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# Journal of the British Dragonfly Society

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**Cover illustration:** *Aeshna caerulea* in dull conditions beside the Cooran Lane, Galloway. Photograph by David Clarke.

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# Migrant and dispersive dragonflies in Britain during 2020

# Adrian J. Parr

10 Orchard Way, Barrow, Bury St Edmunds, Suffolk, IP29 5BX

# Summary

Following a dramatic season in 2019, the year 2020 turned out to be a quieter one for migrant dragonflies in Britain, though there were still several highlights. A number of these probably relate to the legacy of past influxes, but significant fresh immigration also clearly took place.

The migrant season started with a few mature *Sympetrum fonscolombii* (Redveined Darter) arriving during mid–late May, but by early June several instances of local emergence by this species had also been reported. Successful overwintering of larvae resulting from breeding attempts made during the species' near record breaking year in 2019 had presumably been aided by the mild winter of 2019/20. *Anax parthenope* (Lesser Emperor) also started to appear in early June. In many ways, the highlight of spring was, however, the discovery of significant numbers of *Aeshna isoceles* (Norfolk Hawker) in the Weymouth area of Dorset, almost 250 km from the nearest known UK breeding population. Although the evidence is only circumstantial, it could well be that these sightings reflect a recently-established breeding population, perhaps initiated by migrants arriving during 2018 when *A. isoceles* was noted in the adjacent county of Devon.

Late spring and summer saw further appearances of *S. fonscolombii* and *A. parthenope*, with the latter species going on to have an excellent year, with reports from some 75 sites. Although many individuals must have been immigrants, *A. parthenope* does now also seem to be becoming increasingly established as a resident in Britain. Another highlight of summer was the good showing by *Aeshna affinis* (Southern Migrant Hawker), which was reported not just from its Essex and Kent strongholds, but also from many other areas of southern Britain. This is the third year in a row that records have been quite widespread, and both the establishment of new breeding populations and an increase in immigration and/or internal dispersal seem to be involved. Finally, also of note during mid 2020 were several records of *Ischnura pumilio* (Scarce Blue-tailed Damselfly) well away from the species' core range.

The later part of the season saw some large gatherings of *Aeshna mixta* (Migrant Hawker), plus an unexpected series of records of this species caught overnight in moth traps, the exact significance of which currently remains uncertain though it may well reflect night-time migration. Also of interest were a scattering of records of locally-bred second-generation *S. fonscolombii*, though in unexceptional numbers. Mid September saw the start of a substantial influx of *Anax ephippiger* (Vagrant Emperor) which went on until November. Once a great rarity in Britain, arrivals of *A. ephippiger* are now very much 'expected', particularly in autumn. It will be informative to see whether this trend is sustained.

# Account of species

Notable sightings reported to the BDS Migrant Dragonfly Project during 2020 are detailed below; for information on events during 2019, see Parr (2020a).

# Chalcolestes viridis (Vander Linden) - Willow Emerald Damselfly

After significant range expansion by this recent colonist was seen during 2019, events during 2020 were slightly less dramatic. Relatively little further expansion was thus noted, though there were reports from north Leicestershire, including good numbers seen at Melton Country Park during September (SH), and the first records for Nottinghamshire were also received during that month, with reports from e.g. Rampton on 1 September (DHu). Considerable consolidation did, by contrast, take place near the edge of the species' main range. Sightings continued to come from both north Lincolnshire and east Yorkshire, following the first sightings there in 2019 (Parr, 2020a). This strongly suggests that these more northerly areas have now been successfully colonised. Elsewhere, there was a further record from Warwickshire during September (KPR), and a number of new sites were identified in the Oxfordshire area, for example on Otmoor (PP) and at the Trap Grounds in north Oxford (ND). Further records also came from north Hampshire, e.g. at Yateley Common (PB), and the number of Sussex records also continued to increase, with the gap in distribution previously seen in the High Weald area now starting to close.

# Lestes barbarus (Fab.) - Southern Emerald Damselfly

It was a relatively good year for *Lestes barbarus.* Reports of small numbers at Sandwich Bay in Kent between 25 June–13 August (SBBOT, FP) probably result from fresh immigration, with the last records from this area having been in 2014. Elsewhere, records were received from virtually all of the recently active breeding colonies now present in southern England, though fortunes seemed to vary somewhat between sites. There was just a singleton reported

from Winterton Dunes in Norfolk (31 July; DHe) and the inland population near Beaconsfield in Buckinghamshire limped on after continuing habitat disruption (CL, RM *et al.*). Numbers seen near Bouldnor on the Isle of Wight were also lower than in some years (PHu). By contrast, the species did well in south Essex, with reports from three separate localities in the Basildon/Canvey area between 22 June–9 August (JHa, IP, NPh *et al.*) and from Little Belhus Country Park, which lies some 15–20 km away, on 30 July (PA) and 9 August (JK). At one site near Canvey, in excess of 20 individuals, including 8 tandem pairs, were reported during early August (NPh).

# Coenagrion scitulum (Rambur) – Dainty Damselfly

No new sites for this highly localised recent (re)colonist were discovered during the year, but the colony found in the Sandwich Bay area of Kent during 2019 (British Dragonfly Society, 2020) is obviously thriving, with at least 180 individuals being noted during 2020 (SBBOT).

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

Following significant range expansion during 2019, the present reporting year produced far fewer highlights. A sighting of two males at West Williamston, Pembrokeshire, on 30 July (AC) was, however, the first record for the county.

# Ischnura pumilio (Charp.) - Scarce Blue-tailed Damselfly

*Ischnura pumilio* is normally absent from large parts of central and eastern England but, during the period 17 May–22 August, an extensive series of reports was to come from unexpected localities in these areas as a result of either internal dispersal or immigration; these involved a number of first or second county records. Sites involved included Feckenham Wylde Moor in Worcestershire (AWa), both Crowthorne (NPe) and Mortimer (ABo) in Berkshire, Banbury in Oxfordshire (BS), Sompting in West Sussex (TF) and Ipswich in Suffolk (MG). With a teneral individual being found at Mortimer on 17 May it is clear that this site was colonised prior to 2020, perhaps during the eventful times of 2019 (Parr, 2020a). Whether records at other sites were also the result of earlier movements, or due to fresh dispersal during spring 2020, is often difficult to say; although mid–late summer emergences were noted at several sites, these are not necessarily inconsistent with colonisation during the current reporting year since the species is potentially bivoltine (Martens *et al.*, 2017).

# Aeshna affinis (Vander Linden) – Southern Migrant Hawker

This recent colonist is now well-established in the Thames Estuary area, but

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since 2018 there have also been good numbers of records well away from this region. The current reporting year saw a continuation of this trend and, in all, during the period 15 June–31 August confirmed records were received from fourteen counties in England (Cornwall, Dorset, Isle of Wight, Hampshire, East Sussex, Kent, Essex, Hertfordshire, Oxfordshire, Suffolk, Norfolk, Cambridgeshire, Gloucestershire and Lincolnshire) plus one (Glamorganshire) in south Wales.

Part of this trend towards an increased spread of records clearly arises from several small breeding colonies having now become established well away from the species' Thames Estuary strongholds. During 2020, localities such as Lytchett Bay in Dorset, Winchelsea in East Sussex, the Walberswick area of Suffolk, Quy Fen in Cambridgeshire and Hempsted in Gloucestershire thus each recorded Aeshna affinis for the third year in a row. Several immatures were also noted on Otmoor in Oxfordshire during mid June (GWy), with mature adults being seen later in the season. Although these are the first county records, it would seem that breeding is now also taking place in this area, the founding adults obviously having gone unobserved. Multiple immatures were similarly noted at Knowlands Wood, East Sussex, on 22-23 June (SLi, JL). In addition to the presence of new breeding colonies, continuing immigration also seems to be involved in the wide spread of records. Reports from novel sites thus peaked sharply over 7-11 August, highly suggestive of an influx, and August 2020 is also known to have brought several A. affinis to southern Sweden (Magnus Billqvist, pers. comm.). Increasing internal dispersal within Britain may now also be playing an important role in determining the species' distribution.

# Aeshna cyanea (Müller) – Southern Hawker

There were no significant reports from Britain during the year, but only the second ever confirmed Irish record – from Tullow in County Carlow on 21 September (SBo) – serves as a reminder of the species' dispersive potential.

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

Recent years have seen many reports well away from the species' traditional strongholds, probably as a result of both increased internal dispersal and a degree of immigration, and several new breeding populations have become established in parts of south-east England (Brooks *et al.*, 2014; Taylor, 2021). The 2020 reporting year saw a continuation of this trend. Of the more notable records, singletons were seen in Essex at Little Belhus Country Park on 28 May (IP), on the River Chelmer near Boreham on 15 June (SJe), at Paglesham on 22 June (SBr) and at north Wivenhoe on 23 June (GE). Even more unusually, a male was then noted at Spurn in East Yorkshire on 17 July (SBO). The highlight

of the year was, however, the discovery of multiple individuals in the Radipole area of Dorset during late spring. At Radipole itself, individuals were seen over the period 7 June–2 July at least (many observers), with a maximum count of seven on 14 June (MG). At least two individuals were also reported from nearby Weymouth (PHr *et al.*). This type of event is unprecedented, and rather suggests the presence of a recently-established breeding colony at Radipole. Possibly it was founded back in 2018 when, although there were no reports from Dorset at the time, a single *Aeshna isoceles* was seen in the adjacent county of Devon (Parr, 2019). The generation time of *A. isoceles* in Britain is indeed thought to typically be two years (Brooks *et al.*, 2014).

#### Aeshna mixta Latreille – Migrant Hawker

The reporting year was notable for both some large aggregations and for several records from unusual places or under unusual circumstances, all this suggesting that Aeshna mixta showed a considerable degree of mobility during 2020. About a hundred were seen at Holme, Norfolk, on 24 August (RP), with a similar large gathering of hawkers, presumably mostly/all A. mixta, also being noted at Draycot, Derbyshire, on the same day (ETM). A large "apparent movement" was noticed between Marshside and Hesketh, Lancashire, on 14 September (PK), when 150 were also seen between Ashington and Druridge Bay, Northumberland (MWe). Some 500 were then reported from Ham Wall RSPB Reserve, Somerset, on 20 September (MHa). Although numbers involved were lower, records from at least three sites on the Isle of Man in early September (PHa), from Glen lorsa on the Isle of Arran on 5 September (KB) and from Seton Sands, East Lothian, on 17 September (BH) are also of note, representing new site records near the very edge of the species' British range. In addition to the above sightings, there was also an extensive series of records of individuals caught overnight in moth traps in southern and central England during the course of the year; such records of dragonflies at light frequently seem to involve migrants (Parr, 2006). Between 2-20 August, individuals were discovered in traps at Great Yarmouth in Norfolk (IM), Curry Rivel in Somerset (MP), Marston Moretaine in Bedfordshire (SLe), Bracklesham in West Sussex (DL), Ashford in Kent (LC), Pitsford in Northamptonshire (CC) and Bawtry in South Yorkshire (SBa). Most individuals were female, and at least two are known to have arrived between midnight and 2:00 a.m.

While some of the above records no doubt refer to individuals moving within Britain, it seems highly likely that significant immigration from the Continent also took place. In this context, a record of two individuals seen on a boat in the North Sea roughly 100 km off the north coast of the Netherlands on 11 August (Waarneming.nl, 2020) is of considerable interest.

# Anax ephippiger (Burmeister) – Vagrant Emperor

2019 – A late record was received of up to seven individuals, including at least one female, at a private gravel pit complex in north Nottinghamshire over the period 7 July–8 August 2019 (DHu). These sightings tie in with the records of multiple individuals seen in other parts of England during summer 2019 (Parr, 2020a; Parr, 2020b) but are notable for involving an inland site, almost all other records at the time being coastal.

2020 – Following the record year for the species in 2019, involving at least three separate influxes (Parr, 2020a; Parr, 2020b), another significant invasion took place during 2020. An individual was noted at Ashington in Northumberland on 6 August (MWe), following which some 15+ sightings were then made over the period 17 September–9 November. Records typically referred to singletons that were seen on just a single day, and were primarily from coastal areas of south Wales and southern and south-eastern England. A male was, however, photographed well inland near Milton Keynes, Buckinghamshire, on 25–26 October (HB) and, in addition, there were also a few more northerly sightings, notably at Spurn in East Yorkshire on 17 September (HW) and at both Heysham (KE) and Little Thornton (GWh) in Lancashire during early November. As seems quite typical for autumn influxes of *Anax ephippiger*, some individuals were attracted overnight to moth traps, in this instance at Pakefield, Suffolk, during the night of 30 September (AWr) (Plate 1) and at Church Cove on the Lizard, Cornwall, during the night of 29 October (MTu).

# Anax imperator Leach – Emperor Dragonfly

Although the species is rapidly expanding its range northwards, Scottish populations of *Anax imperator* are still few and relatively small. No less than 16 individuals, including five ovipositing females, were however noted at Newmains ponds near Reston in the Scottish Borders on 6 August (DG). This is the highest count ever recorded at this site, and with far fewer having been seen just a few days previously it is possible than an influx of some sort was involved. Elsewhere one was caught in a moth trap at Portland Bill, Dorset, on the night of 9 August (MCa); dragonflies attracted to light often seem to involve migrants (Parr, 2006).

#### Anax parthenope Sélys – Lesser Emperor

It was one of the best years ever for *Anax parthenope* in Britain, with records from over 70 sites during the year, spread across 28 counties as far north as Dumfries and Galloway, though with a concentration in south-eastern England.



**Plate 1.** *Anax ephippiger* (male) attracted to a 60W actinic moth trap at Pakefield, East Suffolk, on the night of 30 September 2020. Photograph by A. Wren.

Reports spanned the period 30 May–6 September, with a broad peak in new sightings during mid July, followed by two sharper peaks around 30 July–1 August and 8–12 August that were coincident with spells of unusually hot weather and generally southerly or easterly winds (Met Office, 2000a). Particularly notable records included a male at Cowpen Bewley Woodland Park, County Durham, on 11 July (IF), another male on Skokholm Island, Pembrokeshire, on 9 August (RB) and three individuals, including an ovipositing pair, at Kirkconnell Flows, Dumfries and Galloway, also on 9 August (RS); at this last site a male remained until at least 6 September (ABr). Scottish records of *A. parthenope* remain highly unusual, and the Kirkconnell record is the first reported breeding attempt for the country.

As well as occurring as a migrant, *A. parthenope* is strongly suspected to have also been breeding at a few scattered localities in Britain for some years, though rigorous proof is typically still lacking. Evidence suggests that an increasing number of such breeding sites may now be becoming established, with several locations that recorded the species during 2018 or 2019 again reporting the species in 2020. Such sites included Windmill Farm and Drift Reservoir in Cornwall, with an obviously immature, and presumably locally-bred, individual being seen at the latter site on 12 July (CM). Other sites producing repeat

sightings included Longham Lakes in Dorset, Dungeness in Kent, West Rise Marsh in East Sussex, Carlton Marshes in Suffolk, both Felbrigg Hall and the Trinity Broad complex in Norfolk, and also Cosmeston and Kenfig in Glamorganshire, plus a site in the north of the Isle of Man. In addition, immature, and thus potentially locally-bred, individuals were reported from Kingston-on-Thames, Surrey, on 19 July (JT) and from Winterton Dunes in Norfolk on 26 July (DW).

# Crocothemis erythraea (Brullé) – Scarlet Darter

There were no records of *Crocothemis erythraea* from Britain itself during 2020, but an immature male was photographed on the Channel Islands at St Ouen, Jersey, on 7 June (JH). Despite now being relatively widespread on the near Continent, the species is apparently still very rare on the Channel Islands.

# Libellula fulva Müller – Scarce Chaser

This species has been undergoing considerable range expansion over recent years (Cham *et al.*, 2014). A male photographed at Forest Farm Nature Reserve near Cardiff, Glamorganshire, on 2 June (FS) and a male and female at Llangorse Lake, Breconshire, on 25 June (MWa) constitute only the second and third confirmed Welsh records.

# Orthetrum cancellatum (L.) - Black-tailed Skimmer

An individual was observed arriving off the sea at Heysham, Lancashire, on 25 June (per PM), and "many more than normal" were reported from Crosby Marine Park, Lancashire, the following day (PK); this may indicate a local influx. In Scotland, records of the species are presently extremely scarce but, during 2020, individuals were noted at two sites in the Scottish Borders. One was present near Newmains on 12–13 July (DG), while up to ten were present at nearby Millars Moss over 7–19 August (DG). These are the first Scottish records since 2015.

# Sympetrum danae (Sulzer) – Black Darter

There were several unexpected records made in England during September. A male at Little Bradley Ponds, Devon on 13 September (DS) was, for example, the first record there for over 40 years. Away from the known breeding site in the county, single *Sympetrum danae* were seen in Gloucestershire at Woorgreens on 14–27 September (JP *et al.*) and at nearby Dam Green on 16 September (JP). In Lincolnshire, singletons were similarly reported from Alkborough Flats



**Plate 2.** Sympetrum fonscolombii (immature male). Croft Pascoe pool, the Lizard, Cornwall, 30 May 2020. Photograph by D. Cooper.

on 2 September (ND), Winteringham on 6 September (CG) and Gibraltar Point on 12 September (BW). Several of the above records probably arise from relatively local-scale internal dispersal but some, including the Gibraltar Point record, may result from immigration from the Continent.

#### Sympetrum fonscolombii (Sélys) - Red-veined Darter

2019 – A late record was received of roughly 30 seen near Misson, Nottinghamshire, on 7 July 2019, with some individuals lingering until 8 August (DHu). *Sympetrum fonscolombii* had a very good year in Britain during 2019 (Parr, 2020a).

2020 – Following a mild winter in Britain (Met Office, 2020b), spring 2020 was notable for emergences of locally-bred *S. fonscolombii* being either observed directly, or else strongly suspected, at several widely scattered sites in England. Immatures were noted at Croft Pascoe pool, Cornwall, on 30–31 May (DC, MJ)

(Plate 2) and a teneral female was seen at Brockholes, Lancashire, on 2 June (JC), with an immature female being seen there on 13 June (SJo). Exuviae were found at Sandwich Bay, Kent, also on 2 June (SBBOT), with a teneral male and three exuviae being found at an undisclosed, and possibly different, site in Kent around the same time (MHe). Elsewhere, immatures were seen on the East Devon Pebblebed Heaths throughout the first half of June (MTw, DS *et al.*), a young female was seen at Chelford, Cheshire, on 16 June (AE), and small numbers emerged at Langley Park Wetlands and Oakenshaw Wildlife Reserve in County Durham between 17 June–5 July (KW).

In addition to local emergences, fresh immigration also took place during early 2020. A male was seen at Caer Bran, Cornwall, on 14 May (DF), and mature males were photographed at Minsmere, Suffolk, on 22 May (TW) and at Beeston, Norfolk, on 23 May (MCI). The highlight of a steady trickle of records thereafter was a significant influx seen around 23–25 June, coincident with a period of very hot, sunny, weather (Met Office, 2020a), and by the end of July sightings had been received from well over a dozen counties. Particularly notable records included a male on Papa Westray in the Orkney Islands on 25 June (DR) and another male at Seton Fields, East Lothian, on 9 July (BH). Although increasing, Scottish records of *S. fonscolombii* still remain relatively scarce; the Papa Westray sighting is the most northerly ever reported from Britain.

Following the events of spring and early summer, late summer and autumn proved to be considerably quieter. An emergence of locally-bred second-generation individuals was noted at Sandwich Bay in Kent during mid-late August (SBBOT), and single teneral or immature *S. fonscolombii* were seen at Warmwell, Dorset, on 29 July (HM), at Radley Lakes, Oxfordshire, on 4 September (WB) and at Oakenshaw Nature Reserve, County Durham, on 18 and 22 September. Few other signs of successful local breeding were noted, though single relatively young individuals seen at Bovey Heath, Devon, on three dates between 6–18 September (JW) may perhaps have been locally bred. Relatively fresh individuals seen on the coast at Trimingham, Norfolk, on 17 September (SC) and Durlston County Park, Dorset, on 29 September (HM) are, by contrast, more likely to represent migrants from elsewhere. Towards the end of the season, a mature male was seen at Flamborough, East Yorkshire, on 8 September (MP) and an individual was reported from Kessingland Beach, Suffolk, on 16 October (LBC).

# Sympetrum striolatum (Charp.) – Common Darter

2019 – There was a late report of up to 47 seen in a garden at Weybourne on the Norfolk coast during the week 28 July–3 August 2019, with numbers gradually

declining thereafter (BG). This is strongly suggestive of an immigration event.

2020 – It was seemingly a quiet year for migration by *Sympetrum striolatum*, though movements involving only small numbers can be difficult to detect.

#### Discussion

Following relatively dramatic years for migrant dragonflies in both 2018 and 2019, the current reporting year turned out to be somewhat less eventful. Some highlights indeed reflected successful local breeding by migrants that arrived in previous years, rather than fresh immigration seen during 2020. A significant proportion of spring records of *Sympetrum fonscolombii* thus related to immatures, often apparently locally-bred, rather than the arrivals of fully-mature individuals more normally seen. The high number of records of *Anax parthenope* received during the year also likely include a significant contribution from locally-bred individuals as a result of an increasing strength of local populations.

Many changes and trends that have become apparent over the past one to two decades, probably as a result of ongoing climatic warming, continued during the present reporting year. *Anax ephippiger* used to be only a rare and erratic visitor to Britain but has recently become noticeably more common, and 2020 saw yet another significant influx. The recent colonist *Aeshna affinis* continued to be reported from a growing area of southern Britain, probably reflecting a mix of continuing immigration and dispersal from a widening spread of now thriving local populations. Sightings of *Aeshna isoceles* are nowadays also following a similar trend, in contrast to the situation during the twentieth century when British populations remained small and highly localised.

In addition to the above highlights, several other significant events took place during the year. Notably, there was a series of records of *Ischnura pumilio* from new areas in southern England resulting either from immigration from the Continent, internal dispersal, or both (indeed conditions that favour movement from the Continent are perhaps likely to also encourage movement within Britain, and visa versa). Some large autumn gatherings, preceded during August by a series of records from UV moth traps, also hint at unusual movement patterns shown by *Aeshna mixta* during 2020, though again it is not fully clear what sort of distance scales are involved.

Although slightly less spectacular than those of 2018 and 2019, migratory/ dispersive events during the current reporting year were clearly still of considerable note. Although many fit within emerging patterns, other events were slightly more unexpected and serve to emphasise just how much still remains to be learnt about the migratory strategies of European Odonata.

# Acknowledgements

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# Anax ephippiger (Burmeister) (Vagrant Emperor) larvae surviving the winter and emerging in spring in the Maltese Islands

# **Charles Gauci**

28 Triq il-Kissier, Mosta, Malta MST1822

# Summary

Following the discovery of successful breeding of *Anax ephippiger* in the Maltese Islands in late autumn 2019, three larvae of this species were confirmed to have emerged in spring 2020 clearly indicating that the larvae had managed to survive the winter. Another fresh exuvia was found at Imselliet Valley in May 2020. Four sightings of mature males in April were deemed to have been locally emerged individuals since there was no evidence of migration.

# Introduction

Anax ephippiger has a very wide range that includes large parts of Africa and extends over the Arabian Peninsula into north-east India and parts of central Asia. The presence of the species in Europe is largely dependent on migration from Africa or south-west Asia, and the number of individuals seen each year varies greatly. Large influxes are irregularly witnessed in the Mediterranean, sometimes reaching northern Europe in sizeable numbers. Arrivals in spring, followed by oviposition, regularly result in successful reproduction in the Mediterranean, resulting in a new summer generation the same year (Boudot & Kalkman, 2015). Large numbers arrived in central Europe in late spring 2019 and successfully bred in The Netherlands and Belgium (van der Heijden, 2019; Manger, 2020) as well as in the Czech Republic (D. Matthey, pers. com.). Several exuviae and tenerals were found in these countries in August and September. Large numbers also reached the United Kingdom but successful breeding was not confirmed (Parr, 2020).

Anax ephippiger has been recorded in the Maltese Islands since the first half of 20th Century (Valetta, 1949) and has been observed mating and ovipositing (Ebejer et al., 2008). However, it was only confirmed to have bred successfully for the first time here in 2019, emergence from eggs laid in late September-early October taking place in late November-early December (Gauci, 2020).

# Observations

In late October 2019 a number of *Anax* sp. larvae were collected from a drying out rock pool and released in three small ponds and an outdoor aquarium at the author's house. Between late November and mid-December three *Anax ephippiger* imagos had emerged, this being the first confirmed breeding of this species in the Maltese Islands (Gauci, 2020). In early November 2019, following a rainy period, the same rock pool had filled up again but was drying out once more in early February 2020. By 21 February the pool had dried up but was covered by a fairly thick algal mat. About 40 *Anax* sp. larvae, most in their final or penultimate instars but including six early instars, were taken out of the algal mat and transferred to the ponds at the author's house. Between 26 February and 16 May, 27 *Anax imperator* (Emperor Dragonfly), 11 *Anax parthenope* (Lesser Emperor) and three *Anax ephippiger*, a female, emerged on 22 March, followed by a male on 30 April and another male on 5 May (Plate 1).

In addition, an *Anax ephippiger* exuvia was collected from Imselliet Valley on 12 May 2020. In spring 2020 there was no evidence of any migration of this species in the Maltese islands. It can be safely presumed that four males sighted in April – one each at Imselliet Valley on 5th, Chadwick Lakes on 7th, Mosta on 13th, and again at Chadwick Lakes on 28th had also emerged locally.

Two other instances of larvae surviving winter in Europe have been recorded. A teneral female found in the Donana National Park, in Andalusia, Spain on 27 March 1979 and fresh exuviae, tenerals and immatures on 29 April 2000 in the Rhone delta in France (Boudot & Kalkman 2015).

Unfortunately, hopes of further observations in 2020 were dashed as the rainy season arrived late in the Maltese Islands and was very patchy. The rock pool from which the larvae were retrieved was still dry in mid-November. *Anax ephippiger*, which during recent autumns had been relatively numerous, was this year largely conspicuous by its absence. Generally just a few single males were seen but on 20 September at Wied Rihana seven males were observed, one of which was in an ovipositing tandem. During the same day (and on the previous day) there had been a large influx of *Anax parthenope* (Lesser Emperor), *Sympetrum fonscolombii* (Red-veined Darter) and *Pantala flavescens* (Wandering Glider) with 80+, 100+ and 16 respectively counted at the same place on the same date.

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Plate 1. Emergence sequence of a male *Anax ephippiger* on 5 May 2020.

# Discussion

While in the African continent Anax ephippiger breeds in environments which are extremely rich in macroplankton and larval development is rapid taking about 100 days (Dumont & Desmet, 1990), Matthey (in Gauci, 2020) recorded a larval development as short as 54 days in the Czech Republic in summer 2019. The species has long been known to breed in southern Europe (Askew, 1988) but in 2019 successful breeding in large numbers was recorded as far north as the Netherlands and Belgium (Van der Heijden, 2019; Manger, 2020; Parr, 2020). Ovipositing tandems were also observed in England and successful breeding could have easily been overlooked (Parr, 2020). In the Mediterranean region spring arrivals of this species regularly result in successful reproduction, resulting in a new summer generation the same year (Boudot & Kalkman, 2015). However, in the Maltese Islands breeding activity has in recent years been regularly observed in autumn (Gauci 2014, 2018, 2019, 2020), although successful breeding was only confirmed in late autumn 2019 (Gauci, 2020), with a larval development period similar to that found by Matthey in the Czech Republic. The larval period of the imagos emerging in Malta in spring was considerably longer, spanning between 150 and 180 days, similar to that of the two other Anax sp. which breed in the Maltese Islands. It seems likely that larvae which reach their penultimate or final instar stages by late autumn, and which do not emerge that same autumn, are capable of overwintering to emerge the following spring. These would likely be larvae hatching from eggs laid between late September and mid-October, when temperature is still in the high twenties or even higher and food is still abundant, enabling a faster growth. Successful breeding is therefore dependent on the timing of the autumn rains.

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# Aeshna caerulea (Ström) (Azure Hawker) in Galloway: a history

# **David Clarke**

Burnfoot, Cumwhitton, Brampton CA8 9EX

# Summary

The only breeding population of *Aeshna caerulea* in the UK south of the Scottish Highlands was discovered in 1949 at the Silver Flowe, Galloway but has declined since then and may now be lost. Studies at that site, especially in the 1980s and 1990s, revealed much about the species' natural history and enabled the hitherto little-known larval stages to be characterised and published. Its apparent extinction at this location during the present century is discussed and linked to the direct and indirect effects of changes in climate and weather patterns on the species and its habitat.

# Introduction

The Azure Hawker (*Aeshna caerulea*) is a boreo-alpine dragonfly, found above or north of the tree line from Scandinavia eastwards as far as Kamchatka in the far east of Russia. It also occurs as a post-glacial relic in Scotland and in some mountains in central Europe, including the Alps (Dijkstra, *et al.*, 2020).

Its main UK range is in the Highlands of Scotland but an outpost population was discovered in Galloway by the noted ecologist and naturalist Derek Ratcliffe (Ratcliffe, 1949). This was from near Loch Twachtan (NX429866), a remote lochan at 470 metres under the NE slopes of the Merrick range. Though not a breeding observation, these were soon to come at the Silver Flowe (NX4782), where Ratcliffe was conducting a major study on the vegetation of this bog system (Ratcliffe & Walker, 1958). This site lies about 6 km southeast of Loch Twachtan and about 50 km west of Dumfries. Little more information was then forthcoming for many years - in part a reflection of the relative remoteness and inaccessibility of the area. Three male specimens at Tullie House Museum, Carlisle were collected by local naturalist W. R. Laidler on 28 June 1964. There are no counts of adults until the 1980s, and no reports of larvae before then. The only record of the species from elsewhere in Galloway was by Norman Moore on 2nd July 1976 from Cairnsmore of Fleet, about 15km SSE of the Silver Flowe bogs – at an isolated rushy pool below the Spout of the Clints. It

seems unlikely this was a breeding site; it is suggested that the species may well have wandered over the Galloway uplands in that era.

# The Habitat and Area

The Silver Flowe is an exceptional series of patterned blanket bogs extending over about 200 ha (2 km<sup>2</sup>) in the valley drained by the Cooran Lane (a headwater stream of the river Dee), between the Rhinns of Kells range and the lower foothills of the Merrick range in Kirkcudbrightshire (Plate 1). The site was designated a NNR in 1956 but de-designated in 2018. Ratcliffe (2007) described the bogs as "the most extreme type of western blanket bog in the region," having "features otherwise confined to flow bogs in the Scottish Highlands". The average altitude of the bogs is about 250 metres a.s.l. The system has a wide range of pools, many of which are ribbon-like and aligned to the contours. Many are rich in Sphagnum species. The bogs are immediately west of the Cooran Lane and well above its channel. Plate 2 shows the remote and upland character of the habitat. There are no equivalent sites at higher altitudes in the area. Climatologically, the area is relatively oceanic and its closeness to the Atlantic and the Irish Sea tends to minimise the temperature rises experienced elsewhere in the UK. Local rainfall is about 2200 mm p.a. and is increasing. However, there are recent signs of changes in rainfall patterns (see below).

# Aeshna caerulea at the Silver Flowe 1986-2001

Visits by the author began in 1984, though were not annual. The first adult of *Aeshna caerulea* was found on 27 June 1986. As was later to become the familiar scenario, this was not in the breeding habitat but near the forest edge to the east of the bogs. First finds of larvae, just two mature examples, were on 3 May 1988 at High Cornarroch and Brishie bogs. They are presumed to be the first known from this site. The adults were reared out, emerging on 15 and 16 June respectively, and were returned to the site.

Apart from his many other visits, the author conducted five well-attended Field Meetings of the British Dragonfly Society (BDS) (1988, 1991,1992,1996, 2001). The BDS visits represent the most intensive searches ever in terms of observers present on any one day (Table 1). Including these visits and visits by others, at least 106 recorder-days were invested in looking for the species from the late 1980s up to and including 2001. In addition to the Silver Flowe itself, the bogs at Ellergower Knowe Moss at NX4879, about 1.5 km south of the Silver Flowe (Plate 1), also proved of interest. Hatchling larvae were found there in 1996 and adults were also observed. These records are the foundation of what we know about the species in SW Scotland.



**Plate 1.** Ellergower Knowe Moss (1) and the Silver Flowe bogs (2-7). 2, Craigeazle Bog; 3, Snibe Bog; 4, High Cornarroch Bog; 5, Craignaw Bog; 6, Brishie Bog; 7, Long Loch and Round Loch Bogs. (British National Grid Reference at 3: NX469820). Dark green, standing forest; light green, felled forest. Base image © Google Earth, 2011.



Plate 2. View across High Cornarroch Bog towards Dungeon Hill, October 2019.

Abundance counts of adults were much influenced by prevailing weather, the number of observers - and later also by the findability of adult dragonflies owing to tree-felling operations (see below). The data that are most significant relate to larvae, since these should always have been present. However, even in periods of apparent relative abundance, larvae did not always prove easy to locate. This suggests highly localised occurrence and perhaps small numbers even then. The fact that there were no sightings of emergence, very few records of exuviae and even fewer of mating or oviposition may, in part, be a reflection of the lack of June dates amongst the surveys, though also of unsuitable weather on some occasions. (See Life Cycle and Phenology below.)

#### **Observations on larvae at the Silver Flowe**

Larvae were found in a variety of pool sizes. In NW Scotland, a preference for small pools has been found (Smith, *et al.*, 2000). This was also the case with hatchling larvae at Ellergower Knowe Moss (Plate 1) in 1996. 'Good pools' on Silver Flowe (Plates 3, 4) have varied much in size and usually have much floating sphagnum, but also open water of moderate depth, with deep bottom detritus of putty colouration. Larvae could often be seen walking over this

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**Table 1**. Data from the British Dragonfly Society visits 1988-2001. Most of the adult *Aeshna caerulea* were males. The results for larvae should be viewed in the light of text comments and Table 2. No final instar larvae were found during these visits. Bracketed numbers in the date column refer to the number of attendees at the meetings. The letters in the table refer to approximate numbers - B, 2-5; C, 6-20; D, 21-100.

	Adults			
Date			Exuviae	Larvae
	Total	Female		
9-10 July1988 (16)	D	1	1	2 intermediate from Snibe Bog [9 attendees searched]
13-14 July1991 (23)	С	В	-	[bogs not visited]
11-12 July1992 (17)	С	2	6	1 at High Cornarroch Bog
6-7 July 1996 (17)	С	2	-	2 intermediate + 4 hatchlings at Brishie Bog; hatchlings at Eller- gower Knowe Moss
14-15 July 2001 (9)	B (on 15th)	-	-	Negative at Brishie Bog on 14th; no larval searches reported from 15th

material. It was sometimes possible to find a range of larval sizes within certain pools (Table 2).

Pools with dark bottom debris and little sphagnum appeared unproductive. There is no convincing evidence that the locations of productive pools were other than random in relation to the pool system as a whole.

The range of sizes encountered on single occasions was judged unlikely to have originated from a single oviposition in just one season. As evidenced by the size distribution of larvae from the Silver Flowe, and also confirmed by others (e.g. Corbet, *et al.*, 1960; Clarke, 1994), larval life appears to span at least three years. Larvae of a range of instars were always present, though final instars were absent from late June until late summer, when they were again present and clearly an overwintering stage. The smallest instars recorded would presumably have hatched in spring following oviposition in the previous year -

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**Table 2.** Aeshna caerulea larvae found at the pool system on High Cornarroch Bog (Plate 4),1992-2004.

Date	Number	Size Range
25 May 1992	15	3 in range 36-39mm, 12 others in range 21-28mm
14 Oct 1992	2	2 final instars: male 35.5mm, female 34mm
04 May 1993	9	1 each of 34mm, 29mm, 20mm; 6 in range 10-13mm
21 June 1993	1	17mm
23 Sepr1993	10	all in range 6.5-9.5mm
05 July1994	20	1 each of 30mm, 26mm; 18 in range 13- 16mm
15 Sept 2004	none	



**Plate 3.** Close up of pool on High Cornarroch Bog, showing sphagnum rafts and open water with deep light-coloured bottom debris.



Plate 4. A pool system on High Cornarroch Bog which yielded the larvae detailed in Table 2.

the species having diapause eggs typical of many northern *Aeshna* species (Corbet, 1999, p.61).

Larvae of *Aeshna caerulea* often shared pools with the larger *Aeshna juncea* (Common Hawker), which was always the more abundant and more widely occurring species. Like all such larvae, those of *A. caerulea* appear to be general predators of small aquatic invertebrates, but no specific information is available. They are readily distinguishable from those of *A. juncea* at all stages (Plate 5). Further notes on larvae can be found in Clarke, *et al.* (1990) and Clarke (1994, 2002), including what appear to be the first line illustrations of *A. caerulea* larvae in the British literature. (The exuvia illustrated in Cham (2007) is a Silver Flowe specimen.)

#### Observations on adults at the Silver Flowe

Most sightings of *Aeshna caerulea* related to males in the forest rides or basking on larger boulders, sometimes more than one at a time. On lichen-covered boulders the species was often surprisingly inconspicuous, and could be closely approached, with care (Plate 6).





А



**Plate 5.** Aeshna caerulea. (A) intermediate instar (length c. 21 mm), showing the yellow abdominal spot on segment 7 and the remnants of the yellow mid-line found in earlier instars; (B) mature larva (length c. 36mm). Note that the pale spots on abdominal segments 5 - 7 of earlier instars are now barely visible; (C) head capsule of exuvia, showing 6-segmented antenna. Scale bar: 3 mm.



Plate 6. Betty Smith photographing a male Aeshna caerulea. July 1988.

This behaviour contrasts with that of Aeshna juncea. The ability of A. caerulea to tone down its bright blue colouration (Plate 7) in cooler conditions was studied in males by Sternberg, who concluded that the basking habits of this species were related to this reversible temperature-controlled colour change and that they could perhaps "make the males most sensitive to critical temperatures and could enable them to perform the normal activities even at low temperatures" (Sternberg, 1987). The male in Plate 8 was probably showing this effect rather than immature colouration. Despite Sternberg's assertion to the contrary (Sternberg, 1987), this phenomenon seems also to occur in females, at least in the UK. At the BDS meeting on 6 July 1996, one kept for a while in the dark in a box was considerably duller on release. Such colour changes also appear to improve camouflage. The species can be active despite lack of direct sunlight, as we observed on several occasions. Both blue and brown colour phases of the female were encountered, seemingly in about equal abundance. It was noted that small antehumeral stripes were present in fresh or young females (Plate 9) and may thus be a guide to age since they tend to become more obscure with maturity - leading to claims in some Field Guides (e.g. Dijkstra et al., 2020) that they are absent altogether. Indeed, these stripes are not unique to the Galloway population - as can be seen by close inspection of some images from Highland populations, such as Plate 5A in Willet (2013).



Plate 7. Mature male *Aeshna caerulea* on lichen-covered rock. 9 July 1988. Photograph by Mike Averill.



Plate 8. Male Aeshna caerulea in dull conditions in grass beside the Cooran Lane, 27 June 1986.



**Plate 9.** Female *Aeshna caerulea*, blue form, captive-bred. Collected as a final instar larva on 14 October 1992 and emerged on 7 June 1993. Note the ante-humeral stripes and the markings on the tip of the abdomen. (Specimen now in Tullie House Museum, Carlisle.)

The dorsal spots on abdominal segment 10 of *A. caerulea* females are much larger and squarer than those on segment 9 (Plate 9). This is not the case in *A. juncea* females and therefore is useful as a diagnostic in the shared habitat. (These spots tend to remain paler than the paired spots on other segments.) I am not aware of this being mentioned elsewhere in the British literature. It would obviously have been preferable to be able to check larger samples, though I have also seen the same feature in specimens from the Scottish Highlands.

Females were always less in evidence than males, in part perhaps because they had more tendency to bask rather than engage in active flight. Males apparently chasing or seeking females were observed in the forest edge, as was copulation – though on one occasion only.

The only instance of oviposition was on 26 June 1995 at Brishie Bog (Plate 1) at 3 p.m. A male seen that day searching the bogs was also a rare instance of this sex in the breeding habitat; the only other instances were two sightings on 8 July 1989 in late morning.

# Life cycle and phenology

Silver Flowe observations confirm that *Aeshna caerulea* appears to be a classic example of Corbet's concept of a 'spring species' (e.g. Corbet, 1999, p. 245). As mentioned above, the final larval instar is entered pre-winter, emergence being well synchronised and relatively early in the following season. Emergence at the Silver Flowe appears to have been in mid-late June in an average season. This means that the bulk of mating and egg-laying could normally have been completed by early July. The latest date for sightings of adults was 10 August. However, our visits in August were few and there are insufficient data. The Galloway 'season' seems much as quoted by Willet (2013) for Scottish populations generally. This differs somewhat from most European populations, in which the flight period is later, typically mid-July to mid-September (Dijkstra *et al.*, 2020).

# The post 2001 decline

As the records in the national database confirm, an apparent decline of *Aeshna caerulea* seemed to set in by about the late 1990s. Because normal recording does not admit negative records, it is especially difficult to assess the intensity of recording effort and thus the true nature of trends at this remote locality. Changes in the findability of adults may have in part been due to removal of the forest and the boulders favoured as basking sites. Sightings of adults continued into the 2000s, becoming increasingly erratic. There were undoubted records in 2003, 2006 and 2010. By the last-mentioned year it was ever more critical to be sure that no confusion with early Common Hawkers had occurred - placing heavy reliance on what was known about the experience level of recorders.

Visits conducted by the author post the 2001 BDS meeting, sometimes with others, were in 2004, 2005 (two), 2010, 2011, 2017, 2018 and 2021. Searching for larvae was often the objective, but on the days on which sightings of adults might have been expected (10 July 2004, 26 July 2005, 13 July 2010, 4 July 2011 and 15 July 2021), none were seen. Other experienced recorders visiting in this period were Bob Merritt, Geoff Shaw, and Richard and Barbara Mearns. Stephen Hewitt in 2003 (Hewitt, 2004) and Jonathan Willet (JW) in 2002, 2011, 2016 and 2017 (Willet, 2012, 2017), carried out surveys commissioned by Scottish Natural Heritage. None of us noted adults beyond 2010 or larvae beyond 2000 - except as noted below.

JW finally found one intermediate instar larva at Brishie bog (Plate 1) on 30 May 2016 (Plate 10). From its size (c. 22 mm – possibly an F-3 instar), the year of oviposition may have been 2013. He also found two *A. caerulea* exuviae, cast in water, both about 10 mm long. The dearth of records of adults in the decade



Plate 10. Larva of *Aeshna caerulea* about 22mm long from Brishie Bog. 30 May 2016. Photograph by Jonathan Willet.

preceding this is therefore curious and the possibility that oviposition away from the Silver Flowe has occurred, at least casually, and thus enabled limited 'recolonisation' cannot be totally discounted. Equally, it is possible that scarcity of the species by this year simply resulted in it often being missed.

The total number of recorder-days in the post-2001 period was thus at least 20. All visits in the period, other than that of JW in 2016, failed to reveal larvae. Searches, long and hard, have been undertaken to check whether sites beyond the Silver Flowe support the species. In particular, Richard and Barbara Mearns, who have extensive knowledge of Galloway and its dragonflies, have explored the Cairnsmore of Fleet hills (2007) and the Merrick range including Loch Twachtan (2013), all with negative results.

# Forestry and its impacts

At the time of Ratcliffe's discovery, there was no significant woodland in the Rhinns of Kells area and large scale coniferisation of SW Scotland had only just started. Today there are already second-generation forests. Planting in the

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Cooran Lane valley began in the mid-1960s. Large scale felling began in the 2000s and is now complete insofar as the immediate environs of the Silver Flowe are concerned. The Silver Flowe itself has not been directly affected by the coniferisation. While this occurred to the north, south and east of it, the rocky western range with summits of Craignaw and Dungeon Hill was untouched. Even on the east side, planting was east of the Cooran Lane (Plate 1).

During the 1960-2000 era, the presence of the modern forest seemed to provide a haven for the species and other Odonata - and was a convenient place in which to seek it. At the time, large boulders in the forest rides were favourite perching areas for *Aeshna caerulea*, though many of these were subsequently destroyed for road making. The closed canopy of the mature conifers was of little benefit to dragonflies, but the system of rides, creating multi-directional woodedge situations, undoubtedly was. Shelter from winds and rain, and abundant aerial Diptera prey, is beneficial for all Odonata species. The large boulders were much used for basking by *A. caerulea* – in contrast to other species. This may well have related to its thermoregulatory behaviour discussed by Sternberg (1987). Planting some of the felled areas with upland deciduous trees might compensate – though not instantly and would not solve the breeding habitat problem, which appears primarily climatic.

# Condition of the Silver Flowe bogs

Clearly this is of critical importance for *Aeshna caerulea* as a notified species. The condition of the Silver Flowe bogs was cited as 'favourable' in the monitoring reports by Hewitt (2004) and by Willet (2017) – but in this context they related primarily to the continuing presence of the species and were not intended in a botanical or ecological sense.

The fact that other 'on-the-ground' observations appear to paint an apparently different picture is therefore not necessarily in conflict with the above. Bob Merritt and the author noted in October 2017: "... not many larvae of any sort were found, ... Most pools had only a few centimetres of surface water over a deep 'gunge' of greyish sphagnum and jelly-like algae, which was probably the reason for the low counts ... an environment not particularly suited to predatory larvae..." (R. Merritt, pers. comm.). I noted in late May 2018 that the state of the bogs, Brishie especially, looked 'dire', and that there were similarly low numbers of Odonata larvae. Such comments relate to drought effects, which may of course be temporary, though exactly how temporary may vary greatly. Both 2020 and 2021 had notable spring droughts.

On 15 July 2021 the author and Bob Merritt variously searched pools on High Cornarroch, Brishie and Long Loch bogs (Plate 1). The condition of these

sites showed the effects of yet another long (and continuing) dry period – such that it would have taken many weeks of significant rain to bring them back into condition. Visible water was not evident in most pools, leaving large 'draw-downs' of bleached sphagnum at the edges, and a deep muddy black 'ooze' where there should have been many centimetres of clear water.

# Discussion

Speculation as to those factors which may have contributed to the 'decline' inevitably focus on changes in weather conditions – or collectively, climate. As Sternberg (1997) pointed out, the temperature conditions required by larvae (especially the early instars) differ considerably from those preferred by adults of this species of cool northern climates. Young larvae need warmth, which is best delivered in shallow pools. Good weather in the flight period from June through July is crucial for adults to feed, mature and breed.

Climate change, increasing temperatures and erratic rainfall, threatening the species' bog pool habitat, are all cited by the British Dragonfly Society, who list it as Vulnerable (British Dragonfly Society, 2021). Such environmental threats have already been noted elsewhere in Scotland (Pat Batty, pers. comm.) and might be expected to have most effect on this southerly outpost population (Willet, 2013).

Whilst no onsite meteorological data is available, the Corsock Automatic Weather Station, 27 km SE of the Silver Flowe, provides useful local data. Although droughts are hardly a new phenomenon, it seems not without significance that a greater tendency to spring droughts and wetter summers in Galloway (as elsewhere) post-2000 has become apparent, with "a radical redistribution of rainfall in the past two decades" (Corsock AWS, 2021). This tends to produce drier springs and wetter summers. Both could have affected the amount of oviposition activity, lowering the abundance of some generations. Droughts at any season can be damaging to the breeding habitat. Such events may break or weaken larval life cycles, especially if the species already occurs only sparsely in the breeding habitat.

Specialist assessments on the effect of changing climatic conditions on the habitat seem highly desirable, though it is unlikely that any remedial measures would be possible with a site of this scale and structure.

Many questions thus remain to be answered. Is there now change to the bogs that somehow makes them unsuitable for *Aeshna caerulea*? Has the species permanently disappeared from the Silver Flowe? Are there residues

of population elsewhere in the area? What are the key elements of change in weather or climate that have led to the presumed extinction of the species in SW Scotland?

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