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Cover illustration: A fresh *Chalcolestes viridis* oviposition scar tract. Photograph by Mark Tyrrell

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- Manuscripts should be one and a half spaced, on one side of the page only and with margins at least 25mm on both sides and top and bottom. Footnotes should be avoided.
- Use of these terms is acceptable: 'exuvia' for cast skin (plural: 'exuviae'); 'larva' (instead of 'naiad' or 'nymph'); 'prolarva' to designate the first larval instar.
- Dates in the text should be expressed in the form: 24 July 2010.
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- The legend for each table and illustration should allow its contents to be understood fully without reference to the text.

Please refer to a recent issue of the journal for further style details.

SCIENTIFIC AND ENGLISH NAMES OF BRITISH ODONATA

ZYGOPTERA	DAMSELFLIES	<i>Aeshna mixta</i>	Migrant Hawker
<i>Calopteryx splendens</i>	Banded Demoiselle	<i>Anaciaeschna isoceles</i>	Norfolk Hawker
<i>Calopteryx virgo</i>	Beautiful Demoiselle	<i>Anax ephippiger</i>	Vagrant Emperor
<i>Ceragrion tenellum</i>	Small Red Damselfly	<i>Anax imperator</i>	Emperor Dragonfly
<i>Chalcolestes viridis</i>	Willow Emerald Damselfly	<i>Anax junius</i>	Green Darter
<i>Coenagrion armatum</i>	Norfolk Damselfly	<i>Anax parthenope</i>	Lesser Emperor
<i>Coenagrion hastulatum</i>	Northern Damselfly	<i>Brachytron pratense</i>	Hairy Dragonfly
<i>Coenagrion lunulatum</i>	Irish Damselfly	<i>Cordulegaster boltonii</i>	Golden-ringed Dragonfly
<i>Coenagrion mercuriale</i>	Southern Damselfly	<i>Cordulia aenea</i>	Downy Emerald
<i>Coenagrion puella</i>	Azure Damselfly	<i>Crocothemis erythraea</i>	Scarlet Darter
<i>Coenagrion pulchellum</i>	Variable Damselfly	<i>Gomphus flavipes</i>	Yellow-legged Club-tail
<i>Coenagrion scitulum</i>	Dainty Damselfly	<i>Gomphus vulgatissimus</i>	Common Club-tail
<i>Enallagma cyathigerum</i>	Common Blue Damselfly	<i>Leucorrhinia dubia</i>	White-faced Darter
<i>Erythromma najas</i>	Red-eyed Damselfly	<i>Leucorrhinia pectoralis</i>	Large White-faced Darter
<i>Erythromma viridulum</i>	Small Red-eyed Damselfly	<i>Libellula depressa</i>	Broad-bodied Chaser
<i>Ischnura elegans</i>	Blue-tailed Damselfly	<i>Libellula fulva</i>	Scarce Chaser
<i>Ischnura pumilio</i>	Scarce Blue-tailed Damselfly	<i>Libellula quadrimaculata</i>	Four-spotted Chaser
<i>Lestes barbarus</i>	Southern Emerald Damselfly	<i>Orthetrum cancellatum</i>	Black-tailed Skimmer
<i>Lestes dryas</i>	Scarce Emerald Damselfly	<i>Orthetrum coerulescens</i>	Keeled Skimmer
<i>Lestes sponsa</i>	Emerald Damselfly	<i>Oxygastra curtisii</i>	Orange-spotted Emerald
<i>Platycnemis pennipes</i>	White-legged Damselfly	<i>Pantala flavescens</i>	Wandering Glider
<i>Pyrrosoma nymphula</i>	Large Red Damselfly	<i>Somatochlora arctica</i>	Northern Emerald
<i>Sympetma fusca</i>	Winter Damselfly	<i>Somatochlora metallica</i>	Brilliant Emerald
ANISOPTERA	DRAGONFLIES	<i>Sympetrum danae</i>	Black Darter
<i>Aeshna affinis</i>	Southern Migrant Hawker	<i>Sympetrum flaveolum</i>	Yellow-winged Darter
<i>Aeshna caerulea</i>	Azure Hawker	<i>Sympetrum fonscolombii</i>	Red-veined Darter
<i>Aeshna cyanea</i>	Southern Hawker	<i>Sympetrum pedemontanum</i>	Banded Darter
<i>Aeshna grandis</i>	Brown Hawker	<i>Sympetrum sanguineum</i>	Ruddy Darter
<i>Aeshna juncea</i>	Common Hawker	<i>Sympetrum striolatum</i> *	Common Darter *
		<i>Sympetrum vulgatum</i>	Vagrant Darter

* Includes dark specimens in the north-west formerly treated as a separate species, *Sympetrum nigrescens* Highland Darter

Hatching of submerged eggs of *Chalcolestes viridis* (Vander Linden) (Willow Emerald Damselfly)

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Summary

Chalcolestes viridis (Willow Emerald Damselfly) showed a major expansion of range in 2016 (Parr, 2017), resulting in its discovery at a small pond in Finedon Pocket Park, Northamptonshire in October of that year. In 2017 adults and oviposition were recorded at Finedon into a set of Willow trees (*Salix* spp.) growing in the water. During the very wet winter of 2017-2018, the pond flooded and the Willows were completely submerged such that no sign of them was obvious by April 2018. Adults were again recorded in 2018 and, during routine recording, some empty scars from 2017 were noted on previously submerged Willow branches. Images taken of these scars alongside those of fresh egg scars and those known to have hatched outside of the water confirmed that the eggs of this species can tolerate submersion during hatching and therefore hypoxic conditions are not required to stimulate egg hatching; neither do they inhibit it. Other observations suggest that egg hatching in *C. viridis* is stimulated by photoperiod and/or temperature.

Introduction

A number of odonate species lay their eggs out of water, for example, *Chalcolestes viridis* (Willow Emerald Damselfly) oviposits endophytically into thin, young branches of Willow (*Salix* spp.) (and other species of tree), overhanging water (Cham *et al.*, 2014) and *Lestes sponsa* (Emerald Damselfly) is known to oviposit into soft stemmed plants around pond margins, clear of the water (Cham *et al.*, 2014). Furthermore, several species are known to oviposit on dry substrates away from water, for example, *Aeshna cyanea* (Southern Hawker) does so endophytically (Brooks *et al.*, 2014) while *Sympetrum sanguineum* (Ruddy Darter) does so exophytically (Cham *et al.*, 2014). Conversely, other species such as *Pyrhosoma nymphula* (Large Red Damselfly) and *Anax imperator* (Emperor Dragonfly) oviposit endophytically exclusively into submerged plants (Brooks *et al.*, 2014). These two differing approaches have some degree of correlation to the larval habitat, where typically endophytic larvae live among the

vegetation whereas exophytic live at the bottom of the water body. However, there are exceptions such as *Platycnemis pennipes* (White-legged Damselfly) which is endophytic but whose larvae live in the mud (Cham *et al.*, 2014). It may be that the eggs of species such as *C. viridis* cannot tolerate submersion, perhaps requiring higher oxygen levels for larval survival, especially as this species often lays its eggs up to 10m above the water, the larvae dropping into the water upon hatching (Parr, 2016).

Site

All observations were made at the only known breeding site of *Chalcolestes viridis* in Northamptonshire, Finedon Pocket Park (SP913723). This pond also hosts another 15 breeding species including a strong population of *Lestes sponsa* (Emerald Damselfly) and *Erythromma viridulum* (Small Red-eyed Damselfly), so is a high quality habitat for Odonata.

Observations

The first record of adult *Chalcolestes viridis* at Finedon Pocket Park during the 2018 season was on 20 August, compared with 24 August in 2017. The maximum count in 2018 was only four adults (three males and one female) at one time; typically only one or two. This was an unexpectedly low figure given that this was the second generation to emerge from this pond and raised concerns about the success of this species at Finedon Pocket Park.

Records of *C. viridis* oviposition scars were made over the two previous seasons since it was first recorded - 2016 & 2017 - and their location and position in the trees noted. All of the scar tracts in 2016 were found in a set of partially submerged Willows (*Salix* spp.) (Figure 1), 0.5-1.5m above the water surface. During the 2017 season, scars were also found in three bank-side Willows up to ~3m above the water surface. At the start of the 2018 odonate season, at the end of April, the pond was found to be completely flooded following the very wet and cold winter of 2017-2018 and the Willows shown in Figure 1 were completely submerged such that no sign of them was visible from the bank. However, the eggs in the bank-side Willows remained clear of the water. Eggs are known to hatch from the end of April to the start of May in central Europe and Parr (2016) considered that this should be little different in Britain, which would indicate that, at Finedon, some were underwater when they were due to hatch. At this point it was hypothesised that the flooding of the submerged Willows had killed the eggs before hatching and that the adults seen were from those eggs laid clear of the water, giving rise to the lower than expected observed adult population.



Figure 1. The pond at Finedon Pocket Park, Northamptonshire, showing the submerged Willows *Salix* spp. on 17 August 2018.



Figure 2. A fresh *Chalcolestes viridis* oviposition scar tract recorded on 7 September 2017.



Figure 3. Empty oviposition scars of *Chalcolestes viridis* recorded on the same branch as shown in Fig 2, on 22 August 2018, after being submerged during the spring.



Figure 4. *Chalcolestes viridis* oviposition scars recorded on the same branch as shown in Figures 2 & 3, showing holes which could indicate successful hatching. Photograph by Steve Cham.



Figure 5. The internal structure of the *Chalcolestes viridis* oviposition scars shown in Figure 4 showing what could be either shrivelled (hatched) egg cases or undeveloped larvae. Photograph by Steve Cham.



Figure 6. The internal structure of *Chalcolestes viridis* oviposition scars showing unhatched eggs (arrow) in-situ. Photograph by Marc Heath.



Figure 7. *Chalcolestes viridis* oviposition scars recovered in April 2019 from oviposition recorded in October 2018, showing holes indicating the hatching and exit of larvae. Photograph by Steve Cham.



Figure 8. The internal structure of the hatched *Chalcolestes viridis* oviposition scars from Fig 7, showing shrivelled egg cases and successful hatching. Photograph by Steve Cham.

Scanning the submerged Willows on 22 August 2018, while looking for adults, a series of scars was noted on a branch that had been used in 2017 (Figure 2) which, on close examination of digital photographs, appeared to be empty (Figure 3). Samples of these scars were taken and high magnification images made using a Canon 7D and Canon MP-E 65mm macro lens at 5x life size. These revealed definite holes (Fig 4), suggesting that the eggs had hatched and that the larvae had emerged successfully. When the bark was stripped back to reveal the inside of the scars, shrivelled structures were clearly seen (Figure 5) that could either be empty egg cases or undeveloped, dead larvae.

Heath (2018), photographed fresh egg scars and demonstrated the eggs *in situ*, showing a pair of eggs either side of the central insertion point. Comparison of these images with the submerged scars suggests that the eggs had indeed hatched, and the remains shown in Figure 5 are those of empty egg cases.

Further egg scars were recorded during the 2018 season and monitored weekly from the beginning of April 2019 to determine the approximate hatching time. On 10 April, the first scars were found that had hatched, having done so between 3 April and 10 April, although other scar sets were found at this time that remained unhatched. It was, however, noted that eggs laid in areas that were shaded in early spring due to the lower angle of the sun, hatched later than those laid in areas with higher light levels. By 24 May, all known scars showed signs of hatching, which could imply a time-dependency to the hatching process. A sample of the hatched scars from 10 April was taken (Figure 7) and stripped back to reveal the inner structures and photographed (Figure 8) in the same way as the previous year's submerged scars.

Comparison of the internal structures shown in Figures 5 and 8 are identical in appearance, suggesting that the remains seen in Figure 5 are indeed dried, empty egg cases rather than undeveloped larvae. This in turn suggests that the eggs on the submerged scars did hatch successfully.

Discussion

Lestes is one of only a few UK genera the members of which lay diapause eggs, i.e. eggs that reach a certain level of development at the onset of winter, enter a pause in their development and complete development at the on-set of spring (Corbet, 1999). *Chalcolestes viridis* eggs laid in the autumn also enter diapause in a state of incomplete development, completing the development process in late winter or early spring (Corbet, 1999). The stimulus/stimuli for hatching may be rising temperatures, time since eggs were laid or were submerged in water (causing hypoxia), or photoperiod (Corbet, 1999). Egg hatching in *Lestes*

sponsa appears to be stimulated by hypoxia since eggs laid in July in water have been shown to hatch in September, whereas eggs laid clear of the water hatched in the following spring (Corbet, 1999). In contrast, it has been shown that egg hatching in *Aeshna mixta* (Migrant Hawker) is temperature dependent (Corbet, 1999).

As eggs of *C. viridis* do not normally enter water, the hypoxia stimulus cannot apply and this is supported by the observations reported here that egg hatching occurs in both hypoxic (submerged eggs) and hyperoxic (non-submerged eggs) conditions at about the same time. At Finedon, both hatched and unhatched egg scars were present in mid April 2019, the unhatched scars being found in shadier parts of the pond. This suggests that some temperature or photoperiodic-dependency may be affecting hatching. For species that oviposit endophytically with diapause eggs such as *L. sponsa* and *C. viridis*, the strategy of ovipositing out of water is thought to be related to reducing egg parasitism by limiting their detection by typical aquatic parasites. Placing them in trees some distance from water further reduces the loss of eggs compared marginal vegetation that could be submerged during winter rains (Harabis, 2019). This also may expose the eggs to higher light levels. However, as egg scars were found in Willow branches as low as 0.5m above the water, this may not be the case. As shady conditions can lead to low light levels and lower temperatures, it is not clear which of these is the dominant factor to stimulate egg hatching.

Conclusions

Evidence presented here suggests that, in the case of *Chalcolestes viridis*, egg hatching can happen in air or water and is likely to be stimulated by photoperiodic or temperature changes in late winter or early spring.

Acknowledgements

I would like to thank David James for pointing out the previously submerged branch containing the empty scars and Adrian Parr for helpful comments on these observations. I would also like to thank Steve Cham for the photographs in Figures 4, 5, 7 & 8 and for additional discussions on this topic, and to Marc Heath for permission to use his images of the eggs *in situ* (Figure 6).

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Migrant and dispersive dragonflies in Britain during 2018

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Summary

In the UK, 2018 will go down as one of the most spectacular years in modern history for migrant and dispersive dragonflies. *Somatochlora flavomaculata* (Yellow-spotted Emerald) was recorded as new to Britain when a male was photographed at Carton Marshes near the Suffolk coast on 2 July, while only the fourth ever record of *Leucorrhinia pectoralis* (Large White-faced Darter) was made elsewhere in Suffolk on 27 May. As well as these great rarities, large scale arrivals of many of the currently less unusual migrant species were also reported, though *Sympetrum fonscolombii* (Red-veined Darter) had a rather more low-key year. *Anax ephippiger* (Vagrant Emperor) appeared in numbers during October and was even seen ovipositing, while it was the second best year ever for *Anax parthenope* (Lesser Emperor) in the UK with records from over 40 sites. A substantial arrival of *Aeshna affinis* (Southern Migrant Hawker) was noted in southern England during July and early August, and *Aeshna isoceles* (Norfolk Hawker) also produced a number of unexpected sightings away from breeding sites. Most notable of these was a record from the Exminster Marshes, Devon, on 12 July. In addition to these migratory movements, significant internal dispersal by species such as *Orthetrum caeruleum* (Keeled Skimmer) was seen during the year. Many of our recent colonist damselflies also had a productive season. *Erythromma viridulum* (Small Red-eyed Damselfly) was noted on the Lizard Peninsula in Cornwall during early July, some 100 km away from previously known UK sites for the species and thus perhaps indicative of a fresh immigration event. Continued immigration by *Lestes barbarus* (Southern Emerald Damselfly) was also detected during 2018, while the first ever inland breeding site for the species was discovered in Buckinghamshire.

Account of species

Notable sightings reported to the BDS Migrant Dragonfly Project during 2018 are detailed below; for information on events during 2017, see Parr (2018).

***Calopteryx virgo* (L.) – Beautiful Demoiselle**

Individuals of *Calopteryx virgo* turned up in a number of new localities in central/southeast England during the season, perhaps as a result of the unusually hot summer (Met Office, 2019) having stimulated dispersal, but also probably as part of the general range expansion that has become apparent in recent years. Most significantly, males were noted in Hertfordshire near Bishop Stortford, at Hertford Heath and along the Cuffley Brook, these perhaps being wanderers from Middlesex (per RW). A single individual was also seen at Cranfield in Bedfordshire (per RM).

***Chalcolestes viridis* (Vander Linden) – Willow Emerald Damselfly**

A recent colonist that first arrived in 2007 (Cham *et al.*, 2014), this species continued its range expansion in southeast England, with the most northerly known site now being at Kirkby-on-Bain, Lincolnshire (JM), and the most westerly being at Stowe Gardens, Buckinghamshire (AN). The first records for both East Sussex [Brede Levels (JLu, MHo); Broadwater Warren (SC); Weir Wood Reservoir (AGr)] and Berkshire [Windsor Great Park (KHi)] were also received during September. When viewed at the UK-wide scale, changes since 2017 were, however, still relatively modest.

***Lestes barbarus* (Fab.) – Southern Emerald Damselfly**

It was one of the best years ever in the UK for this migrant/recent colonist species, with our new breeding populations doing well and with signs of fresh immigration. Although there were no records from Winterton in Norfolk, where the species has been frequently recorded over the last decade and a half (though without proof of breeding), there were several sightings at the well-known breeding sites at Cliffe in Kent and on the north coast of the Isle of Wight. In addition, a new colony was discovered near Beaconsfield in Buckinghamshire during late June (DF). With counts of 50+ being noted on good days during late June/July and with numerous ovipositing pairs being seen (DF *et al.*), it would seem that this population is already well established, its initial foundation apparently having been missed. A series of records of small numbers near Canvey Island, Essex, during late June/July (ID, DSp, AT, MA) perhaps also indicates another established colony, though recent immigration cannot be totally discounted. In addition to these sightings, isolated individuals were seen near Fleet in Hampshire on 1 July (AB) and at Lullington Heath, Sussex, on 4 & 6 August (ST, DSA); these most likely do result from fresh immigration.

***Erythromma viridulum* (Charp.) – Small Red-eyed Damselfly**

This species first appeared in the UK during 1999 and rapidly colonised much of southeast England, with further range expansion then typically occurring at a slower pace (Cham *et al.*, 2014). During 2018, significant expansion and range-infilling was to be noted, with many new site records being made. The most spectacular sighting relates to small numbers discovered at St Keverne on the Lizard Peninsula in Cornwall on 9 July (JF); this is the first record for Cornwall. Being coastal, and some 100 km away from any previously known site, this record might conceivably result from a fresh immigration event, with northern France being a possible source area. A subsequent sighting of a single near Falmouth, Cornwall, on 2 August (DC) could perhaps relate to the same movement. Elsewhere, an apparent small influx was noted at Eccles-on-Sea, Norfolk, during late July/August (NB), and a single individual was attracted to an MV moth trap at Pegwell, Kent, on the night of 19 August (FS).

***Aeshna affinis* (Vander Linden) – Southern Migrant Hawker**

Good numbers were reported from the recently established breeding populations around the greater Thames Estuary but the year was most notable for an extensive series of records elsewhere in southern England, with two reports also from East Yorkshire (Fig. 1). Some sightings in the London area – for example those at the Oare Marshes in Kent (DBo, MHe *et al.*) and Hanningfield Reservoir in Essex (SJ *et al.*) – may perhaps refer to dispersing individuals from the Thames Estuary populations and, with two immature females being found at Walberswick, Suffolk, on 6 July (CM), it is even possible that the species is now breeding more widely than currently appreciated. The bulk of new sightings, however, appear to result from one or more major influxes from the Continent. The majority of records occurred over the period 6 July–11 August (peaking in late July), with a few largely unconfirmed sightings reported over the next few weeks. In all, 15 counties in England produced confirmed records, these being Cornwall, Somerset, Dorset, Hampshire, East Sussex, Kent, Surrey, Essex, Hertfordshire, Suffolk, Norfolk, Cambridgeshire, Bedfordshire, Gloucestershire and East Yorkshire. Particularly notable sightings included up to 13 at Winchelsea, East Sussex, during late July (MHo) plus singles seen at Flamborough Head, East Yorkshire, on 23 July (AA) and at Spurn, East Yorkshire, on 25–27 July at least (DBa, SBO). In addition, one was attracted to an MV moth trap at Pegwell, Kent, on the night of 6 August (FS). Although most presumed immigrant individuals were solitary males, mating and/or oviposition were reported from a few scattered localities including Winchelsea in East Sussex (MHo) and Hertford Heath in Hertfordshire (per RW). It is thus possible that new breeding sites in southern England may become established as a result of the events of 2018.

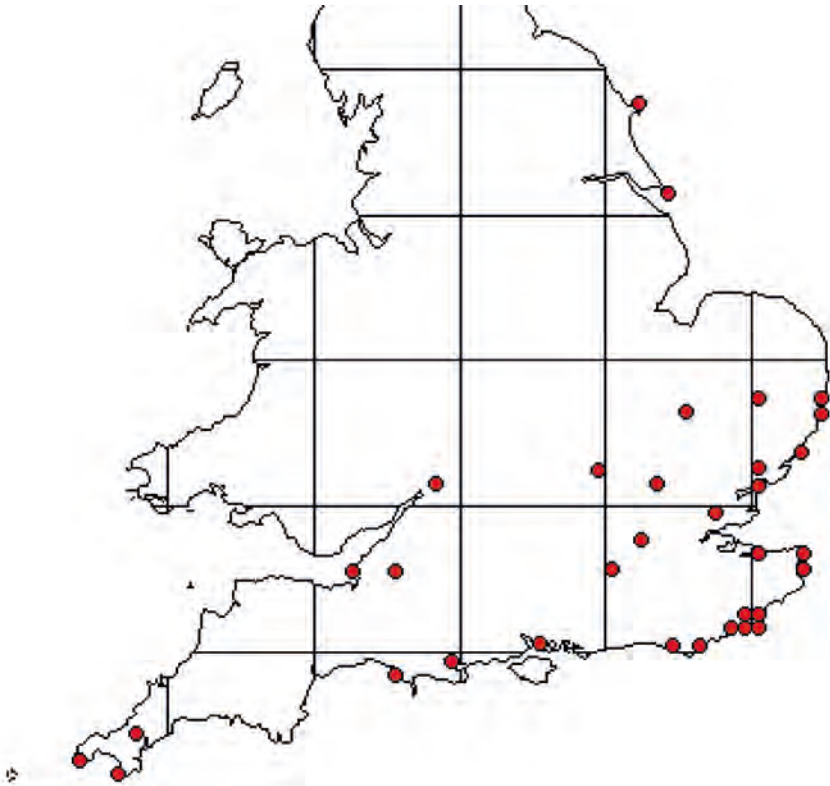


Figure 1. Distribution of confirmed sightings of *Aeshna affinis* (Southern Migrant Hawker) made during 2018 at localities away from the known Thames Estuary populations.

***Aeshna grandis* (L.) – Brown Hawker**

There were some interesting records along the east coast of England during late July/early August, rather suggestive of immigration or enhanced internal dispersal. At Spurn Bird Observatory, East Yorkshire, there have only ever been just over a dozen records of *Aeshna grandis*, with all previous reports referring to singletons (Branch, 2019). Two or three were, however, seen in the area on 1 August 2018 (DBa). Further south, one was attracted to a UV moth trap at Bawdsey, Suffolk, on the night of 20 July (MDe) and two were similarly caught at Bradwell-on-Sea, Essex, on the night of 27 July (SD). Dragonflies caught at light traps are thought to often include migrants (Parr, 2006), and the Bradwell-on-Sea record is the first ever report of the species from light traps at this intensively studied site. Elsewhere in England, one on the Grand Western

Canal, Devon, on 6 July (per DSm) was only the second ever county record; its likely origin remains unclear.

***Aeshna isoceles* (Müller) – Norfolk Hawker**

Several sightings were made in southeast England away from known breeding sites, probably as a result of both enhanced internal dispersal and immigration from the near Continent. In addition to records from new localities in the Amwell area of Hertfordshire, more noteworthy sightings included reports from a garden in Ipswich, Suffolk, on 27 May (LH); at the London Wetland Centre, Greater London, over 6–11 June (RB); from Holland Haven, Essex, over 19 June–8 July (MR *et al.*); from near Trimley, Suffolk, on 25 June (SP); from Lakenheath RSPB Reserve, Suffolk, on 30 June (DWh) and at Felpersham, Bedfordshire, on 1 July (JG). Even more spectacularly, a male was seen on the Exminster Marshes in Devon on 12 July (KR), this clearly having travelled a considerable distance whatever its source population.

***Aeshna mixta* Latreille – Migrant Hawker**

There were signs of significant movement on the east coast of England during late summer. Some 150 were reported from Spurn in East Yorkshire on 3 September (DBa), this being one of the highest counts ever recorded at this site (Branch, 2019). At Sandwich Bay in Kent, the year's peak count of 80 was made just a few days later on 12 September (SW), while other large counts included 100 at Holkham, Norfolk, on 19 September (HM). In addition to these high counts, rather suggestive of migration, individuals were attracted to UV moth traps at Bawdsey, Suffolk, on 9, 14 & 28 August (MDe); Orfordness, Suffolk, on 12 August (MMa); Bradwell-on-Sea, Essex, on 3 September (SD) and Sandwich Bay, Kent, on 17 September (SW). Such records of dragonflies at light traps often seem to involve migrants (Parr, 2006).

***Anax ephippiger* (Burmeister) – Vagrant Emperor**

This species is currently being seen in the UK with some regularity (e.g. Parr, 2018). Although there were no early season records during 2018, during October and the first days of November reports were received from roughly 30 sites in the UK. These were principally in southwest England but there were also records from Lancing, West Sussex, on 1 October (MCB); Southsea, Hampshire, on 5 October (to MV light, JLa); Spurn, East Yorkshire, on 13 October (JLo); Kingsgate, Kent, on 14–17 October (BHu); the Llyn Peninsular, Caernarvonshire, on 18 October (DWo); Harlescott, Shropshire, on 19 October (IA); Dungeness, Kent, on 24 October (DWa, OL) and a series of records from no less than five sites in East Suffolk over the period 20 October–1 November

(AE, PG, TG, RH *et al.*). One of the features of the late 2018 influx was the presence of multiple individuals in several areas. Most spectacularly, up to 20 were present at Croft Pascoe Pool on the Lizard Peninsula in Cornwall over the period 20–25 October (JWs *et al.*), with a few others also being noted elsewhere on the peninsula. As many as five ovipositing pairs were seen at Croft Pascoe, though the chances of successful breeding remain unknown. Although no *Anax ephippiger* were apparently recorded from Ireland during 2018, one was reported from Guernsey in the Channel Islands on 18 October (per TB).

***Anax imperator* Leach – Emperor Dragonfly**

This species colonised southern Scotland during the first years of the present century as a result of natural range expansion (Cham *et al.*, 2014). Following several hard winters, records however started to dwindle, and the last confirmed sighting from Scotland was in 2015 (Batty, 2019). During 2018, the species was, however, to reappear in the region as a result of a fresh round of arrivals. At Newmains Pond, Reston, Berwickshire, the first site records since 2013 were made when two individuals were noted on 24 June and up to three were present between 6 and 28 July, these July individuals perhaps being different to those seen earlier (DG). Some 50 km further to the northwest, a male *Anax imperator* was noted at Aberlady Bay, East Lothian, on 27 June with a female then seen the following day (BHi, AM); these are the first site records. Away from Scotland, signs of movement were less conspicuous, but the first sighting from the Isle of Man since 2011 was made during the summer (per PH). Individuals were also attracted to UV moth-traps at Nagshead RSPB Reserve, Forest of Dean, Gloucestershire, on 29 June (JWe) and at Portland Bill, Dorset, on 29 July (MC).

***Anax parthenope* Sélys – Lesser Emperor**

With reports from nearly 45 sites, 2018 proved to be the second best year ever for *Anax parthenope* in the UK, the best year being 2006 when the species was recorded from at least 57 sites (Parr, 2007). Counties that hosted the species comprised Cornwall, Devon, Somerset, Dorset, Hampshire, East Sussex, Kent, Surrey, Hertfordshire, Middlesex, Berkshire, Buckinghamshire, Suffolk, Norfolk, Northamptonshire, Gloucestershire, Monmouthshire, Warwickshire, Staffordshire, Glamorgan, Lincolnshire, Nottinghamshire, Lancashire and South-west Yorkshire. Records spanned the period 27 May–30 September, with a peak around mid July and with no less than four records during September, which is unusually (though not unprecedentedly) late. These late season records presumably relate to unexpected autumn emergences, and indeed at least two of the September individuals – from Bethnall Green in Greater London on 4 September (PB) and from Winterton Dunes in Norfolk on 18 September (JS) – were clearly somewhat immature.

Although much immigration obviously occurred, a significant number of records received during 2018 came from sites that had also recorded the species in 2016 and/or 2017 and perhaps thus relate to locally-bred individuals though, with generally only 1–2 dragonflies being noted at each site, the possibility that fresh immigrants are simply finding particularly favourable habitat each year cannot always be discounted. Good candidates for locally-bred *A. parthenope* include individuals seen at Dungeness in Kent throughout the summer and early autumn (including a mating pair sadly caught and eaten by a Great Egret (*Ardea alba*) on 30 September (AP)) plus small numbers seen at Longham Lakes in Dorset (IB, OF *et al.*) and the Trinity Broads complex in Norfolk (many observers) over mid June–mid July. Sites such as Blashford Lakes in Hampshire, Hilfield Park Reservoir and Tyttenhanger Gravel Pits in Hertfordshire, Belvide Reservoir in Staffordshire and Winterset Reservoir in West Yorkshire also have a history of past sightings, and individuals seen at these sites in 2018 could thus potentially also have been locally-bred. Perhaps the most intriguing record of the year relates to an immature female photographed at Brockholes in Lancashire on 5 July (KHa). Although *A. parthenope* was suspected of breeding at Brockholes in the late 2000's (White & Smith, 2015) there have not been any other definite records there in more recent years, and neither this individual nor any other was to be seen again later in the season. The background to this record thus remains uncertain; indeed our understanding of the species' current status in the UK as a whole still requires considerable clarification.

***Somatochlora flavomaculata* (Vander Linden) – Yellow-spotted Emerald**

The following record, accepted by the Odonata Records Committee, constitutes the first British sighting of this species:

2 July - Male photographed at Carlton Marshes, Suffolk (Andrew Easton)

Although breeding as close to southern England as Belgium and the Netherlands, *Somatochlora flavomaculata* is not known for its dispersive tendencies, and the UK record thus came as something of a surprise. The species has, however, increased noticeably in the Netherlands over the last few decades (der Vlinderstichting, 2019a) and a period of high temperatures and easterly winds over northwest Europe during late June and early July 2018 (Ventusky, 2019) must no doubt have facilitated dispersal. Further details of this record are given by Easton (2019).

***Leucorrhinia pectoralis* (Charp.) – Large White-faced Darter**

There was one record during the year:



Plate 1. Male *Somatochlora flavomaculata* (Yellow-spotted Emerald). Carlton Marshes, Suffolk, 2 July 2018. Photograph by A. Easton.

27 May - Male photographed at Landguard, Suffolk (Nigel Odin *et al.*)

This is only the fourth British record but it follows individuals seen at both Landguard and Dunwich Heath in Suffolk during 2012 (Parr, 2013). Over the last 2–3 decades the species has become considerably more widespread on the near Continent (der Vlinderstichting, 2019b) and future records along the east coast seem a distinct possibility. Indeed, the species may now be a potential colonist.

***Libellula quadrimaculata* L. – Four-spotted Chaser**

High numbers were seen at several sites along the east coast during early/mid June, perhaps indicative of an immigration event. Sixty were noted in the Marl Loch area of Aberlady Bay, East Lothian, on 6 June (BHi), this being a substantially higher count than any other previously made at this site. Further south, counts of 50–150 were made at several sites in the Minsmere-Aldringham area of coastal Suffolk on 16 June (SP).



Plate 2. Male *Leucorrhinia pectoralis* (Large White-faced Darter). Landguard, Suffolk, 27 May 2018. Photograph by D. Walsh.

***Orthetrum caerulescens* (Fab.) – Keeled Skimmer**

This species often shows enhanced dispersal during hot dry summers, and 2018 was to be no exception. A male at Mow Cop in Cheshire on 24 July (AGo) is probably the first modern county record, while a female seen at Hertford Heath, Hertfordshire, on 27 June (RW) is only the second county record. Suffolk just failed to record its first ever sighting when a vagrant individual noted at Lopham and Redgrave Fen SWT Reserve on 8 July (BB) chose to frequent an area just a few tens of metres into Norfolk. Other unusual sightings during the summer included records from Wimbledon Common, Surrey, on 16 July (SR) and from Thornwick Pools, East Yorkshire, on 30 June (MDa) with another nearby at Flamborough Head on 23 July (FBO).

***Sympetrum fonscolombii* (Sélys) – Red-veined Darter**

By modern standards it was a relatively quiet year for *Sympetrum fonscolombii* in Britain, though by the end of the season one or more reports had been received from almost 20 counties. Records spanned the period 11 May–2 November and, as is typical of the species, fell into two main groups – a spring/early summer phase and an autumn phase, corresponding to two different generations of adults. During spring/summer, records came from Cornwall, Somerset, Dorset, Isle of Wight, Hampshire, East Sussex, Kent, Hertfordshire, Worcestershire, Warwickshire, Glamorgan, Pembrokeshire, Lincolnshire, Lancashire and East

Yorkshire. Sightings frequently related just to singletons, though 10+ were seen at West Bexington, Dorset, on 15 June (MMo) and 15+ were present in the Atherfield area of the Isle of Wight on 18–19 July (AB, DD). Several reports came from sites that had also held the species during 2017, and despite no formal proof being available it is possible that some sightings relate to locally-bred individuals. Since there were to be no other records at all from northwest England during the year, this is particularly likely for the 1–3 individuals seen at Ainsdale Dunes, Lancashire, over 31 May–5 June (DT, PK *et al.*). Significant fresh immigration must, however, have also taken place given the sudden appearance of not just fully mature, but indeed even quite worn, individuals at some sites.

In line with the relatively quiet spring, there were no reports of any clearly locally-bred second generation individuals appearing during late summer/autumn, though small numbers of immatures seen at Sandwich Bay in Kent during August (SBBOT) are likely candidates. A series of records of mature adults from the Scilly Isles, West Cornwall, Devon, Wiltshire, Dorset, Suffolk, Norfolk and Gwynedd over the period 10 October–2 November is of some note; these individuals will represent fresh immigrants from the south accompanying the influx of *Anax ephippiger* that also took place at that time (see above).

***Sympetrum striolatum* (Charp.) – Common Darter**

Some 400 were seen at Spurn, East Yorkshire, on 29–30 August (DBa), this being one of the highest ever counts reported from the area (Branch, 2019), while possibly up to a thousand were present at Holkham, Norfolk, on 19 September. In addition to these large aggregations, highly suggestive of immigration, individuals were attracted to UV moth traps at Bawdsey, Suffolk, on 14 August, 11 September and 16 October (SD); at Bradwell-on-Sea, Essex, on 19 & 27 September (SD) and at Portland Bill, Dorset, on 20 August & 13 October (MC).

Discussion

The year 2018 was notable for extensive immigration by a wide variety of migrant dragonflies and for the occurrence of some very rare species, with *Somatochlora flavomaculata* being added to the British list during early July. Enhanced internal dispersal of a number of species was also noted during the year. Many of these events are no doubt associated with the exceptional summer weather of 2018, which was both unusually warm and unusually dry in Britain and many other parts of Europe (Met Office, 2019; Anon., 2019). In terms of weather averages, summer 2018 in the UK was on a par with the

exceptional summers of 1976, 1995 and 2006 (Hadley Centre, 2019). The latter two years also saw major movements of migrant Odonata, though the situation in 1976 is less clear, since it coincided with a period when dragonfly recording was at a low ebb.

Migrants recorded during 2018 comprised both species with a predominantly southern distribution in Europe – e.g. *Anax ephippiger* and *Anax parthenope* – and species with a predominantly eastern distribution – e.g. *Somatochlora flavomaculata* and *Leucorrhinia pectoralis*. Movements of other eastern species, such as *Sympetrum flaveolum* (Yellow-winged Darter), were noted in countries such as the Netherlands, Denmark and Sweden (Waarneming.nl, 2019; Bo Nielsen, pers. comm.; Magnus Billqvist, pers. comm.) but conditions meant such influxes did not quite reach Britain.

The addition of *S. flavomaculata* to the British list is the first such addition since *Sympecma fusca* (Common Winter Damselfly) was recorded in south Wales during December 2008 (Parr, 2009). With ongoing range expansions on the Continent linked to climatic warming, it is likely that the next new species will not be too far away. *Sympetrum meridionale* (Southern Darter) is one candidate likely to appear in the near future, but with *S. flavomaculata* itself being somewhat unexpected, it will be of considerable interest to see what the next new species actually is.

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An update on the status of some of the less common odonate species in the Maltese Islands.

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Summary

Four new sightings of *Aeshna mixta* (Migrant Hawker) in the Maltese Islands are reported. *Anax ephippiger* (Vagrant Emperor), which in recent years has been regularly seen ovipositing in small numbers in Autumn, has shown a dramatic increase in numbers in the last two years although, to date, there has been no confirmation of successful breeding. The status of *Sympetrum striolatum* (Common Darter), a common species over most of Europe but very rare in the Maltese Islands, is discussed and records of three new sightings are presented.

Species accounts

***Aeshna mixta* (Latreille) - Migrant Hawker**

There have been relatively few sightings in Malta, and Gauci (2018) has reviewed the records of this species and listed in chronological order the nine definitive records occurring between June 1948 and August 2014. Seven of these were of sightings between 2009 and 2014, including an ovipositing female in Gozo (Ruf *et al.*, 2011).

There were a further four sightings in October 2017, three of which were recorded by the author: a male hunting in an orange grove at Buskett on 11 October, a male at Ghadira Nature Reserve on 15 October (Ray Vella and Oriana Balzan pers. com.), a male and a female at Chadwick Lakes on 29 October and a male, also at Chadwick Lakes, on 31 October. All of these sites are in the western half of Malta. None were recorded in 2018.

***Anax ephippiger* (Burmeister) - Vagrant Emperor**

The status of *Anax ephippiger* in the Maltese Islands has been reviewed by Gauci (2014, 2018). While the species is irregularly recorded, sometimes in large numbers, in Spring, it has occurred annually in the Autumn from 2012 to 2018 (Fig. 1).

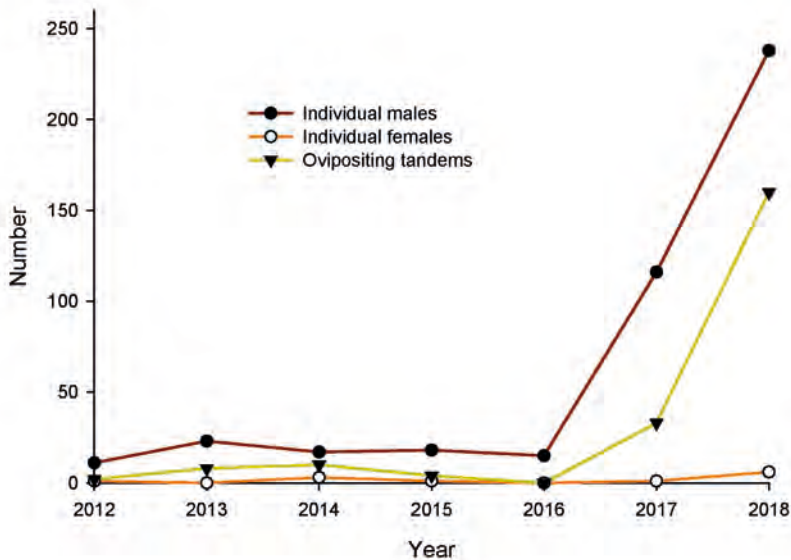


Figure 1. *Anax ephippiger* numbers in the Autumns of 2012 – 2018.

Ebejer observed several individuals mating and ovipositing but did not give any dates (Ebejer *et al.*, 2008). Sciberras (2011), quoting Ebejer *et al.* (2008), commented that these observations had been made in September 1984. However, no such information is to be found in Ebejer *et al.* (2008).

I have only once witnessed attempted oviposition in Spring (30 March 2016), when a tandem tried to oviposit at Ta' Qali reservoir but was repeatedly chased away by *Anax imperator* (Emperor Dragonfly) males which were holding territory there. In autumn I have seen the species regularly ovipositing (except in 2016), mostly at one of the reservoirs at Chadwick Lakes which invariably holds water even in dry autumns (although the water in this reservoir is often heavily polluted by drainage overflow) and at Imselliet Valley. The number of ovipositing tandems (33) was much higher in 2017 than the previous high of 12 in 2014 (Fig. 1). Autumn 2018 was wet, as a result of which valley systems were brimming with water in October-November. This probably contributed to the surge in numbers both of individual males as well as ovipositing tandems, with a record number of 230 and 160 respectively in 2018 (Fig. 1). On one day as many as nine tandems were seen ovipositing close together in an area of one square metre on floating plant debris carried by flood waters. Despite the

good numbers of ovipositing tandems over the past years, no evidence has yet emerged of a resulting emergence. Sciberras (2011) attributed this to the fact that all tandems seen by him were ovipositing in rock rain pools which dry up before larval development is complete. However, places such as Chadwick Lakes and the valley system comprising Imselliet, Wied il-Hzejjen and Ghajn Rihana, where I have recorded most of the ovipositing tandems, do not fall into this category, as some of the reservoirs there hold water all the year round.

A small piece of expanded polystyrene, on which a tandem had been seen ovipositing for at least half an hour, at Chadwick Lakes on 8 November 2018 was collected the following day and put in an aquarium on my roof. On 10 December about 20 first instar *Anax* sp. larvae were seen, increasing to about 60 by the 15 December. Most of these were transferred to two small ponds in my garden and two small aquaria on my roof. However, they all gradually disappeared and the last two (presumably 2nd instar as they were about 3mm long) were seen on 3 March 2019. There is no way of knowing which species of *Anax* these larvae belonged to as both *A. imperator* and *Anax parthenope* (Lesser Emperor) females could also have oviposited on the same piece of expanded polystyrene earlier on.

Spring 2019 again failed to produce any conclusive evidence of a generation resulting from the previous Autumn's breeding activity. No teneral were seen and the few *Anax* exuviae collected all belonged to either *A. imperator* or *A. parthenope*. There was a spate of sightings of adults between 18 March and 31 March (also one male on 18 April) coinciding with an influx in other Mediterranean countries. On 24 March at least 20 were present at Is-Simar Nature Reserve and some tandems were seen ovipositing (R. Galea pers com). Four other tandems were seen ovipositing at Chadwick Lakes and Imselliet Valley between 25 March and 31 March. None were seen after 18 April. The larval stage for this species is reported to be around 100 days (Dumont & Desmet, 1990).

While tandems were frequently seen ovipositing next to both *Anax imperator* females and *A. parthenope* tandems in 2018, patrolling males were regularly observed flying a few centimetres above the water surface and mobbing both conspecific ovipositing tandems (Plate 1) as well as female *A. imperator* (Plate 2). Indeed, on some occasions males were seen trying to mate with female *A. imperator*.

***Pantala flavescens* (Fabricius) – Wandering Glider**

In recent years this species is being reported more regularly from the Mediterranean Basin. Dijkstra & Lewington (2006) reported that it was frequently recorded only in the eastern part of the Mediterranean (Cyprus and south-east



Plate 1. A male *Anax ephippiger* harassing a conspecific ovipositing tandem.



Plate 2. A male *Anax ephippiger* harassing an ovipositing female *Anax imperator*.

Turkey) but noted that there were recent records from European Turkey, Rhodes and north-eastern Greece. Galliani *et al.* (2017) stated that, in Europe, the only areas where reproduction occurs are in Turkey, with recent reports for Cyprus and the Aegean Islands. In the central Mediterranean it was reported for the first time on the Pelagic Islands of Lampedusa and Linosa in October 2012 (Corso *et al.*, 2012). In November 2018, Corso and Vigano recorded 5+ (probably at least 20) individuals at Saline di Priolo, Syracuse, Sicily and photographed one in flight (Corso, 2018b). Janni (2018) stated that, on the island of Linosa, it is always seen in October-November following south-westerly winds and, indeed, Corso (2018a) noted that about 15 individuals were recorded on Linosa in the Autumn of 2018.

In the Maltese Islands there were three records of single individuals in 2013 – in August, late September and the end of October (Degabriele, 2013). A fourth sighting was made at Dingli on 18 October 2014 (Gauci, 2018). A male was seen by the author at Imselliet on the morning of 8 August 2019, making it the fifth known occurrence in the Maltese Islands. A strong wind varying between SW and SE had been blowing since the day before.

***Sympetrum striolatum* (Charpentier) - Common Darter**

The Common Darter is one of the most common and widespread European libellulid species (Askew, 2004; Dijkstra & Lewington, 2006; Boudot *et al.*, 2009; Boudot & Kalkman, 2015; Galliani *et al.*, 2017). Boudot & Kalkman (2015) stated that, in the Mediterranean basin, it is very common on streams which are reduced in summer to residual pools. In the data presented by Boudot *et al.* (2009) and Boudot & Kalkman (2015) the species is not particularly common in Sicily and Tunisia. However, it is listed as common on the Italian islands by Galliani *et al.* (2015). Askew (2004) stated that the species is strongly migratory and Dijkstra & Lewington (2006) noted that "Migrations are often seen and are sometimes massive". Galliani *et al.* (2017) stated that immatures move away from their places of emergence, and adults are seen back at their breeding areas from September.

In recent work on the odonata of the Maltese Islands all authors have repeated the same statement made in Ebejer *et al.* (2008) that local records suggest that the species was previously more common (Sciberras, 2008; Corso *et al.*, 2012; Degabriele, 2013; Sciberras & Sammut, 2013). Ebejer *et al.* (2008) listed 18 specimens collected in the 55 year period from 9 June 1952 to 11 August 2007 which they found in local collections. Gauci (2014, 2018) had questioned whether it could be that the species had possibly been confused with the locally occurring and very common *Sympetrum fonscolombii* (Red-veined Darter) since, prior to 2008, only a handful of communications listing the odonates

encountered had been published. The identity of those specimens in collections listed in Ebejer *et al.* (2008) is not in doubt but it seems likely that their comment that "Local records suggest that the species was previously more common" is difficult to justify.

Between 2009 and 2013, the author photographed the species just twice in the Maltese Islands – single males on 7 October and 25 October, both in 2011 (Gauci, 2014) and, despite almost daily observations at various sites, the author did not find any between 2014 and 2017. In 2018 the author photographed three individuals at Wied il-Hzejjen, all in exactly the same place, at the edge of one of the reservoirs. The first was an immature female on 16 May, followed by an immature male on 21 May (Plate 3a,b). In autumn the author found a mature male on 13 November (Plate 4). Despite monitoring several sites, including Wied il-Hzejjen, daily, none were seen in Spring 2019.

Other species

In the period 2014–2018 there have been no further sightings of the other rare/vagrant species mentioned by Gauci (2014) – *Calopteryx virgo* (Beautiful Demoiselle), *Calopteryx haemorrhoidalis* (Copper Demoiselle), *Orthetrum brunneum* (Southern Skimmer), *Orthetrum nitidinode* (Yellow-veined Skimmer) and *Orthetrum chrysostigma* (Epaulet Skimmer). However, Gauci (2018) added the following comments regarding three of these species:

***Calopteryx virgo*:** After re-analyzing all the relevant literature it is "Vagrant, but it is highly questionable whether it has actually occurred in the Maltese Islands".

***Orthetrum brunneum*:** "Probably extinct" in the Maltese Islands.

***Orthetrum nitidinode*:** As regards the four sightings at Wied Rihan in Sciberras & Sammut (2013), "There is no mention of who saw these specimens or what their sex was. Neither were the dates when they were seen given. As such, this claim has to be taken with a pinch of salt and the record rejected".

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A



B

Plate 3 Teneral of *Sympetrum striolatum* (A) female at Wied il-Hzejjen on 16 May 2018, (B) male at Wied il-Hzejjen on 21 May 2018.



Plate 4. A mature male *Sympetrum striolatum* at Wied il-Hzejjen on 13 November 2018.

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Coenagrion pulchellum (Vander Linden) (Variable Damselfly) in Northamptonshire VC32: A review of preferred breeding habitats.

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Summary

The habitat preferences of *Coenagrion pulchellum* (Variable Damselfly) are not well understood, with apparently suitable habitat not selected for breeding. In Northamptonshire, this is a rare species, known from only three sites, one long-standing (Maxey Pits), one discovered in 2018 (Weldon Woodland Park) and the third discovered in 2019 (Wicksteed Park). This review examines the habitats chosen by *Coenagrion pulchellum* and finds that there are many characteristics that are shared with other sites that do not host this species, but that one feature – the presence of flowering lillies (*Nymphaea* spp.) - is common to all three of the host sites but rare at other sites. *C. pulchellum* appears to use these exclusively for oviposition, suggesting that the habitats in Northamptonshire, despite its rich matrix of well-vegetated gravel pits, are not suitable unless they possess this type of lilly pad.

Introduction

Vice County 32, Northamptonshire includes the modern-day political County of Northamptonshire and the Soke of Peterborough, the latter being in the administrative county of Cambridgeshire. Northamptonshire has a rich matrix of gravel pits centred in the Nene Valley that host a number of species, including *Brachytron pratense* (Hairy Dragonfly), *Calopteryx virgo* (Beautiful Demoiselle) and *Libellula fulva* (Scarce Chaser) (Tyrrell *et al.*, 2013). In VC32, there are three known breeding sites for *Coenagrion pulchellum* (Variable Damselfly), one of which is well established in the Soke of Peterborough, the other two some distance away. Thus, in 2018, a new colony of *C. pulchellum* was discovered at Weldon Woodland Park near Corby (Underwood, 2018), and the following year more adults were recorded indicating (but not proving) successful breeding (Tyrrell, 2019). In 2019, the other, apparently well established, new colony was discovered at Wicksteed Park, Kettering (Underwood, 2019). In both cases, photographic evidence to confirm identity was obtained. Interestingly, despite the network of mature gravel pits along the River Nene, *C. pulchellum* has not

yet been found breeding there.

Occasional sightings have been made in the Nene valley, for example at Ditchford Lakes & Meadows Wildlife Trust Reserve (Tyrrell *et al.*, 2013) and Irthlingborough Lakes & Meadows Wildlife Trust Reserve (Tyrrell, 2016), but never more than a single male. In 2019 two males were reported from Barnwell Country Park (Underwood, 2019), prompting interest that another new colony had been found, however no further records were made.

According to Cham *et al.* (2014), *C. pulchellum* breeding sites have abundant and extensive emergent vegetation, are often sheltered, but not shaded, small mesotrophic ponds with surrounding woodland. Sites in the East of the UK frequently have fenland-like characteristics. Smallshire & Swash (2018) described breeding sites as well vegetated grazing ditches, fens, ponds & lakes and *C. pulchellum* often occurs together with *Brachytron pratense* and *Sympetrum sanguineum* (Ruddy Darter). In Ireland, *C. pulchellum* is widespread in central and eastern areas and favours lowland cut-over bogs, small lakes and ponds (Nelson & Thompson, 2004). It is most common in mesotrophic sites but less so in eutrophic sites. In VC32, the waters are eutrophic, which may explain its scarcity (Tyrrell *et al.*, 2013). It is present in the fenland of neighbouring Cambridgeshire and Lincolnshire (Cham *et al.*, 2014), where standing waters tend to be eutrophic, although some clay and gravel pits may be mesotrophic (Cambridgeshire & Peterborough Biodiversity Group, 2008). However, it is widely recognised that exact habitat requirements are not clear and that apparently suitable sites close to known colonies are not inhabited. These descriptions bear some resemblance to the three known breeding sites in VC32 but there are some significant differences between them; indeed the three sites differ in some key characteristics themselves. This inconsistency with the literature and within the County prompted further study of the habitats to help understand breeding site preferences in VC32.

Sites

Maxey Pits

Until 2018, *Coenagrion pulchellum* was known from only one site in VC32, Maxey Pits near Peterborough (British OS grid reference TF1207). This colony is small but stable and has been recorded in successive years since at least 2007 (Tyrrell *et al.*, 2013). Maxey Pits is a former gravel working close to Maxey Cut and is now a complex of five coarse fishing lakes, one of which is more natural, surrounded by trees and used by dog walkers. The other four are open

lakes used for intensive coarse fishing with limited conservation potential. There is also a permit-only nature reserve with shallower pools.

The colony of *C. pulchellum* is highly localised to a small section of the more natural, tree-lined lake (Plate. 1), where access to the water is no longer possible due to overgrowth of the surrounding trees. In 2013, this area was more open and access to the water was possible, allowing good observation of ovipositing pairs (Plate. 2). Adults are regularly recorded along the footpath and in surrounding hedges close to the water, adjacent to their now inaccessible ovipositing site. This lake has poor emergent vegetation but rich submerged vegetation (Table 1). The waters are eutrophic showing algal blooms in mid summer, especially in the surrounding lakes (Plate 1). The lake chosen by *C. pulchellum* includes a flowering water lilly, *Nymphaea* sp. with extensive, floating leaves and it is into the underside of these that pairs of *C. pulchellum* have exclusively been seen ovipositing (Plate 2).

Coenagrion pulchellum is absent from the neighbouring gravel pit complex of Lolham Bridges (TF1006) but these pits do not contain any flowering water lillies.



Plate 1. Maxey Pits showing the tree-lined lakes and open fishing lakes, as well as the newer gravel workings. The *Coenagrion pulchellum* colony is localised in the area marked by the arrow. The dark green in the other lakes indicates the presence of algal blooms. © 2019 Google, used in accordance with Google license agreement.



Plate 2. A pair of *Coenagrion pulchellum* ovipositing into the underside of a floating leaf of a flowering water lily (*Nymphaea* sp.), Maxey Pits. June 2013.

Weldon Woodland Park

The lake at Weldon (Plate 3) is a man-made, large pond (SP9189). The pond hosts a strong population of *Erythromma viridulum* (Small Red-eyed Damselfly), *Coenagrion puella* (Azure Damselfly) and *Orthetrum cancellatum* (Black-tailed Skimmer) among 15 recorded breeding species. However, there is no known breeding colony of *Brachytron pratense*. It is tree lined with Willow (*Salix* spp) growing around a set of concrete tiles that form the lining of the lake. There are significant expanses of *Ceratophyllum demersum* (Rigid Hornwort), which provide excellent habitat for ovipositing and emergent *E. viridulum*, and expansive areas of flowering water lillies, *Nymphaea oradata* and *N. xiafei* (Plate 4). The lake has very little emergent and marginal vegetation apart from a dense stand of *Typha angustifolia* (Lesser Bulrush) at one end (Table 1).

The colony of *C. pulchellum* was discovered in May 2018 (Underwood, 2018), when maturing adults were photographed among nettles close to a fast-flowing brook that hosts both *Calopteryx splendens* (Banded Demoiselle) and *Platycnemis pennipes* (White-legged Damselfly). To date this remains a small colony and maturing adults were recorded again in May 2019, suggesting successful breeding had taken place.



Plate 3. The lake at Weldon Woodland Park, showing the three *Nymphaea* sp. plants (arrowed). © 2019 Google, used in accordance with Google license agreement.



Plate 4. *Nymphaea odorata* (American Water Lilly) at Weldon Woodland Park. May 2018.

Wicksteed Park

Wicksteed Park is a pleasure park in the centre of Kettering (SP8876) and contains a variety of different water bodies ranging from heavily engineered boating lakes to more natural fishing lakes. These are all man-made, dating back to 1916 when the park was first constructed (Wicksteed Park, 2019). The lakes host a strong population of *E. viridulum*.

Of more interest to Odonata is the large fishing lake at the back of the park (Plate 5), which has a very natural feel with extensive emergent sedges and submerged *C. demersum*. This lake is surrounded by trees but with enough separation to allow emergent vegetation to grow and is close to the Rive lse, which runs through the park. There are numerous fishing stands that provide good territorial habitat for male *O. cancellatum*. The habitat is complex, ranging from open waters to secluded and sheltered areas. In addition to a colony of *E. viridulum*, there are also many thousands of *Enallagma cyathigerum* (Common Blue Damselfly) and *C. puella*. In the Autumn both *Sympetrum striolatum* (Common Darter) and *S. sanguineum* (Ruddy Darter) can be found in good numbers. The nearby River lse hosts *P. pennipes*. However, *B. pratense* is not known to breed here.

The colony of *C. pulchellum* is very localised to an area close to a flowering water lilly, *Nymphaea* spp, (Plate 6. Table 1), on which several ovipositing pairs have been recorded (Plate 7).

Table 1 summarises the key characteristics of these three habitats in VC32.

Conclusions

Of the three known breeding colonies of *Coenagrion pulchellum* in Northamptonshire VC32, there are several factors in common (Table 1). However, these are also shared by sites in which *C. pulchellum* does not breed, such as man-made, luxuriant marginal and submerged vegetation, sheltered surrounds and the presence of 14+ breeding odonate species.

There is one factor, however, which is rare in the County outside of ornamental lakes, that is common to the three *C. pulchellum* breeding sites; that is the presence of flowering water lillies *Nymphaea* spp. In all three sites, adults have been recorded ovipositing exclusively into the undersurface of these lilly pads, despite the presence of extensive areas of other submerged vegetation such as *Elodea canadensis* (Canadian Pondweed) and *Ceratophyllum demersum*. It will be interesting to see if these colonies allow *C. pulchellum* to expand into other



Plate 5. The fishing lake at Wicksteed Park, where the colony of *Coenagrion pulchellum* is localised in the area marked by the arrow. © 2019 Google, used in accordance with Google license agreement.

Table 1: Comparison of the key characteristics of the three known *Coenagrion cpulchellum* breeding sites in VC32.

Site Name	Type of water body	Emergent vegetation	Submerged vegetation	Surroundings	Breeding species (excluding <i>C.pulchellum</i>)
Maxey Pits	Manmade. Flooded gravel pit used for fishing	Sparse	Canadian Pondweed; Flowering lilly	Arable fields; woodlands; nearby linear manmade river (Maxey Cut)	14
Weldon Woodland Park	Manmade. Large pond with concrete base tiles	Sparse	Rigid Hornwort; Flowering lilly	Housing & industrial; playing fields; woodland	15
Wicksteed Park	Manmade. Used for fishing	Rich, mainly sedges	Rigid Hornwort; Flowering lilly	Scrub ground; slow flowing river (River Ise).	14



Plate 6. The localised area where *Coenagrion pulchellum* can be found in association with a flowering water lily (*Nymphaea* sp.) at Wicksteed Park. May 2019.



Plate 7. An ovipositing and a tandem pair of *Coenagrion pulchellum* on a leaf of the flowering water lily *Nymphaea* spp. Wicksteed Park. May 2019.

habitats that do not have this in common.

At Barnwell Country Park (TL0387), only single males have been recorded. However, this site holds extensive areas of *Nuphar variegata* (Yellow Pond Lily) a member of the *Nymphaea* family, on the gravel pit lakes, which are also prevalent on the River Nene in this area. This may herald the start of a new colony.

While it is difficult to draw firm conclusions regarding why *C.pulchellum* appears only to select sites with *Nymphaea* spp. in VC32, it is possible that this is a strategy that allows them to survive in eutrophic waters?

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