be univoltine in small ponds at 50° and 51°N respectively, also in England. Due to the alternating wet and dry seasons, most aquatic habitats in the Maltese Islands are ephemeral and thus odonate breeding activity largely depends on timing and the amount of rainfall. Poor late winter and early spring rainfall results in most aquatic habitats drying up soon after the first generation of most species emerges. Like other dragonfly species breeding in the Maltese Islands, *A. imperator*, besides being generalist, is also opportunist and quickly occupies newly created habitats such as, for example, rock pools which fill up by leaking mains pipes or even reservoirs partly filling up following either burst pipes, such as at Chadwick Lakes, or with water coming from unknown sources as happened at Wied Rihana (Plate 2) in late spring 2023.



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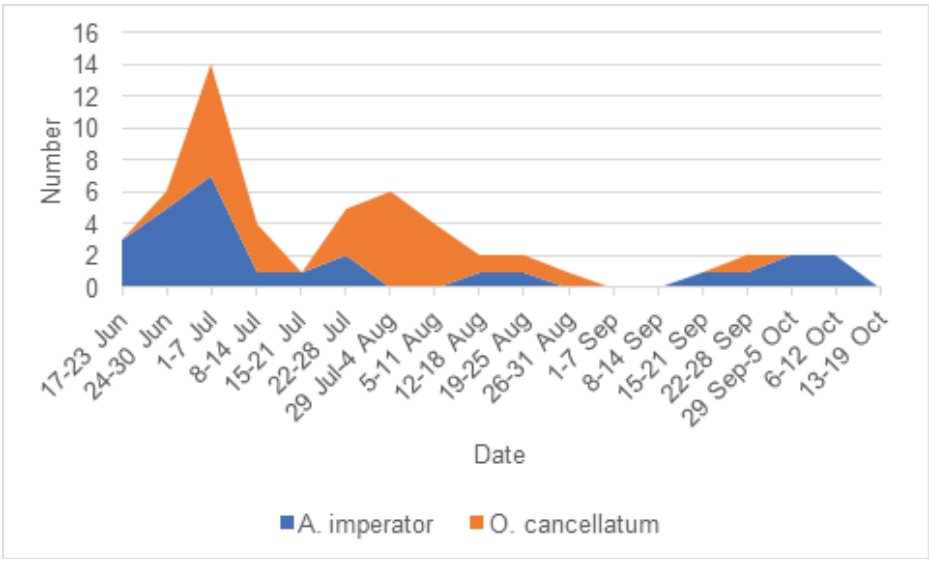

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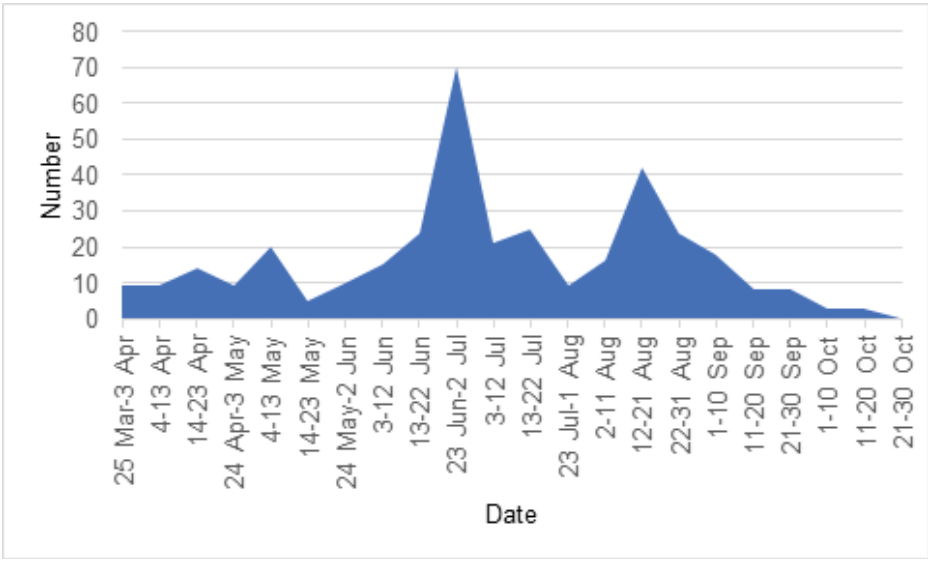
Figure 2. Emergence numbers from Pond 1 in 2023. (A) *Crocothemis erythraea*, (B) A*nax imperator* and *Orthetrum cancellatum.*



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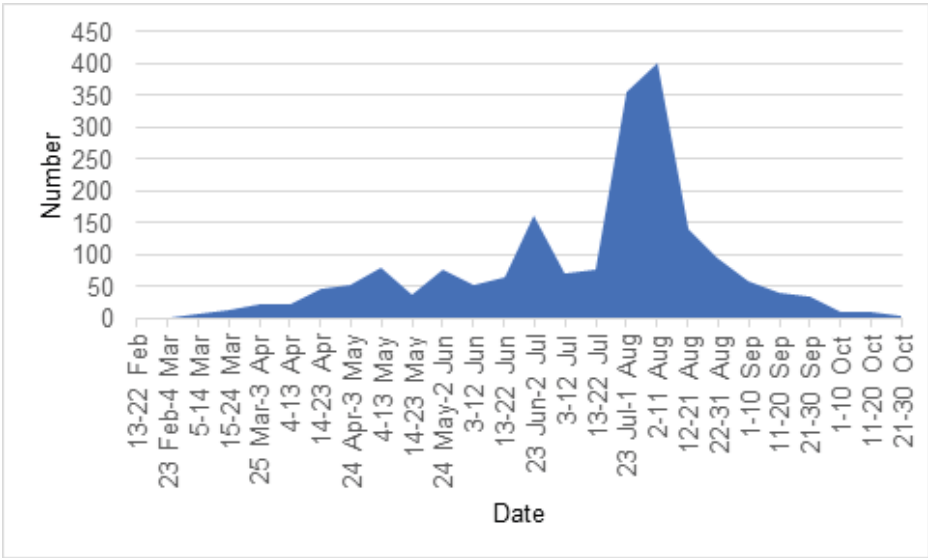

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Figure 3. Numbers of *Anax imperator* exuviae collected in 2020-2023. (A) from the four Ghadira ponds, (B) from all sites.

Plate 2. The reservoir at Wied Rihana.

The period of *A. imperator* emergence in 2020-23 spans 262 days between February and October. Data from 2019 have been excluded since *A. imperator* and *A. parthenope* exuviae were not identified to species level in that year. Direct observation of the emergence of 27 individuals in 2020 confirmed the identification of females in these two *Anax* species as given by Cham (2012). Data from exuviae collected from the four ponds at Ghadira Nature Reserve (considered as unregulated since water is available for breeding all year round) and from all sites (most of which are regulated as they are ephemeral) in 2020-23 indicate that *A. imperator* is bivoltine in the Maltese Islands at approximately 36°N. The more than two peaks resulted from the emergence of different cohorts Fig. 3a,b), in the case of Ghadira at the different ponds and at all other sites due to various factors. For example, the peak from the end of July to mid-August resulted mainly from the reservoir at Wied Rihana filling up towards the end of spring 2023. The low numbers of exuviae collected overall between the end of February and the end of April outside Ghadira results, in part, because collection at most valley reservoirs is restricted to the shoreline at each end as the sides are often steep and very slippery.

Acknowledgements

I would like to thank Mark Gauci, Land Use Manager at Birdlife Malta who consented to the regular collection of exuviae from the ponds at Ghadira Nature Reserve, and to David Attard, Ray Vella and Victor Cilia for their help in locating the exuviae as well as for collecting the exuviae on occasions when I was away. Thanks also go to Denis Cachia who for several years provided records of sightings, oviposition and predation at Pond 1 where he used to set his photography hide.

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Recent colonisation of the River Ise in Northamptonshire by *Libellula fulva* Müller (Scarce Chaser) and *Calopteryx virgo* (Linnaeus) (Beautiful Demoiselle), and the decline in P*latycnemis pennipes (*Pallas) (White-legged Damselfly).

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Summary

The River Ise in Northamptonshire has varied habitat ranging from well-lit open stretches to fully tree-shaded sections, as well as slow-flowing, silty-based sections to fast-flowing gravelly-bottomed stretches. Water flow is engineered in sections, such as under road bridges, through urban areas and with weirs, to increase flow rates to prevent flooding. There are also naturally fast-flowing areas. The river has had a long-standing population of *Platycnemis pennipes* (White-legged Damselfly), and has recently been colonised by both *Libellula fulva* (Scarce Chaser) and *Calopteryx virgo* (Beautiful Demoiselle). Currently the most abundant species is *Calopteryx splendens* (Banded Demoiselle). In some areas of the Lower Ise Valley, *C. virgo* and *L. fulva* can be seen in close proximity to each other at the peak of their seasons, making this an interesting river to study. In the Upper Ise Valley, *C. virgo*, is now present in all suitable sections, but *L. fulva* is absent. This paper explores the habitats of this river and the colonisation by both new species, and details the decline in abundance (but not distribution) of *P. pennipes.*

Introduction

The River Ise in Northamptonshire is a tributary of the River Nene, rising in the north-west of the County at Naseby in a field that was part of the Battle of Naseby. It is a naturally fast-flowing river in its upper reaches, but has been over-deepened in places, causing a disconnect with water flood plains. It flows across the county and turns south between Rushton Hall and Boughton House, eventually joining the River Nene at Wellingborough in an area that forms part of the Upper Nene Valley Gravel Pits Special Protection Area (Natural England, 2014). The river has been straightened and deepened as it passes through

towns such as Kettering and Burton Latimer to prevent flooding, and a good example is along the public footpath by the Weetabix Food Company where the river has been split in two to avoid flooding the factory. Flow is managed through a network of 13 weirs and one sluice. These barriers are considered to have a negative impact on the aquatic environment, causing buildup of sediment, prevention of gravel movement and providing barriers to fish passage, and therefore presumably to movement of Odonata larvae too (Nene River Trust, 2022).

The Upper Ise (between Naseby and Burton Latimer) (Fig. 1) is classified as 'Ecologically Good (occasionally Moderate)' under the Water Framework Directive, with good levels of fish and high invertebrate levels (Environment Agency, 2023a). The Lower Ise is considered 'Poor', with only 'Moderate levels of Invertebrates' (Environment Agency, 2023b). The Lower Ise suffers poor nutrient management and poor livestock management as well as receiving run-off from urbanisation. There are a number of man-made devices to modify water flow, including the weirs at Burton Latimer. These devices reduce the flow upstream, creating a slow-flowing, silty river with densely vegetated margins. The Upper Ise is characterised by shallower channels, whereas the lower Ise generally has deeper channels, although there are plenty of faster flowing sections.

The Revital-Ise project (River Nene Trust, 2022) has made a number of recommendations including:

1) Additional riparian tree planting and management to increase shading
2) Reconnecting the river to its flood plain
3) Improving water quality and flow
4) Flood risk management.

As a result of this project, some barriers to fish movement have been removed. The level of tree shading on the Upper Ise is classed as good, but in some areas is considered too heavy, with the result that there is little or no aquatic plant growth.

Methods

The River Ise at Burton Latimer Pocket Park has undergone significant Odonata recording by the author over the last 20 years, with all records stored in iRecord (Biological Records Centre, 2024). Surveys have taken the form of monthly visits during the main flight season. Other areas of the Ise have been less regularly surveyed. The discovery of *Calopteyx virgo* (Beautiful Demoiselle)

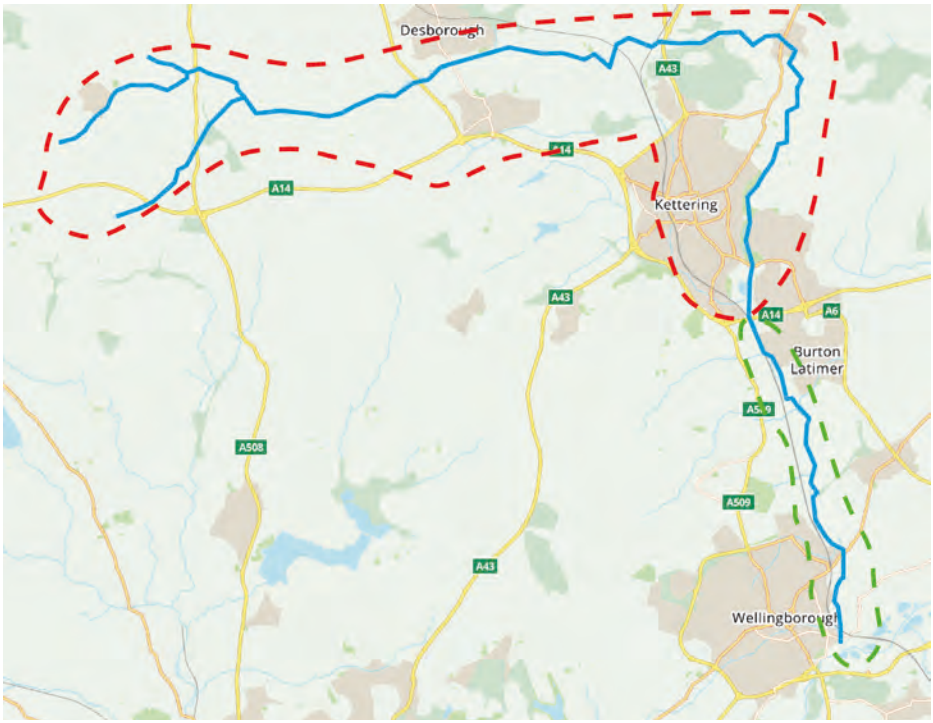

Figure 1: The River Ise showing the Upper Ise Valley (------) and the Lower Ise Valley (------). Map data from OpenStreetMap.

at the Pocket Park in 2020, and a possible sighting of *Libellula fulva* (Scarce Chaser) in the area around The Slips (British Grid reference SP8970) prompted a wider survey. During the 2022-2024 flight season (May – July), all areas of the Ise were visited and Odonata recorded. The Google Maps app running on an Apple iPhone 14 Pro Max was used to indicate likely areas for Odonata activity, and thus to focus attention. Additional records of *L. fulva* and *C. virgo* uploaded to iRecord (Biological Records Centre, 2024) were also included.

Results

The Upper Ise Valley

This section covers the river from its source at Naseby through Kettering to the A14 at Burton Latimer. The river is heavily tree-lined as it passes through arable fields for much of its length, opening out just north of Wicksteed Park. While *Calopteryx virgo* is tolerant of shade, completely shaded sections are

avoided, but those sections that get sunlight on the water at different times of the day can be occupied (Cham *et.al*., 2014). At Warkton, (SP890801) (Plate 1A) and Arthingworth (SP752811) (Plate 1B), for example, the river's flow rate is increased under road bridges which are of an open aspect required for road safety; consequently *C .virgo* is found in these short sections. Tree-shaded sections (Plate 2, for example) are devoid of any Odonata.

The dominant species on the Upper Ise is *C. virgo* (Fig. 2), where in many areas it is the only species present. Scattered records away from the river are thought to originate here, and their presence on Slade Brook in Kettering (SP863774) shows signs of further expansion into suitable habitat. The nature of the river in this section, with large areas of tree shading, is such that colonies of *C. virgo* tend to be quite isolated from each other. However, this species can occupy quite short sections of the river that meet the specific requirements for breeding. Whether this will ultimately harm the colonies is to be seen, but as it appears that all suitable sections on the Upper Ise Valley are already occupied, topping up of adults should continue.

The Lower Ise Valley

This covers the section of the river south of the A14 and includes the SSSI Southfields Farm Marsh. While this section is classified as ecologically poor (Environment Agency, 2023b), 16 species of Odonata have been recorded (Table 1). The majority of these species have been recorded in the very slow-flowing section at Burton Latimer Pocket Park (SP8874) (Plate 3A), where the water pools upstream of the weir (Plate 3B), essentially reducing flow to near zero. The dominant vegetation in the Lower Ise Valley comprises *Sparganium erectum* (Branched Bur-reed), *Phalaris arundinacea* (Reed Canary-grass) and *Schoenoplectus lacustris* (Common Club-rush). Slower sections support *Nuphar lutea* (Yellow Water-lily), which suggests that the channels have been over deepened (Nene River Trust, 2022). Downstream of the weir (Plate 3B), flow speeds up considerably and the diversity of Odonata declines significantly.

The first *Calopteryx virgo* were recorded on the Lower Ise Valley in 2020. *Calopteryx splendens* (Banded Demoiselle) is the dominant species on the Lower Ise but, in many sections of the upper reaches of the Lower Ise, both *C. splendens* and *C. virgo* can be seen together (Plate 4). While it has been reported that *C. virgo* favours faster flowing, shallower, gravelly rivers (Cham *et.al.*, 2014) and *C. splendens* slow-flowing muddy rivers (Cham *et.al*., 2014), these habitats would appear to be mutually exclusive. However, sections that host both species tend to be moderate-flowing and have muddy margins and reduced mud in the centre. Perhaps the larval requirement for gravelly substrate is less important than thought, and it is the flow rate (related to oxygen level) that is the determining factor.

A

B

Plate 1: (A) Fast-flowing, gravelly section under Pipe Lane, Warkton (SP890801), hosting a small colony of *C. virgo*; (B) Fast-flowing section under the bridge on Kelmarsh Road, Arthingworth (SP752811), hosting a small colony of *C. virgo*.

Plate 2: Typical tree-lined section of the River Ise (SP885795), with no odonate activity. .

Platycnemis pennipes (White-legged Damselfly) is also present here but has declined in the last 20 years, from estimates of ~120 adults at Burton Latimer Park in 2004 to zero recorded in 2024 (Fig. 3). The reasons for this decline are not understood, although during this time there has been a decline in *Phalaris arundinacea*, for which there is a known association (Cham *et. al*., 2014), along with an increase in *Sparganium erectum,* as well as an increase in flow rates during heavy periods of rain. This decline has been noted in terms of abundance of adults, but their distribution along the river has not changed significantly.

The sections covered by British National Grid References SP8971 and SP8970, as the River Ise flows south to enter Wellingborough, are more natural and pass through arable fields, but are not tree-shaded in many parts, presenting an open sunny aspect. Tree-shaded sections offer poor habitat for Odonata just like in the Upper Ise Valley. The river has a combination of faster flowing sections that host *C. virgo*, and slower flowing sections that host *P. pennipes* (Plate 5) and *Libellula fulva* (Plate 6) and, as the river widens and deepens towards its confluence with the River Nene at Wellingborough, *C. virgo* gives way to *L. fulva. Libellula fulva* is now well established on the River Nene, where first breeding was proven in 2006 (Tyrrell, 2013), and its distribution now extends to Cogenhoe and Billing near Northampton (Northants Dragonflies Group, 2024). *Libellula fulva* was first recorded on the River Ise in 2023. However, the

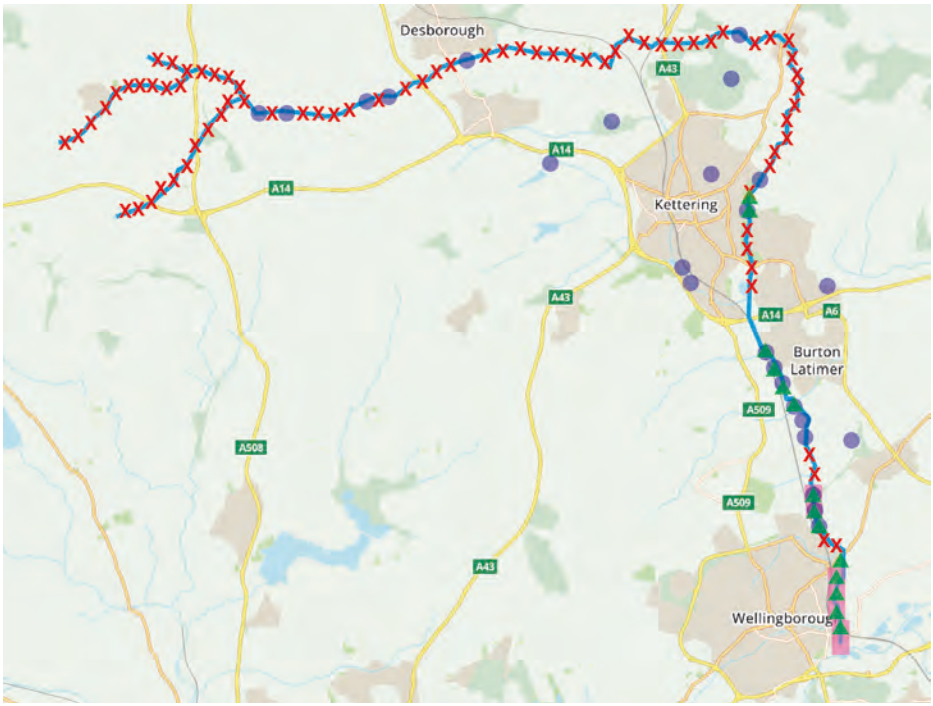

Figure 2: Distribution map showing records of all three target species on the River Ise. ● , *Calopteryx virgo*; ■ *Libellula fulva*; ▲ *Platycnemis pennipes*; X, areas with no Odonata present. Map data from OpenStreetMap. Gaps are where none of the three target species have been recorded, but where other Odonata have been recorded.

colonies become smaller as they extend north on the Ise, and have so far failed to reach Burton Latimer Pocket Park, which offers ideal habitat. Small breeding colonies offer less scope for expansion than large colonies. Should *L. fulva* become established at the Pocket Park, northwards expansion to the section by Kettering Skate Park is possible, but this may be some years away.

The resolution in Figure 2 is not sufficient to show the granular detail of the overlap in records of these three species. Individual records plotted to 100m resolution on the section of the Lower Ise Valley between Burton Latimer and North Wellingborough more clearly show this overlap (Fig 4). Here there are two 100m sections where all three species overlap, corresponding to areas where there are water pools just upstream of a weir. *Libellula fulva* is found in the area where the water pools, and *C. virgo* in the fast-flowing area, although all three species disperse along the river margins to establish their own territory.

Table 1. Species of Odonata recorded along the Lower Ise Valley and their breeding status.

Species	Breeding Status
Pyrrhosoma nymphula	Breeding
Brachytron pratense	Breeding
Coenagrion puella	Breeding
Enallagma cyathigerum	Breeding
Ischnura elegans	Breeding
Calopteryx splendens	Breeding
Calopteryx virgo	Breeding
Libellula fulva	Breeding
Orthetrum cancellatum	Not Breeding
Platycnemis pennipes	Breeding
Erythromma najas	Breeding
Anax imperator	Breeding
Aeshna mixta	Breeding
Aeshna grandis	Breeding
Sympetrum striolatum	Breeding
Chalcolestes viridis	Breeding not confirmed

Discussion

Potential Dispersal Routes to the River Ise

The River Ise at its confluence with the River Nene (Plate 7) is the source of the *Libellula fulva* colonies on the River Ise (Fig 5). The colonisation of the Nene by *L. fulva* has been tracked from its first discovery in 2007 at Fotheringhay (Tyrrell, 2013; Northants Dragonfly Group, 2024), but its spread northwards on the Ise will be determined by the river flow rates. Results from this study suggest it is unlikely to extend to the Upper Ise Valley upstream of SP8877, where the slow-flowing sections change to faster flowing or tree-shaded sections through Kettering. This is still 5km north of its current range boundary.

Tyrrell *et.al*. (2009) identified the potential of the River Ise for future colonisation by *Caloptreryx virgo* from the Brampton Valley Way (BVW) (Fig. 5), a tributary of the River Nene, which had just (2009) begun to be colonised by *C. virgo*. Since then, *C. virgo* has fully colonised the BVW (Tyrrell, 2013; Northants Dragonfly Group, 2024). The spread of records on the BVW, and the timing of records on the Ise, suggest that the source of the colonies of *C. virgo* on the Upper

A

B

Plate 3: (A) The River Ise at Burton Latimer Pocket Park is very slow-flowing and muddy, with abundant marginal and in-water vegetation; (B) The man-made weir at Burton Latimer Pocket Park.

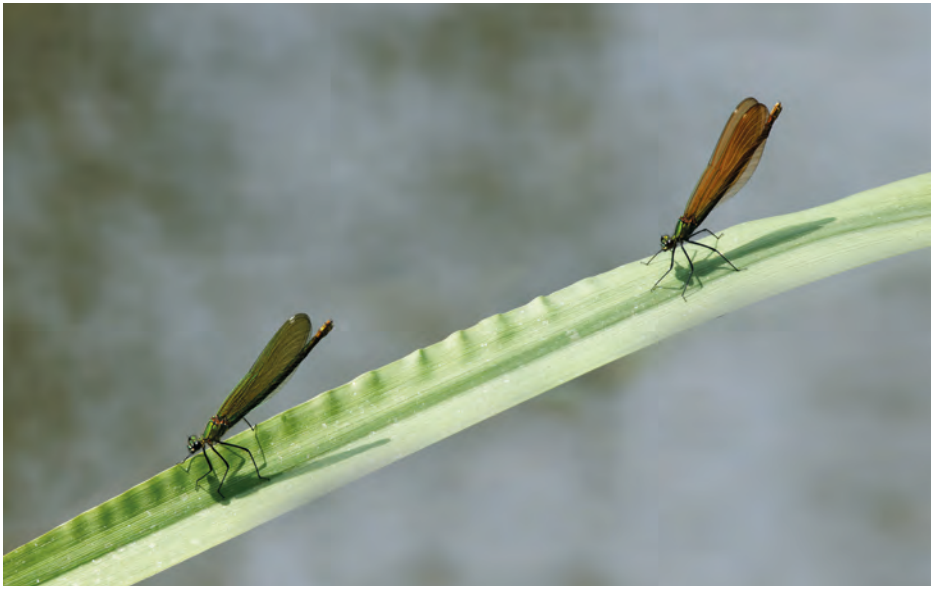

Plate 4: Female *Calopteryx splendens* and *Calopteryx virgo* sharing a perch overlooking a fast-flowing section at Burton Latimer Pocket Park.

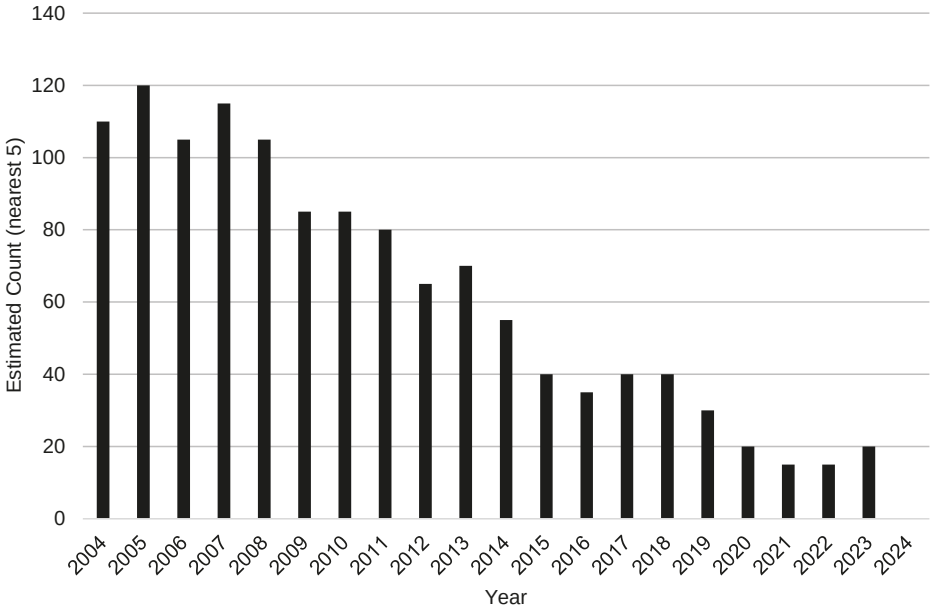

Figure 3: The decline in *Platycnemis pennipes* at Burton Latimer Pocket Park, 2004 – 2024. Counts are estimates rounded to the nearest five. *Platycnemis pennipes* was not recorded here in 2024.

Plate 5: *Platycnemis pennipes* ovipositing at the River Ise, Westfield Lodge (SP900718) in July 2023.

Figure 4: Detail of the Lower River Ise in the region of Burton Latimer. The records refer to 100 m stretches of the river and show overlaps of all three target species. ■, Libellula fulva; ▲ Platycnemis pennipes; ●, Calopteryx virgo. Map data from OpenStreetMap.

Plate 6: *Libellula fulva* in-cop. River Ise, Westfield Lodge (SP900718). June 2023.

Ise is different to that on the Lower Ise (Fig 5). The colonies on the BVW are some 5km south of the closest colonies on the Upper Ise, but those on the Lower Ise are about 12km east of the BVW. The source of colonisation of the River Welland (Leicestershire & Rutland Dragonfly Group, 2024), marking the boundary between Northamptonshire and Leicestershire, is also thought to have originated from the same source on the BVW as the Upper Ise Valley colonies. *Calopteryx virgo* is a wandering species and records from areas with no water are common (for example at Brampton Wood (SP795855), and the centre of Kettering Fig 2), so further expansion could occur at random.

The River Ise

The River Ise's importance to Odonata in the East Midlands is due in part to its combination of slow, silty sections and faster flowing sections, which have allowed the colonisation of both *Libellula fulva* and *Calopteryx virgo.* While the river has changed little over this time, the well documented eastwards movement of *C. virgo* made it inevitable that the existing suitable habitat of some sections of the Ise would be colonised. Similarly, the westwards expansion of *L. fulva* along the Nene lead to its colonisation of the Lower Ise. *Calopteryx virgo* is now present in all sections that appear to offer the optimum conditions; further expansion is only possible away from the river to Harper's Brook, which is 3 km north and 9 km east of the Upper Ise – a shorter distance than the proposed

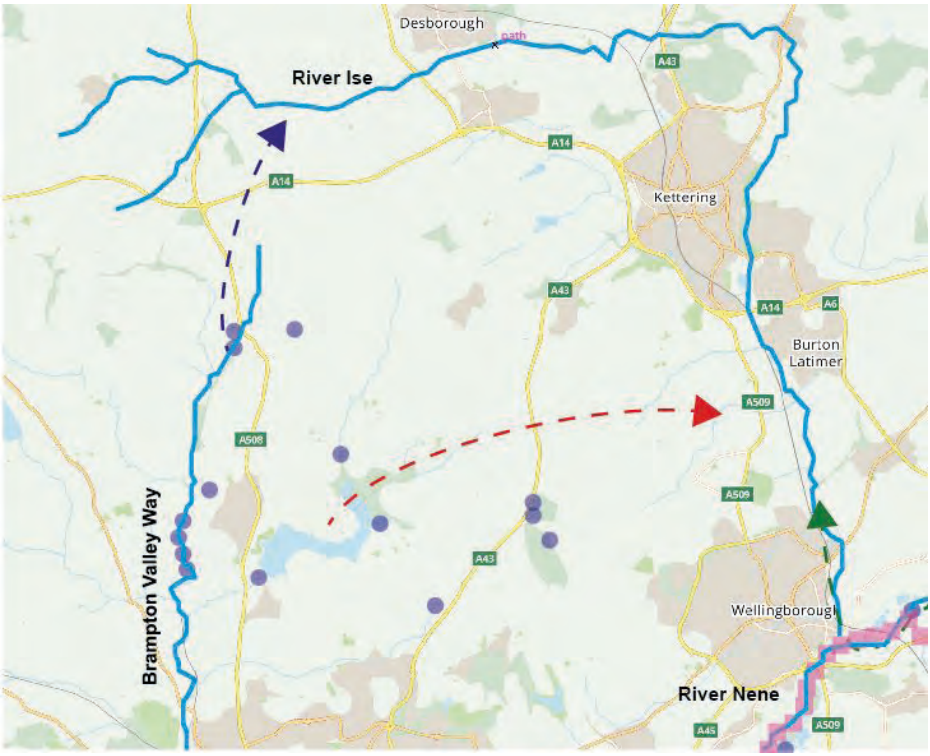

Figure 5: Likely dispersal routes of *Calopteryx virgo* from the Brampton Valley Way (- - - - - & - - - -) and *Libellula fulva* from the River Nene (- - - - -). Records of *C. virgo*, ● and *L. fulva*, ■ along the dispersal routes are shown.

colonisation route from the BVW to the Ise. Indeed, Doug Goddard recorded *C. virgo* close to Harper's Brook in June 2024 (Northants Dragonfly Group, 2024). *Calopteryx virgo* on the Ise does not appear to require the typical fast-flowing, gravelly-bottomed habitat that this species is known for, although it does occupy these on the Ise where they exist. However, it also occupies moderate-flowing stretches that are not overly gravelly. Indeed, it can be found in close proximity to *L. fulva*, which has totally different habitat requirements. It would appear that both species can tolerate moderate flow levels. Some washing away of silt and mud by the flowing river is expected, but on moderate-flowing sections of the Ise this is not to the extent found in other rivers where *C. virgo* is found (Cham *et.al*., 2014). The amount of exposed gravel on the riverbed reflects flow rates – very high flow rate leads to maximum gravel exposure. Oxygen levels will increase as flow rate increases and gravel bed exposure increases, but perhaps there is an increase in flow rate that raises water oxygen levels sufficiently to allow *C.virgo* to breed, but has limited effect on increased gravel exposure. This apparent broadening of the habitat requirements for *C. virgo*,

Plate 7: The confluence of the Rivers Ise (left) and Nene (right) (SP905689).

and its range expansion, reflect a positive response to climate change, allowing it to occupy formerly suboptimum habitats. *Libellula fulva* larvae live in the mud around marginal plant roots (Cham *et.al*., 2014) so, if the flow allows these to remain muddy, then there would be suitable larval habitat for this species as well. Flow rates will vary from the middle of the river to the margins, such that mud remains in the margins, but gravel begins to be exposed in the middle. This might just provide suboptimal conditions for both species.

The Revital-Ise project (River Nene Trust, 2022) is likely to lead to increased flow rates in the Upper Ise as it is restored to its more natural state, with improving tree shading as a form of flood control. There is also a recommendation that flow rates be increased at Burton Latimer Pocket Park, as the near stationary nature of the river, managed by the weir (Fig 3B), causes sedimentation, allowing the growth of *Nuphar lutea*, which is not considered beneficial to a river of this type. These changes may ultimately benefit *C. virgo*, but will be to the detriment of future expansion of *L. fulva* and for the other species of Odonata that breed in the Pocket Park (Table 1). The Lower Ise is naturally deeper and unlikely to be managed any differently to now, so the existing colonies of *C. virgo* and *L. fulva* look to be secure for now.

The decline in *Platycnemis pennipes*, and its apparent disappearance from some areas, such as Burton Latimer Pocket Park, is worrying but, where it maintains a stronghold, it seems to be stable but in low numbers. The now

isolated colonies in Kettering are considered most at risk from disappearing should there be some event that eliminates the larvae or should tree-shading increase, but the colonies south of Burton Latimer Pocket Park may be a source for future recolonisation.

Acknowledgements

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Wing Protection During Emergence in *Brachytron pratense* Müller (Hairy Dragonfly).

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Summary

Observations are reported showing how a recently emerged adult (i.e. teneral) *Brachytron pratense* (Hairy Dragonfly) oriented its body parallel to the direction of the wind during wing hardening, and then re-oriented it back, once the wings were sufficiently hardened, to maximise sun warming. It is considered that this behaviour is aimed at reducing the risk of wing damage through contact, albeit at increased risk of the teneral being dislodged.

Observations

A female *Brachytron pratense* (Hairy Dragonfly) was found in the early stages of emergence at Yardley Chase, Northamptonshire on 05 May 2024 and was observed between 08:20 and 11:30 BST. The day was sunny with temperatures from 9°C – 13°C, with scattered cloud cover, and a moderate south-south westerly breeze of 8mph (Time and Date AS, 2024). The larva had exited the water by climbing a dead stem of *Schoenoplectus lacustris* (Bulrush) and was oriented in an approximately west-east direction to receive the maximum sunlight. Being a south-south westerly breeze, this meant that the larva's orientation placed it close to perpendicular to the direction of the breeze.

After full extraction, the adult *B. pratense* began pumping fluid into its wings. At this stage, the adult remained in position perpendicular to the breeze (Plate 1).

As the wings expanded, the adult re-oriented its body to be close to parallel to the breeze direction (Plate 2). This was very precarious as its grasp on the exuvia was observed to be not as stable as in the original position. The adult struggled to maintain a firm grip on the exuvia, as the area of grip available when oriented parallel to the wind was greatly reduced, with constant re-adjustments of the legs needed to avoid being dislodged.

Plate 1: Fully extracted *Brachytron pratense* starting the wing inflation stage.

Plate 2: *Brachytron pratense* oriented parallel with the south-south westerly breeze direction.

Plate 3: *Brachytron pratense* re-oriented parallel with the sun to maximise warmth on the wings.

When the wings had hardened sufficiently, indicated by the change from milky to clear, the adult re-oriented back to its original position to maximise exposure to the sun (Plate 3). Upon re-orientation, it was observed that the breeze did separate the wings preventing them from coming into contact with each other. Another emerging *B. pratense* was found in close proximity, but this one was in a shaded position. It was noted that, although both began ecdysis at around the same time, the shaded adult took about 20 minutes longer to reach the flight stage, presumably because the warmth from the sun hastens wing hardening.

Discussion

Corbet (1999) discussed the events that lead to mortality during emergence and classified them into three types: 1) failure to moult, 2) failure to expand and harden the wings, 3) predation. The causes of the first two include physical factors such as low temperature and wind. Wind leads to the risk of adults being dislodged or causing damage to the wings. At this stage in the emergence process, the wings are very soft and delicate and subject to damage through contact with each other, or with surrounding plant material. It is a frequent occurrence to find recently emerged adults with damaged wings. The wind levels at the time of the current observation are considered low to moderate, so presumably insufficient to cause wing damage that cannot be mitigated by re-orientation. During windy conditions, adults must adopt the most appropriate strategy for survival, i.e. will orienting their bodies parallel to the wind cause a higher risk of being dislodged than the risk of wing damage? In high wind situations, the risk of either approach will be increased significantly such that neither would reduce the risk of mortality, and this must be balanced accordingly.

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Observations of male-female heterospecific connection between a male *Ischnura pumilio* Charpentier (Scarce Blue-tailed Damselfly) and a female *Coenagrion mercuriale* Charpentier (Southern Damselfly).

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Summary

An unusual heterospecific male-female coupling involving two genera (*Ischnura* and *Coenagrion*) was observed that resulted in full copulation.

Introduction

Male-female heterospecific connections are less frequently observed in Zygoptera than in Anisoptera (Corbet, 1999). Most of these connections are tandem formation. Whilst the male will encourage the female to bend her abdomen forwards, these couplings rarely progress to copulation, due to the incompatibility of the anal appendages and genitalia (Corbet, 1999). The female eventually detaches from the male and they go their separate ways. However, in the following note full copulation between a male *Ischnura pumilio* (Scarce Blue-tailed Damselfly) and a female *Coenagrion mercuriale* (Southern Damselfly) is described.

Observations

On 24 June 2024 a copulating pair of damselflies was observed at one of the rivulets flowing into the Latchmore Brook (British National Grid Reference SU194129) in the New Forest, Hampshire. Closer inspection revealed this to be a male *Ischnura pumilio* copulating with a female *Coenagrion mercuriale*.

The pair were observed for nearly 20 minutes, enabling a series of photographs to be taken. During the period of observation, the pair went through the arching

A

B

Plate 1. (A, B) A male *Ischnura pumilio* copulating with a female *Coenagrion mercuriale.*

movements of the abdomens, suggesting the stages of copulation associated with sperm removal and transfer were ensuing (Plate 1 A, B). Abdominal segment 3 was flexing in the manner of stages 1 and 2 of the copulation sequence described by Miller & Miller (1981), suggesting that copulation was actually taking place. The female finally detached from the male, which flew off while she perched close by.

At the same site, a male *I. pumilio* has previously been observed in tandem with a female *Ceriagrion tenellum* (Small Red Damselfly) of the dark variant var. *melanogastrum* (Cham in Brooks & Cham, 2014). On that occasion it did not progress to copulation.

Discussion

Heterospecific copulation in Zygoptera is rarely reported. The structure of the anal appendages and genitalia of *Ischnura* species is thought to exclude the possibility of forming a tandem linkage and full copulation with a female of a *Coenagrion* species (Corbet, 1999). Whilst the initial tandem formation was not observed, the fact that copulation progressed and continued for the time it did, suggests that both were co-operating during the process. Whether such couplings can result in actual sperm removal or transfer is unclear.

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Colour variants of female *Coenagrion pulchellum* Vander Linden (Variable Damselfly) in populations in England.

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Summary

Females of *Coenagrion pulchellum* (Variable Damselfly) exhibit a range of colouration. The immature colour variants, transitional colouration and their duration are poorly understood and recorded. The terminology used in guides for identification is inconsistent when describing the observed colour variants. This paper discusses the development of colouration and proposes an alternative approach to describing colouration of females and the transitional changes.

Introduction

The vernacular name of 'Variable Damselfly' is typically used to describe the variation seen in the males of *Coenagrion pulchellum*. However, the colouration of female *C. pulchellum* is more variable than in males and they exhibit a range of age-related colour phases. Colour polymorphism is widespread in female Zygoptera, and is well studied in *Ischnura* species, yet is poorly understood in other genera (Cordero & Andres, 1996).

Identification guides refer to two female colour forms of *C. pulchellum*, albeit using a range of differing terminology:

- Corbet *et al*. (1960) - refer to a dark form of females as f. *nigrescens* (Puschnig).
- Gibbons (1986) – describes females as commonly blue with many black markings, but may also be greenish or yellowish.
- McGeeney (1986) - refers to two forms, one blue and a dark form *nigrescens* (Puschnig).
- Askew (1988) – refers to females as dimorphic, being either a blue homeochrome form or a greenish yellow heterochrome form.
- Mendel (1992) – "a dark *nigrescens* form and a blue form."

- Parr in Brooks (1997) – "dimorphic having a blue form and a green form" (illustrated and labelled as a blue form and a dark form).
- Powell (1999) – "a mature blue female and a mature green female."
- Nelson and Thompson (2004) – "a blue form and a dark form."
- Smallshire & Swash (2018) – "a dark form similar to female Azure Damselfly and a blue form which shows a little more blue on the top of the abdomen than the Azure Damselfly."
- Dijkstra *et al*. (2020) – "a blue andromorph form and a green gynomorph form with an all-black abdominal dorsum, not dissimilar to the common type of *Coenagrion puella* (Azure Damselfly) female."
- Riley (2020) – "blue and dark forms."
- BDS (website accessed 03/07/24) – "dark form and blue form; either blue and black or almost entirely black."
- Curd (website accessed 03/07/24) – "two forms; blue/andromorph form and dark/green/gynomorph form."

By definition, andromorph and gynomorph refer to morphology that is male-like and female-like respectively, whereas homeochrome and heterochrome, androchrome and gynochrome relate to colouration. Similarly, the terms 'blue form' and 'green form' refer to colour, whereas the term 'dark form' refers to a shade, the inverse of which is 'light'. Cordero & Andres (1996) acknowledge that polymorphism in Zygoptera is based on colour and not on morphology.

The 'dark form', (also referred to as the gynomorph, gynochrome and heterochrome, or *nigrescens*) has been used to describe females where the dorsum of the abdominal segments is predominantly black. The thin rings at the inter-segmental joints are coloured and contrast with the black.

The term 'blue form' (also referred to as the andromorph, androchrome and homeochrome), has been used to describe females, and is regarded by some authors as male-like, where the dorsum of the abdominal segments is a clearly delineated combination of 'blue' and black; the blue taking up varying proportions of each segment and there also being other colours in some individuals. There has also been a tendency to include all females that are not 'dark form' under the 'blue form', even when they are predominantly green or orangey-brown in the mature phase. This causes issues in terms of identification and recording.

Variety of female colour forms

The colouration of *Coenagrion pulchellum* females comprises a combination of differing colours on the head, thorax and abdomen. This contributes to the confusion provided by descriptions of colour variants based on one colour on the abdominal segments. Thus, for example, Thompson & Nelson (2014) refer to a

'blue form', yet show a female with a green thorax, and a 'dark form' and show a female with a blue thorax. The terminology used to describe colour variants (polymorphism) relating to *Coenagrion* species as outlined above is inconsistent throughout the literature and websites. Little attention has been given to the immature and transitional colour phases and the existing terminology is not appropriate for describing these phases.

Identification to species level has important implications for monitoring and conservation of rare species, as well as the verification of records submitted with photographs. *Coenagrion pulchellum* is of high conservation value and it is important to correctly distinguish females at all stages of development from other *Coenagrion* species, especially *Coenagrion puella*.

Whilst the shape of the posterior margin of the pronotum is the most definitive diagnostic feature to distinguish females of *C. pulchellum* from other coenagrionids, it needs close examination of individuals and is not always easy to see without high-quality, close-up photographs or by catching individuals. Therefore, a good understanding of the different female colour variants helps recorders to assess populations, especially when other species of Coenagrionidae are also present.

Methods

Sites across southern England were visited, over a period of 20 years (2004-2024), to observe and photograph *Coenagrion pulchellum*. Over 3500 photographs of males and females were taken, with particular attention to female colour variants. Whenever possible, dorsal and lateral views of an individual were taken. To facilitate rapid retrieval of any image, all photographs were saved and managed in Adobe Lightroom, sorted by date and keyworded with species, sex, colouration, in-tandem, *in-copula*, ovipositing and location. To supplement these, photographs of *C. pulchellum* posted on social media groups dedicated to British dragonflies were used for comparison, particularly those showing unusual colouration and markings.

Sites visited and where photographs were taken include the following:

- Cambridgeshire - Paxton Pits NR (British National Grid Reference TL1962), Fen Drayton lakes RSPB reserve (TL3369), Meadow Lane gravel pits St.Ives (TL3270), Woodwalton Fen NNR (TL2384).
- Bedfordshire - Felmersham NR (SP9958), Willington gravel pits (TL0950).
- Somerset Levels - Ham Wall RSPB reserve (ST4539), Westhay Moor NNR (ST4543).

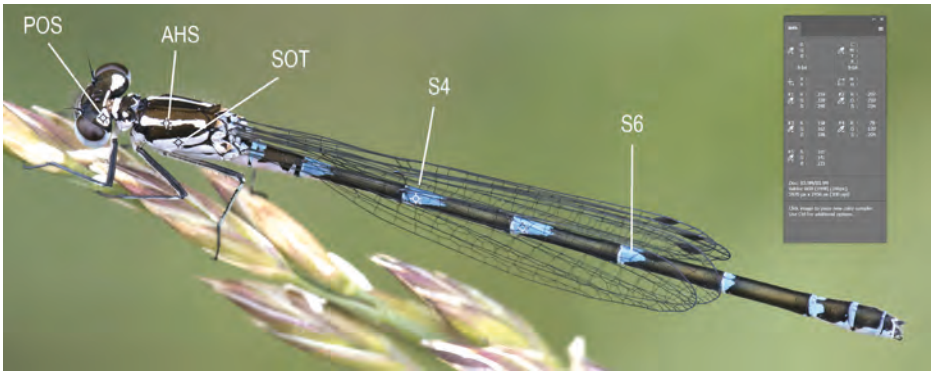
Paxton Pits NR was the primary site visited throughout the flight season of *C. pulchellum*. Breeding has been proven at both Hayling Lake and Rudd Lake, where the large populations are typically recorded each year in either the estimated ranges of 100-500 or >500 (based on the BDS recording scheme). Annual visits and regular observations have been made from emergence, starting in April, through the adult flight season, enabling *C. pulchellum* females to be photographed as they pass through colour transitions during the maturation process. The timing of site visits varied and were typically from approximately 10.00 BST (British Summer Time) through to 16.00 BST. Some visits were made earlier and commenced from 05.30 BST.

Sites on the Somerset Levels, with exceptionally large populations of *C. pulchellum* (estimated in thousands and recorded as >500), were also visited to assess and compare female variations. These sites were assumed to be sufficiently distinct and well separated (322km) from the study sites in Cambridgeshire, to show if any notable differences existed between populations.

The exact timing of maturation is difficult to determine in damselflies. Maturation occurs away from water, in meadows and sheltered hedgerows in the hinterland of the breeding site. (At this time there is little or no activity at the breeding site. In addition, the same areas are utilised for roosting overnight). Sexual activity was observed approximately one week after the first emergences were observed. Females in tandem usually resulted in copulation, confirming that the female had become sexually active. Although copulation can possibly start before reaching full sexual maturity, females arriving in tandem at the breeding site were regarded as mature. Photographs of oviposition in tandem were regarded as females producing fertilised eggs and thus indicating mature colour variants. Teneral individuals, observed emerging and then taking their maiden flight, were targeted for photography to record and confirm the colouration of the early phases.

The limitations of describing colour variation of damselflies by the human eye has previously been highlighted (Joop *et al*., 2006). To reduce the subjectivity in describing colour, the colouration of *C. pulchellum* variants was measured from photographs using the ‘color sampler’ tool in Adobe Photoshop 2024 set to sample 5x5 pixels. Photographs were viewed on a monitor which was calibrated using a Datacolor Spyder X Elite colour calibrator. This allows a number of precise colour points to be measured from individual body parts on a photograph and the RGB value recorded.

Point colour measurements were taken from the centre of a post-ocular spot on the head (POS), the mid-point of an antehumeral stripe (AHS), the mid-point on the upper edge of the coloured bar on the side of the thorax (SOT) and



P**late 1.** Female *Coenagrion pulchellum* showing the points used for colour measurements - POS, post ocular spot; AHS, antehumeral stripe; SOT, side of thorax; S4, coloured portion of S4; S6, coloured portion of S6. Inset shows the colour sampling tool with RGB measurements.

the coloured portion of abdominal segments S4 and S6 (Plate 1). Segments S4 and S6 were selected as these show the greatest differences during colour transitions. For dark variants a point measurement was taken from the intersegmental ring between S4 and S5.

All measurements were performed on high resolution 16-bit images with the minimal amount of in-camera processing or subsequent digital manipulation. Due to differing exposures (luminance) by the camera the absolute colour value is not possible to measure exactly. The colour of any selected point can therefore be described by the relative proportions of three colours from the Adobe RGB (Red/Green/Blue) colour space where pure black is RGB 0:0:0, pure white is 255:255:255 and mid grey is 127:127:127. The relative RGB values taken from points on photographs of *C. pulchellum* therefore show which colour predominates (shown in **bold** in the plate legends).

It should be noted that the colours in the photographs in this paper (saved as 8-bit tiffs), are by default printed in the CMYK (Cyan/Magenta/Yellow/Black) colour space. They will therefore vary slightly from the same photographs displayed on a backlit monitor using colours measured in RGB. The colour plates and associated legends describe the immature, transitional and mature colouration of the observed female variants.

To promote greater clarity in the terminology used to describe female colouration, they will be referred to as ‘dark form’ and ‘variegated form’ in the following sections. Variegated is defined as ‘having a pattern of different colours or marks’ (Cambridge Dictionary (2024)) and is more appropriate than ‘blue form’ for describing the observed variation in female colouration of the non-dark forms.

It should be noted that each of these two forms go through transitional colour phases during maturation which give rise to variations of colour and herewith referred to as 'variants' of these forms.

Results

Many females (single, in-tandem and in-copula) of *Coenagrion pulchellum* were photographed and evaluated, illustrating a range of mature and immature, age-related colouration. In the first few days after emergence commenced, the teneral and immature colouration predominated and no sexual activity (tandem or copulation) was observed. In subsequent weeks a mix of immature and mature colour variants could be distinguished and pairs in-tandem and *in-copula* were observed. From the middle and towards the end of the adult flight season the individuals with teneral or immature colouration diminished to zero.

Tenerals and immature females

Following emergence, and at the time of the maiden flight, the colouration of the sides of the thorax and the antehumeral stripes of both the dark and variegated forms is orangey-pink (Plate 2). Teneral variegated forms show some variation at this stage; some with blue on the abdominal segments (Plate 2) and others with orangey-brown colouration (Plate 3).

Within 1-2 days the teneral colouration has transitioned, with some immature dark and variegated individuals showing a grey colouration with a higher blue component on the head and thorax (Plates 4 & 5).

From all the observations of teneral and early immature individuals, green colouration was not observed on any part of the body during these stages, this developing later in the maturation process.

Mature females

Females observed ovipositing or arriving at water in tandem, and thus mature, were recorded in two 'forms', each with a range of colour variants, comprising the following:

- Dark abdomen with blue thorax (Plate 6).
- Dark abdomen with green (sometimes yellowish-green) thorax (Plate 7).
- Variegated abdomen with blue segments and blue thorax (Plate 8).

Plate 2. Teneral females of *Coenagrion pulchellum* photographed within 15 minutes of taking their maiden flights (Paxton Pits, April 2024).

Variegated form (left) showing early stages of blue colouration on abdominal segments – RGB values::

POS	201	188	**207**
AHS	**172**	132	132
SOT	**181**	165	171
S4	78	78	**124**
S6	87	84	**113**

Dark form (right) – . Note the point measurement S4/5 was taken from the intersegmental ring between S4 and S5. RGB values:

POS	222	216	**237**
AHS	**206**	182	204
SOT	210	197	**219**
S4/5	164	172	**203**

Plate 3. Teneral female of *Coenagrion pulchellum* Variegated form. This individual is likely to develop through the brown phase to the green variant. Note the lack of blue on the abdominal segments compared to the Variegated form shown in Plate 2. RGB values:

POS	**210**	181	193
AHS	**227**	196	195
SOT	**143**	108	83
S4	**129**	123	97
S6	**135**	121	101

- Variegated abdomen with turquoise-green segments and green (sometimes yellowish-green) thorax (Plates 9, 10, 11, 12 &13).
- Variegated abdomen with turquoise green segments and orangey-brown thorax (Plates 14 & 15).

The ‘dark form’ described by various authors (above) was observed to occur in at least two mature colour variants. The dorsum of the abdominal segments was predominantly black with a coloured ring at the margins of the inter-segmental joints. In the majority of dark forms this ring was blue but, in some individuals, was green. In dark form females the sides of the thorax becomes either green or blue in mature individuals. In addition, the colour of the post-ocular spots on the head was similar to the colour of the antehumeral stripes and sides of the thorax. This feature could be observed from distance with binoculars or from photographs when other parts of the body were obscured. These two mature ‘dark form’ females are best described as ‘dark form – blue variant’ and ‘dark form – green variant’.

The ‘blue form’ described by various authors (above) can only correctly be applied to mature females of the ‘variegated form’ that have blue on the thorax and on the abdominal segments. The blue on the abdominal segments of these mature females is strongly deep blue (Plate 8). This is a fully mature female best described as a ‘variegated form - blue variant’.

Plate 4. Female *Coenagrion pulchellum.* Dark form - immature. This individual will develop through to blue. Note that blue is the dominant colour in each measurement. RGB values:

POS	225	225	**247**
AHS	220	217	**247**
SOT	206	206	**241**
S4/5	96	97	**125**

Other females of the 'variegated form' had combinations of colour where 'blue form' does not adequately describe these individuals. Females were recorded with a green thorax and antehumeral stripes and abdominal segments that were in a transition phase from blue to turquoise-green to green**.** This colour variant is clearly different from the all-blue variant (Plate 8) with less deep blue on the abdomen and best described as a 'variegated form - green variant' (Plate 9). Thus a number of the mature individuals of the 'variegated form' appeared to be transitional phases and have a different maturation pathway to individuals of the 'variegated form - blue variant' (Plates 10-16). In transition they tend to show remnants of the brown on the head and turquoise blue on the abdomen (Plates 10 & 11) or a yellowish-green thorax (plate 12). Some of these variants had some faded blue on the abdominal segments and others where the colour of the abdomen could be described as yellowish-green, turquoise-green or green (Plates 9 -13). Although the yellowish-green individuals were mature, they were transitional and continued to become greener as they aged.

The greatest departure from the 'blue' or 'dark' forms, used previously, were mature females that had orange-brown colouration on the thorax and antehumeral

Plate 5. .Female C*oenagrion pulchellum*. Variegated form – transitional phase. This individual will develop through to blue. Note that the 'pink' colouration has a high blue component. RGB values:

POS	92	89	**105**
AHS	163	142	**175**
SOT	169	157	**186**
S4	80	77	**184**
S6	95	102	**208**

Plate 6. Female *Coenagrion pulchellum*. Dark form – blue variant - mature. Note that the blue component is the dominant colour in each measurement. RGB values:

POS	208	217	**253**
AHS	173	188	**248**
SOT	109	128	**211**
S4/5	163	173	**239**

stripes (Plates 14 & 15). The post-ocular spots were of a similar colour. The abdominal colours of these same individuals ranged from pale turquoise blue to pale green. These variants were observed in the Cambridgeshire and Somerset populations, and also occur in other populations further away, e.g. in Yorkshire (Pritchard, 2023). These variants are clearly mature adults and seen *in-copula* and ovipositing, yet continue to go through transitional colour changes and become greener as they age. The tenerals and early immatures of these females also had orange-brown thoracic colouration (Plate 3). Individuals of this form might be described as 'variegated form – intermediate variant' until a time when their development pathway can be elucidated.

The populations of *Coenagrion pulchellum* in the Fenlands of Cambridgeshire and the Somerset Levels are among the largest in Britain and Ireland and therefore are representative of the range of forms and their variants of this species. Observations of oviposition and especially group oviposition, have

Plate 7. Female *Coenagrion pulchellum*. Dark form – green variant - mature. Note that green is the dominant colour in each measurement and that the blue component is low. RGB values:

POS	119	**123**	71
AHS	157	**162**	100
SOT	129	**151**	89
S4/5	177	**189**	170

shown that the mix of mature colour forms and associated variants of female *C. pulchellum* can vary between different populations. During May 2024 the 'variegated form-blue variant' was predominant on the Somerset Levels, whereas at Paxton Pits the 'variegated form - green variant' was predominant. Both forms, including all colour variants, were present at each site in differing proportions. Variants exhibiting what has previously been regarded as immature colouration were also observed *in-copula* and ovipositing, confirming that transitional colour phases continue to develop over the adult lifetime. Nelson & Thompson (2004) also noted that the 'dark form'was less numerous in most populations in Ireland.

Discussion

Female colour variants are widespread among Coenagrionidae species. Females of *Pyrrhosoma nymphula* (Large Red Damselfly) and *Ceriagrion tenellum* (Small Red Damselfly) have named colour forms, without specific reference to whether they are male-like or not. The females of *C. tenellum* have three named forms, with the red f. *erythrogastrum* being one of the most convincing examples of a female with male-like colouration of any species of Zygoptera (Brooks & Cham,

Plate 8. Female *Coenagrion pulchellum*. Variegated form – blue variant – mature. Note the very strong blue component in all measurements. Compare this to Plate 5. RGB values:

POS	140	154	**240**
AHS	153	172	**233**
SOT	140	160	**228**
S4	164	182	**251**
S6	181	198	**252**

2014, Smallshire & Swash, 2018). In contrast, females of *Coenagrion* and *Ischnura* species have been referred to as androchrome and gynochrome, or andromorph and gynomorph based on their colour, few of which are compelling male mimics or male-like to human observers. The exception is the blue female of *Ischnura elegans* (Blue-tailed Damselfly), which is a good male colour mimic and can be difficult to distinguish from males without close scrutiny and the term androchrome is applicable in this case. Research has shown that this can convey advantages to these females by avoiding excess male attention (Cordero & Andres, 1996; Van Gossum *et al*, 2008). Male mimicry and the associated terminology are less easy to apply to *Coenagrion* species where the patterns of colouration of females bear little resemblance to males. Joop *et al*. (2006) cautioned about transferring conclusions regarding male mimicry from one genus or even one species to another.

Studies of *Coenagrion puella*, using dead females of different colour variants, have shown that the abdomen coloration pattern and structural features such as the presence of wings were the most important cues for sexual recognition by males (Gorb, 2004). McKee *et al*. (2004) found that males of *C. puella* readily identify and intercept conspecific females, even when flying, and report that andromorphs and gynomorphs are equally susceptible to male attention. One would also expect little if any difference in the closely related *Coenagrion pulchellum* where female colour variants are easily distinguishable from males. Joop *et al*. (2006) concluded that black patterning in *C. puella* is a stronger female attribute for detection by males than the colour differences. They also found that mate recognition is unlikely to be based on ultraviolet signals, which is often quoted to be a characteristic of insect vision.

Plate 9. Female *Coenagrion pulchellum*. Variegated form – green variant – mature. The low blue component in the measurements and the strong red component indicate that this female has developed from the orangey-brown phase. RGB values:

POS	**201**	165	87
AHS	**172**	161	107
SOT	179	**183**	99
S4	182	**196**	172
S6	**192**	185	135

Plate 10. Female *Coenagrion pulchellum*. Variegated form – transitional phase – mature. This female will develop towards green. It still shows remnants of the brown on the head, and the blue on the abdomen is more turquoise and starting to transition to green. RGB values:

POS	**169**	161	101
AHS	175	**195**	142
SOT	138	**168**	112
S4	147	177	**194**
S6	143	169	**180**

Observations of *C. pulchellum* in Cambridgeshire and Somerset show that males readily form tandems with any of the conspecific female variants and this reflects the predominant variant in the population (*pers.obs*.). These observations are comparable to that suggested for *I. elegans* by Tyrrell (2007), where mating success depends on the proportion of each female variant in a population.

Describing females as dimorphic or by one colour overly simplifies the situation and does not adequately describe the range of colour combinations and variation observed in *C. pulchellum* and thus is potentially confusing to novice observers. Colour phases and their transition in *C. pulchellum* females are age-related but not linked with the stages of maturation. Sexually active females, *in-copula* and ovipositing, can exhibit a range and combination of colours and the observations reported here indicate that colouration continues to develop after females have become sexually mature. This has also been suggested for *Ischnura elegans*, where males mate with so-called ‘immature’ females (Tyrrell, 2007; Mill & Green, 2023). This colour development after maturity is also analogous to the over-mature colouration that develops in females of some Anisoptera species, e.g. *Libellula depressa* (Broad-bodied Chaser) (Brooks & Cham, 2014)

Plate 11. Female C*oenagrion pulchellum*. Variegated form – transitional phase – mature. This ovipositing female will continue to develop towards green. It still shows remnants of the brown on the head and thorax, and the blue on the abdomen is more turquoise and starting to transition to green. Note how S6 has a strong green component during this phase. RGB values:

POS	**167**	144	87
AHS	**202**	188	99
SOT	**181**	176	99
S4	150	177	**196**
S6	124	**140**	111

Plate 12. Female *Coenagrion pulchellum*. Variegated form – transitional phase – mature. This female will continue to develop towards green. It still shows remnants of the brown on the head, and the thorax is starting to transition to green through what some authors have described as yellowish. Note how S4 and S6 have a strong green component. RGB values:

POS	**158**	142	111
AHS	180	**183**	102
SOT	165	**174**	88
S4	171	**180**	174
S6	181	**187**	176

Human observers can readily distinguish females of *C. pulchellum* (and *C. puella*) from males in the field, and it is difficult to conceptualise how male *C. pulchellum* could mistake some females for males. The concept of androchrome (male-like) and gynochrome (female-like) colour forms or morphs therefore appears inappropriate terminology for describing colour variation in *C. pulchellum* females.

It is reasonable to describe females as being of either a ‘dark form’ or a ‘variegated form’, which, irrespective of colour describes the patterning on the abdominal segments that persists throughout development from the teneral phase to the mature adult. This comes with the proviso that each form has variants that develop along different maturation pathways and have colour phases with differing combinations of abdominal and thoracic colouration. At sexual maturity the two forms also have different colour variants, none of which can be convincingly described as male-like.

Plate 13. Female *Coenagrion pulchellum*. Variegated form – transitional phase – mature. This female is likely to be in the phase before that shown in Plate 12. It will continue to develop towards green. It also shows remnants of the brown on the head, and the thorax is yellowish-green. Note how S6 has a strong green component. RGB values:

POS	**183**	175	96
AHS	210	**218**	169
SOT	157	**182**	136
S4	178	208	**238**
S6	193	**209**	205

The different colour 'forms' of damselflies give rise to regular identification queries and website requests (British Dragonfly Society, 2024). The terminology and descriptions used to describe female colour forms and variants of Zygoptera throughout the Odonata literature is inconsistent and confusing to novice and experienced observers alike. Its use in future field guides and publications needs to be carefully considered. The use of 'Dark form' and 'Variegated form' is proposed here, as being more appropriate terminology to cover the range of observed female colour variants of *C. pulchellum*, at least until further research can elucidate the maturation pathways in more detail. The following terminology is therefore proposed to distinguish the mature forms and their associated variants.

1. **'Dark form – blue variant'** for those with dark abdomen and blue thorax
2. **'Dark form – green variant'** for those with dark abdomen with green (sometimes yellowish-green) thorax
3. **'Variegated form – blue variant'** for those with variegated abdomen with blue segments and blue thorax

Plate 14. Female *Coenagrion pulchellum*. Variegated form – transitional phase – mature. This female is likely the phase before that shown in Plate 10. It will continue to develop towards green. It shows brown with a strong red component on the head, and the sides of the thorax are transitioning towards yellowish-green. RGB values:

POS	**149**	136	90
AHS	**176**	155	99
SOT	**161**	138	67
S4	130	146	**191**
S6	155	173	**207**

4. **'Variegated form – green variant'** for those with variegated abdomen with turquoise - green segments and green (sometimes yellowish-green) thorax
5. **'Variegated form – intermediate variant'** for those with variegated abdomen with turquoise green segments and orangey-brown thorax

Plate 15. Female *Coenagrion pulchellum*. Variegated form – transitional phase – mature. This female is likely the phase before that shown in Plate 14. It shows orangey brown with a strong red component on the head and the sides of the thorax. The blue on the abdominal segments is transitioning towards turquoise-green. RGB values:

POS	**181**	151	83
AHS	**188**	155	94
SOT	**144**	124	58
S4	159	181	**234**
S6	157	**162**	154

The approach described here has limitations and cannot definitively determine the development and transitional colour phases of individual damselflies. Further research on the maturation process is clearly needed to establish how the colour variants of *C. pulchellum* and possibly other *Coenagrion* species, develop throughout the lifetime of individuals. Mark-release-recapture throughout maturation or captive studies could provide a definitive answer to this question and it is hoped that researchers take up this challenge. The dragonfly recording community across all parts of Britain and Ireland can also contribute, by taking and sharing photographs of *C. pulchellum* with particular attention to colour variants. This will contribute to a better understanding of the variation in, and development of, colour forms of female *C. pulchellum* and differences across populations, as well as helping to distinguish them from those of *C. puella,* without the need for close examination of the pronotum.

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Migratory and dispersive Odonata in Britain: the events of 2023

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Summary

The 2023 dragonfly season saw a number of major migration events, with the highlight clearly being the appearance of at least seven, and probably many more, individuals of the North American *Anax junius* (Common Green Darter) on the Isles of Scilly during late October and the first days of November. A substantial influx of *Anax ephippiger* (Vagrant Emperor) seen during April and May was another highlight, to be followed by smaller scale arrivals during the autumn. The first successful breeding of *A. ephippiger* in Britain was also confirmed when, following oviposition noted during late spring, an exuvia was found at Windmill Farm Nature Reserve in Cornwall on 22 September. *Sympetrum fonscolombii* (Red-veined Darter) arrived in good numbers during spring and early summer, with several instances of successful local breeding then being identified as the season progressed; the first second-generation individuals appeared as early as 10 August. *Anax parthenope* (Lesser Emperor) had a record-breaking year in Britain, though much of this was likely due to the rapidly growing local breeding population. The amount of fresh immigration that took place is difficult to determine, but with a record as far north as the Orkney Islands, it is likely to still have been substantial. The present status of *Aeshna affinis* (Southern Migrant Hawker) in Britain is similar to that of *A. parthenope* but, while the local breeding population appeared to do fairly well, the current reporting year saw relatively little obvious further immigration by the species. Finally, the rapid range expansion of *Aeshna isoceles* (Norfolk Hawker) in Britain continued apace. This once rare and highly localised species was seen as far away from its East Anglian strongholds as Teesside and Cumbria. Little is as yet known about the drivers for this expansion, but records from the south coast of England, at least, might perhaps reflect immigration from the Continent.

Account of species

Notable sightings reported to the BDS Migrant Dragonfly Project during 2023 are detailed below; for information on events during 2022, see Parr (2023).

Chalcolestes viridis (Vander Linden) – Willow Emerald Damselfly

In contrast to many recent years, 2023 was a relatively unspectacular one for *Chalcolestes viridis* in Britain, with neither major range expansion nor obvious fresh immigration being noted. However, a male recorded from Severn Beach, Gloucestershire, on 26 June (VS) becomes the new most westerly record for Britain. Individuals seen at Rainton Meadows, County Durham, on 13 September (IEB) and 9 October (JFi) are also of interest, though these are not quite as far north as the sighting made at Gosforth, Tyne and Wear, during 2022 (Parr, 2023).

Lestes barbarus (Fab.) – Southern Emerald Damselfly

Following a very poor year for the species in 2022, when there were virtually no records submitted from the entire country (Parr, 2023), the current reporting year saw a big improvement in fortunes at most of the species' known breeding sites. The one exception was on the Isle of Wight, where the continued absence of records suggests this colony may now have become extinct. To compensate, a new inland colony was discovered near Cambridge during late June (JB). In addition to this improved breeding success, further fresh immigration is likely indicated by coastal records from near Seasalter in north Kent on 21 August and 6 September (MGo), from Caister-on-Sea, Norfolk, on 22 August (MW) and from near Sheringham in Norfolk during mid-September (JMC).

Lestes dryas Kirby – Scarce Emerald Damselfly

The first records of *Lestes dryas* for Landguard Bird Observatory on the Suffolk coast were made in 2021, under circumstances suggestive of an influx (Parr, 2022). Although the species reappeared in 2022, no sightings were made during 2023 and it would appear this colony's presence was only very transient, presumably because the habitat was sub-optimal. Late June 2023 saw the first records of *L. dryas* for another coastal Bird Observatory, namely Dungeness Bird Observatory in Kent (DBO), and it will be of great interest to follow the fate of the species at this new site.

Away from the coast, the discovery of *L. dryas* at ponds near Woburn in Bedfordshire during high summer (SC) is of considerable interest, this being the first county record for 70 years.

Aeshna affinis (Vander Linden) – Southern Migrant Hawker

Following a quiet season for the species in 2022 (Parr, 2023), it was pleasing to see good numbers of *Aeshna affinis* once again reported from many of its

breeding strongholds in south-east England and from outlying colonies such as those at Otmoor in Oxfordshire and Hempsted in Gloucestershire. There were also suggestions of local range expansion with, for example, records from several sites in the far west of Suffolk, a county where records had hitherto been primarily from the coastal grazing marshes in the east or the valley fens in the north.

Immigration and/or long distance internal dispersal of *A. affinis,* by contrast, appeared relatively low-key during 2023, though with the growing spread of resident breeding populations the precise status of individual dragonflies is becoming increasingly difficult to determine. Records from Newport Wetlands in Monmouthshire on 16 August (PJ) and 27 August (TC) likely refer to migrants, as the only previous reports from the area were back in 2019. A series of sightings from Marazion Marsh and the Lizard Peninsula in west Cornwall during late August and early September, late in the flight season, may well also involve immigrants given the lack of reports earlier in the year, even at the better-watched sites. Of particular interest amongst these records was a male attracted overnight to a moth trap at Kynance Cove on the night of 31 August (TWi). A sighting of a female at Portland Bill, Dorset, on 25 August (MC) is from a well-known migration hotspot, as are sightings of singletons at Spurn, East Yorkshire, on 16 July (TWh), 9 August (HA) and 15 August (CC). A report from Dale Airfield in Pembrokeshire on 13 August (HL) is also of note, though with records there in September 2021 (Parr, 2022), it is perhaps not impossible that an undiscovered breeding site lies nearby.

Aeshna isoceles (Müller) – Norfolk Hawker

The status of *Aeshna isoceles* in Britain has changed markedly in recent years, with this once rare and highly localised species becoming increasingly widespread. Away from the current core populations in East Anglia and surrounding counties, the new colonies at Chichester in West Sussex, Radipole in Dorset and Slapton Ley in Devon all appeared to do well during the current reporting year. Following records there in 2022 (Parr, 2023), further sightings were also made at Amberswood Lake near Wigan, Lancashire, during June and early July (JGi); this suggests a colony is now also present there. Multiple sightings along the coast of East Sussex and southern Kent likewise probably indicate new breeding sites as might, perhaps, the multiple individuals seen at Greylake RSPB Reserve in Somerset during mid-June (MD, AS, MT), with a pair *in cop.* being noted on 12 June (MT).

The species' current major range expansion also continued apace, as a result of either internal dispersal, immigration from the Continent, or both. Individuals were thus seen at Lower Bruckland Ponds in Devon on 16–17 June (SW, TWh),

Plate 1. *Aeshna isoceles*, female. Titchfield Haven Nature Reserve, Hampshire, 21 June 2023. Photograph by S. Finnegan.

Hill Heath on the Isle of Wight on 8 June (JGl), Titchfield Haven in Hampshire on 21 June (SF), Slimbridge in Gloucestershire on 25 June (MMG), Far Ings in north Lincolnshire on 18–19 June (DWo, SR) and Goole in East Yorkshire on 29 July (AW). Even more spectacularly, the first record for Wales was made on 18 June at Llangorse Lake, Breconshire/Powys (BD) while, in the far north of England, singles were seen at Lazenby, Teesside, on 13 June (DWo) and Foulshaw Moss, Cumbria, on 7 July (EW). That the bulk of these new 'extralimital' sightings should come during June is perhaps just coincidence – the species having a rather short flight period – but it is worth noting that it was the warmest June on record in Britain (Met Office, 2023), with winds frequently from the east or north-east during the first half of the month, turning more southerly over the following ten days (Ventusky, 2023).

Aeshna mixta Latreille – Migrant Hawker

One, an obvious migrant, was seen by an experienced observer on Westray in the Orkney Islands on 20 August (SD). This is the first record for the Orkneys, and indeed records from central and more northerly parts of Scotland in general

are still very rare. The species has, however, been reported on occasion from oil rigs in the northern North Sea (e.g. Parr, 2022). Elsewhere, in eastern Britain, up to 100 were present at Herstmonceaux, East Sussex, on 7 August (PMi), while immature males were attracted overnight to moth traps near Dagenham, Essex, on the night of 13 July (BC) and at Ormesby, Norfolk, on the night of 24 July (KH). Such records of dragonflies attracted to moth traps often seem to relate to migrants (Parr, 2006).

Anax ephippiger (Burmeister) – Vagrant Emperor

The reporting year saw some substantial arrivals of *Anax ephippiger* in Britain, and even allowing for the rising number of observers over recent years, the species is clearly no longer the great rarity that it used to be. Unidentified hawker-type dragonflies, most likely *A. ephippiger*, were seen in Plymouth, Devon, on 11 January (PN) and Ventnor, Isle of Wight, on 16 March (IO). Early April then saw the start of a much more substantial influx when, between 3 April and 4 June, over 50 sightings were made in Cornwall, Devon, Dorset, the Isle of Wight and Hampshire, along with two records from Guernsey in the Channel Islands. During late May–early June, oviposition was noted at both Windmill Farm Nature Reserve in Cornwall (ABl) and near Soar in Devon (RM). This influx formed part of a very major movement that was also noted in Spain, Portugal and France (Faune France, 2023; iNaturalist, 2023; Observation.org, 2023), with the British records being clearly linked to a passage of individuals seen along the western seaboard of France during early spring (Faune France, 2023; Bertrand Pinney, pers. comm.). These movements seen in western Europe had been preceded by a separate, very major, arrival in the Canary Islands during mid-February (Nicolai & Grimm, 2024; Wildermuth & Estermann, 2024), and clearly numbers of *A. ephippiger* had been particularly high in source areas of north-west Africa during the early part of 2023.

As spring came to an end, reports of *A. ephippiger* in Britain died away, though a male was photographed at Millbank, Berwickshire, on 5 July (RW). Autumn 2023 then saw yet another significant influx. Between 10 September and 24 October at least a dozen individuals were spotted at coastal sites in Wales and the west of England, with a further record from Sidmouth, Devon, on 19 November (ED). Perhaps the real highlight of autumn was, however, the first confirmed successful breeding of *A. ephippiger* in Britain. Following the report of oviposition at Windmill Farm in Cornwall during spring, a teneral was seen there on 18 September, with an exuvia later discovered on 22 September (DWr, SJ). Jones (2024) provides further background to this important event.

Anax junius (Drury) – Common Green Darner

Anax junius is a strongly migratory North American species (May, 2013), that was first reported in Britain back in autumn 1998 when several vagrant individuals were seen on the Isles of Scilly and in mainland Cornwall (Parr, 1999; Pellow, 1999); these sightings constitute the first records for the Western Palearctic. Since then, singles have also been reported from the Atlantic seaboard of France on 14 September 2003 (Meurgey, 2004) and from the Azores on 7 October 2019 (French, 2020). During late autumn 2023, the species was once again reported from Britain, with several individuals being found on the Isles of Scilly between 19 October and 7 November. The following records have currently been accepted by the national Records Committee:

19 October: Bryher, Isles of Scilly (IOS); female (B. Reed *et al*.)
19 October: Higher Moors, St Mary's, IOS; female (W. Scott)
22–29 October: Sandy Lane, St Mary's, IOS; two males & a female (W.Scott *et al*.)
22 October: Lower Town, St Agnes, IOS; two separate females (L. Amery, M. Young-Powell, K. & M. Schmitz *et al*.)
3 November: Porth Hellick, St Mary's, IOS; male & female (A. Jordan)
7 November: Holy Vale, St Mary's, IOS; female (L. Slaughter)

In addition to these sightings, the species was also noted on the isle of Ouessant off the north-west coast of France (Faune France, 2023), these individuals clearly being part of the same trans-Atlantic movement. Weather conditions leading up to the arrivals had seen a depression form near the eastern seaboard of the USA on 15 October, with offshore winds over a considerable area. This depression then moved north-east, and a warm air plume could be tracked moving rapidly across the Atlantic until it reached north-west Europe around 19 October (Ventusky, 2023); it is this weather system that likely carried the dragonflies to Europe, with an ensuing travel time of roughly 4 days. Given current understanding, it seems highly likely that further Palearctic records of *A. junius* will be forthcoming in the short to medium-term future. Such occurrences would be most likely during late August–October, as this corresponds to the timing of 'normal' autumn migration when large numbers of *A. junius* are on the move along the eastern seaboard of North America (May, 2013).

Anax parthenope Sélys – Lesser Emperor

It was a record-breaking year for *Anax parthenope* in Britain, with records from roughly 150 sites (the exact number pending verification of a few remaining reports). Much of the species' good showing can no doubt be attributed to the growing strength of local resident populations. Sightings of both immature

Plate 2. *Anax junius*, female. Popplestone Fields, Bryher, Isles of Scilly, 19 October 2023. Photograph by B. Reed.

adults and breeding behaviour by fully mature adults were widely reported, and a female exuvia was discovered at Filby Broad, Norfolk, on 30 July (PHe). Some large gatherings were also observed during the year, with double figure counts being made at New Hythe in Kent on 25 June (MH) and 7 July (KP), and with similar numbers being seen in Norfolk at Ormesby Little Broad, Horsey Mere and Strumpshaw Fen during late June–July (KH, KD, SFS *et al*.). The species was indeed quite widely reported from Norfolk in general.

In Scotland, a male was photographed at Murton Nature Reserve in Angus on 16 June (per BDSS), an almost certain individual was seen at West Barns in East Lothian on 23 June (MQ) and a male was found dead at St Peter's Pool, Mainland, Orkney, on 10 July (MGe). Slightly further south, records from northern England included two reports from Cumbria, viz. near Grange-over-Sands on 8 July (MMN) and from North Walney on 16 August (CT). It seems likely that many/all of these very northerly records stem from long distance migration. Records from Yorkshire, however, include several from sites that also held the species during 2021 or 2022, so the status of individuals in this area is less clear. Further south, with colonisation now well under way, it is becoming

increasingly difficult to separate resident, immigrant and internally wandering individuals.

In addition to reports of *A. parthenope* from unusual locations, 2023 also saw several unusually late sightings, particularly from south-west England. Two were seen at Fremington, Devon, on 12 September (AMG), a female was noted at East Prawle, Devon, on 18 September (PMy) and a male was seen on Shipman Head Down, Bryher, Isles of Scilly, on 8 October (DB, JFa). It seems likely that these individuals result from autumn emergences, the life cycle of *A. parthenope* being anything from a few months to two years depending on environmental and other factors (Werzinger & Werzinger, 2001; Corbet *et al*., 2006). Maybe conditions in the far south-west of England encouraged rapid local development. Alternatively, these late season individuals could perhaps have been primary immigrants from warmer climes; certainly the Isles of Scilly do not appear to have any current resident population.

Orthetrum cancellatum (L.) – Black-tailed Skimmer

Two males were noted at Point of Ayre on the Isle of Man over 13–18 June (NM), this being only the second record of the species from the island. A single, almost certainly immigrant, *Sympetrum fonscolombii* was also present over the period 15–18 June (PHa, NM). The co-occurrence of *O. cancellatum* and *S. fonscolombii* has similarly been noted in the past at other sites where neither is established (Parr, 2023), and it seems likely that the two species may sometimes migrate together.

Orthetrum coerulescens (Fab.) – Keeled Skimmer

A male apparently photographed at Cleethorpes Country Park, Lincolnshire, on 22 June would be the first county record if confirmed.

Sympetrum fonscolombii (Sélys) – Red-veined Darter

The first record of the year was from Sandwich Bay, Kent, on 5 May (SBBOT), followed within the next week or so by records of already mature, and thus presumably immigrant, individuals from Dover and Dungeness in Kent and from Windmill Farm NNR and Bass Point in Cornwall. Numerous further reports then followed, with evidence of at least two immigration waves – one around mid/late May and another around mid June (Fig. 1). Records were predominantly from southern, central and eastern England, but notable finds elsewhere included records from Skokholm Island, Pembrokeshire, on 28 May (GE), near the Kerry Ridgeway in Radnorshire on 14 June (MM), at Point of Ayr in the Isle of Man over 15–18 June (PHa), at Middleton Nature Reserve, Lancashire, over 13–29

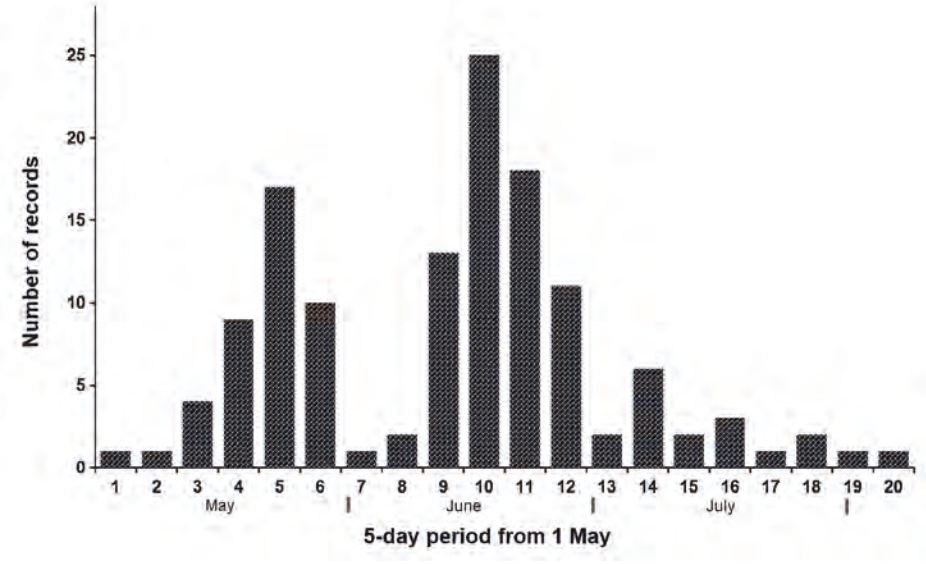

Figure 1. Number of sightings of *Sympetrum fonscolombii* in Britain over five-day intervals throughout the spring/summer of 2023. Time intervals start on 1 May; there were no prior records.

June (JP *et al*.), at Seton Mains in East Lothian over 15–25 June (BH, ABr) and from the Millar's Moss area of Berwickshire on 18–25 June and 8 August (DG).

On 10 August, the first emergences of a locally-bred second generation were noted at Pitstone, Buckinghamshire, and over the following two months several further instances of local breeding were discovered. Counties involved included Cornwall, Devon, Kent, Gloucestershire, Worcestershire and Buckinghamshire, with 'one-off' sightings of immatures at Barcombe Parish in East Sussex on 27 August (SL) and at Kelling in Norfolk on 2 October (CW) possibly also reflecting nearby breeding. With the exception of Pitstone, where double figure counts of immatures were made on dates in mid-August and wandering individuals were often spotted in the nearby countryside, the numbers of individuals seen were, however, low. Given that autumn-emerging individuals rapidly disperse away from natal sites and likely migrate back south, many autumn immatures must, however, have gone unnoticed. The last record of the year was of a mature male photographed at Portland Bill, Dorset, on 14 October (HB); the origin of this individual is unclear, but it might be a fresh immigrant associated with the arrivals of *Anax ephippiger* that were taking place at the time.

Sympetrum striolatum (Charp.) – Common Darter

A female was attracted overnight to a moth trap near Ashford, Kent, on the night

of 4 October (LC). Such records of dragonflies attracted to light often seem to relate to migrants (Parr, 2006).

Discussion

Although the fortunes of individual species varied somewhat, the 2023 reporting year was an exciting one for migrant and dispersive Odonata in Britain, and showcased some of the various lifestyles shown by such species. Only 30 years ago, both *Anax parthenope* and *Aeshna affinis* were essentially unknown from Britain, but they then started to appear as sporadic, and ultimately regular, immigrants. This formed part of a wider ongoing range expansion of these species within western Europe. Since then, both species have gone on to establish significant breeding populations in Britain, with these being very conspicuous during 2023. Significant immigration is clearly still occurring, but is becoming increasingly difficult to monitor by simple observation alone. While *Sympetrum fonscolombii* has been known for a very long time as an occasional migrant to Britain, it too has become much more common in recent years and the present reporting year saw significant arrivals. In contrast to *A. parthenope* and *A. affinis*, resident breeding populations of this species are, however, very much less obvious. There have been reports of transitory populations in some areas, but it is clear that *S. fonscolombii* is much more of a 'traditional' migrant, with any young that emerge during autumn dispersing away and presumably migrating back south. This return journey has certainly been confirmed in middle Asia (Borisov *et al*., 2020), though as yet still remains largely conjectural in Europe. While the migrations of *S. fonscolombii* in the Old World are only gradually becoming better understood, the New World species *Anax junius* has been much more thoroughly researched, and many details of its north-south movements in North America are now starting to be revealed (May, 2013; Hallworth *et al*., 2018). During 2023, Britain was fortunate to see several individuals of this species arrive on the Isles of Scilly during late autumn. This is clearly a case of vagrancy, where dragonflies have been blown off course from their normal migration routes to ultimately end up in unusual places, but to survive a 4,000–5,000 km sea-crossing emphasises the shear dispersive power that strong migrants possess. Yet another well-characterised strong migrant, in this case *Anax ephippiger*, also turned up in Britain during 2023. This is presently considered slightly more of a nomadic species, its core populations following winds and rain within the Inter-tropical Convergence Zone in search of suitable breeding habitat (Corbet, 1999). If conditions are right, the species may however 'break out' of this zone, and occurrences in northern Europe have long been reported; it is even one of the few dragonflies known from Iceland (Corbet, 1999). At the start of 2023, large numbers of *A. ephippiger* were obviously present in north-west Africa and, when wind conditions became favourable, some major movements were then seen in western Europe as far

north as Britain.

While more and more details of dragonfly migration are slowly being pieced together, much still remains to be discovered. In a local context, one area that would repay further study is the dispersive behaviour of *Aeshna isoceles*. Why, for instance, is a once very rare and extremely localised species in Britain suddenly now turning up at sites several hundred kilometres away from previous strongholds? Sightings over the next few seasons are awaited with interest.

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