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Journal of the British Dragonfly Society

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

The Journal of the British Dragonfly Society, published twice a year, contains articles on Odonata that have been recorded from the United Kingdom and articles on European Odonata written by members of the Society.

Articles for publication should be sent to the Editor. Instructions for authors appear inside the back cover.

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Species Reviews: The fourth species review appears in this issue. Others are in the process of being written so if anyone is considering writing a review of their favourite species, please contact the Editor first.

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Cover Illustration: : Larva of *Lestes dryas*. Photograph by Robert Thompson.

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INSTRUCTIONS TO AUTHORS

- Authors are asked to study these instructions with care and to prepare their manuscripts accordingly, in order to avoid unnecessary delay in the editing of their manuscripts.
- Word processed manuscripts may be submitted in electronic form either on disk or by e-mail.
- Manuscripts should be one and a half spaced, on one side of the page only and with margins of 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.
- References cited in the text should be in the form '(Longfield, 1949)' or '...as noted by Longfield (1949)'. All references cited in the text (and only these) should be listed alphabetically at the end of the article in the following forms:
    Hammond, C.O. 1983. *The Dragonflies of Great Britain and Ireland* 2nd Edition (revised by R. Merritt), Harley Books, Colchester, 116pp.
    Longfield, C. 1949. The Dragonflies of the London area. *The London Naturalist* **28**: 90-98.
- Titles of journals should be written out in full.
- Tables should be presented on separate, unnumbered pages.
- Legends for figures should be presented together in sequence on a single, unnumbered page. •
- Figures should be prepared in black and scaled to allow a reduction of 1.5 to 3 times.
- 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	*Aeshna juncea*	*Common Hawker*
Calopteryx splendens	*Banded Demoislle*	*Aeshna mixta*	*Migrant Hawker*
Calopteryx virgo	*Beautiful Demoiselle*	*Anax ephippiger*	*Vagrant Emperor*
Lestes barbarus	*Southern Emerald Damselfly*	*Anax imperator*	*Emperor Dragonfly*
Lestes dryas	*Scarce Emerald Damselfly*	*Anax junius*	*Green Darner*
Lestes sponsa	*Emerald Damselfly*	*Anax parthenope*	*Lesser Emperor*
Lestes viridis	*Willow Emerald Damselfly*	*Brachytron pratense*	*Hairy Dragonfly*
Sympecma fusca	*Winter Damselfly*	*Gomphus flavipes*	*Yellow-legged Clubtail*
Coenagrion armatum	*Norfolk Damselfly*	*Gomphus vulgatissimus*	*Common Club-tail*
Coenagrion hastulatum	*Northern Damselfly*	*Cordulegaster boltonii*	*Gold-ringed Dragonfly*
Coenagrion lanulatum	*Irish Damselfly*	*Cordulia aenea*	*Downy Emerald*
Coenagrion mercuriale	*Southern Damselfly*	*Somatochlora arctica*	*Northern Emerald*
Coenagrion puella	*Azure Damselfly*	*Somatochlora metallica*	*Brilliant Emerald*
Coenagrion pulchellum	*Variable Damselfly*	*Oxygastra curtisii*	*Orange-spotted Emerald*
Coanagrion scitulum	*Dainty Damselfly*	*Leucorrhinia dubia*	*White-faced Darter*
Erythromma najas	*Red-eyed Damselfly*	*Leucorrhinia pectoralis*	*Large White-faced Darter*
Erythromma viridulum	*Small Red-eyed Damselfly*	*Libellula depressa*	*Broad-bodied Chaser*
Pyrrhosoma nymphula	*Large Red Damselfly*	*Libellula fulva*	*Scarce Chaser*
Enallagma cyathigerum	*Common Blue Damselfly*	*Libellula quadrimaculata*	*Four-spotted Chaser*
Ischnura elegans	*Blue-tailed Damselfly*	*Orthetrum cancellatum*	*Black-tailed Skimmer*
Ischnura pumilio	*Scarce Blue-tailed Damselfly*	*Orthetrum coerulescens*	*Keeled Skimmer*
Ceriagrion tenellum	*Small Red Damselfly*	*Crocothemis erythraea*	*Scarlet Darter*
Platycnemis pennipes	*White-legged Damselfly*	*Sympetrum danae*	*Black Darter*
		Sympetrum flaveolum	*Yellow-winged Darter*
ANISOPTERA	*DRAGONFLIES*	*Sympetrum fonscolombii*	*Red-veined Darter*
Aeshna affinis	*Southern Migrant Hawker*	*Sympetrum pedomontanum*	*Banded Darter*
Aeshna caerulea	*Azure Hawker*	*Sympetrum sanguineum*	*Ruddy Darter*
Aeshna cyanea	*Southern Hawker*	*Sympterum striolatum**	*Common Darter**
Aeshna grandis	*Brown Hawker*	*Sympetrum vulgatum*	*Vagrant Darter*
Aeshna isosceles	*Norfolk Hawker*	*Pantala flavescens*	*Wandering Glider*

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

Species list in accordance with Davies, D.A.L. & Tobin, P. (1984 & 1985) The Dragonflies of the World: A systematic list of the extant species of Odonata. Vols 1 & 2.

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Studying British dragonflies in the 1970s: the wilderness years

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Moore (2010) has provided an interesting account of dragonfly recording in the UK prior to the formation of the British Dragonfly Society in 1983. Progressing from his own introduction to dragonflies throughout the middle decades of the century, Moore then outlines the development of Societas Internationalis Odonatologica (SIO) culminating with its first UK meeting in 1975. Merritt et al., (1996) detailed the early history of the Dragonfly Recording Scheme and in particular the first meeting of British dragonfly recorders in April 1979. There are, however, significant gaps in both accounts which, as an odonatologist now in advancing years, are perhaps worthy of recount.

I came to dragonflies in the late 1960s when, quite by chance, I spent a week as a volunteer warden at Arne Nature Reserve in Dorset; I really wanted to go to Mimsmere but they were full! Bryan Pickess was the warden at Arne, he introduced me to dragonflies having, quite rightly, spotted that I would never make it as a birdwatcher. I often wonder what would have happened had I gone to Mimsmere!

It is hard for people today to understand just how difficult it was in the 1970s to study dragonflies. Moore (2010) outlines the problems of identification which can be even better summarised by the Royal Entomological Society’s identification handbook for Odonata (Fraser 1949), a beautifully illustrated publication with detailed drawings of anal appendages and wing venation but hardly a single picture of the complete insect. European books were similarly blighted and with few illustrations. In summary all the books were written by entomologists for entomologists with no thought for the field naturalist. One book, however, is worthy of mention, Robert (1958) produced “Les Libellules”, written in French with some wonderful description of habitat and behaviour with the added bonus of some superb illustrations of dragonflies in colour and in habitat; this was a book to cling to. My French was (and still is) schoolboy but if someone said that “le lac est tout ou moins envahis de vegetation” I knew exactly what they were about.

Lack of published information meant that dragonflies were little studied, to the extent that when I came to publish the Survey of the Odonata of Sussex (Chelmick, 1979), the manuscript was returned to me unread by the Entomologist's Gazette with a short note to the effect that there was no interest in regional surveys of dragonflies and would I please refund the postage. Another important issue was that, as there was no significant interest in dragonflies, there were very few with full English names (Longfield, 1937). Butterflies and moths were the only order of insects to merit the vernacular, all others relied upon their scientific names or anglicised versions thereof (Longfield, 1937) and for old entomologists like myself so it remains to this day. Access to sites was then a problem, as it often is today, but then trespass was commonplace (much harder today) but woe betide you were discovered by a local fishing club on their lake; a flea in the ear was the minimum and a dip in the drink was not uncommon. I do, however, recall one notable exception. Eridge Park is a wonderful piece of habitat where Somatochlora metallica had been first seen in Sussex back in 1909. I recall writing to "The occupier" asking for permission to visit and received a letter by return:

"Dear Mr Chelmick,
Feel free to study dragonflies on my estate
Yours sincerely,
Abergavenny"

The noble Lord was as good as his word and I spent many a contented hour surveying his land.

In 1971 I took over the survey of the dragonflies of Sussex from ECM (Chris) Haes who had just completed the Sussex grasshopper survey. Two events in the early years of the Sussex survey spring to mind. First, in the British Museum (Natural History) amongst the Odonata collections, there is a card index produced by the celebrated entomologist John Cowley. It is a reference collection of all the British species and their known localities. I extracted all the data for my survey but particularly noted Gomphus vulgatissimus and its occurrence on the River Arun. Within days I was on the river – and there it was, Gomphus just emerging along the grassy edges. The second event was one morning on a lake in Ashdown Forest. No digital cameras then so netting was the order of the day and I had caught a male Cordulia aenea, my first emerald dragonfly – but it had a yellow face; it was the much rarer Somatochlora metallica. In or around 1973 I started submitting records to Monks Wood Experimental Station and, more specifically, to John Heath who was the editor of the Atlas for Insects of the British Isles. Whether or not Mr Heath disbelieved my records and needed verification I do not know, but I was contacted by Alan Stubbs, then of the Nature Conservancy Council, with a view to meeting and searching for Gomphus on the Arun. Time was short as the season would soon be over, so one sunny Saturday morning Alan Stubbs and I met near Pulborough on the banks of the River Arun. Alan had another entomologist in tow, Cyril Hammond. I do not recall whether we actually found Gomphus on that day but, in any event, Alan and I kept in touch and some months later he phoned me and said that he had allocated some funds for a survey of the Norfolk Broads and their dragonflies. This would take place in June 1975 and that the attendees would be Cyril Hammond, Eric Gardner, Alan Stubbs and John Ismay. The question was "would I like to join them?" To go into the field with two of the best known amateur entomologists together with two leading professionals in a recently unworked area – unmissable; I readily accepted. And so it came to pass during five glorious days in Norfolk that I got to know Cyril and Eric. On the first meeting the two gentlemen entomologists appeared ready for a day in the field; Cyril in tweed jacket and Eric in blue (somewhat grubby) blazer; both wearing ties and Eric with a cigarette as a permanent attachment to his lower lip; they could have been attending a distant cousin's wedding and put the rest of us to casual and scruffy shame. Cyril was known to me for his book "Flies of the British Isles" (Collyer & Hammond, 1968). Cyril's major contribution had been the meticulous drawings which, even today, rank as some of the finest entomological illustrations. Cyril announced during this trip that he had virtually completed the drawings for a new book on the dragonflies of the British Isles (Hammond, 1977). Eric Gardner was a joy to be with and full of entomological stories. One of the main reasons Eric was on this survey was that he had collected Coenagrion armatum on the Broads back in the 1950s. He told the story of a particularly good piece of Broad habitat that always contained good numbers of the insect. The problem was that the owner was quite opposed to "nature lovers" and woe betide if he found you on his land - you would be thrown in the dyke. Eric countered this problem by always going on a Sunday as the owner, a God fearing gent, would always be in the chapel by 10:00 am and would be there for some hours, Eric waited for the first hymn and was into the Broad – once in no one would ever find him. As well as dragonflies Eric was very interested in beetles and recounted the day when, out with fellow coleopterists, they found a tramp by the side of a track – dead. What to do; report the matter to the authorities? An initial inspection showed that early stages of decomposition had commenced and the resident beetle population was diversifying well. My understanding is that the tramp was moved to a more discreet location and the corpse visited regularly. Eric waxed lyrically of the many new beetles; the eventual fate of the tramp was never made clear.

Over dinner one evening, taking advantage of being with these two celebrated entomologists, I broached the subject of some of our rarities including *Lestes dryas* and where I could find it. Cyril stated that it used to be at Benfleet but had not been seen there for years. Eric was similarly dismissive. L. dryas was almost certainly extinct as a result of the 1953 floods along the east coast. I accepted this explanation which became the received wisdom. It was, of course, nonsense. The reason Cyril had not seen L. dryas at Benfleet in recent years was not because it wasn't there, it was because he hadn't visited. The moral to this tale is never believe received wisdom, it is usually wrong as was so proved in 1983 (Benton & Payne, 1983) when the beast was rediscovered at this very site.

The result of the Norfolk Dragonfly Survey was never published. After nobody was interested in regional surveys! In fact we concluded that Coenagrion armatum was indeed extinct but that our other quarry Aeshna isosceles was thriving. Some weeks later I heard that Eric Gardner had died of a heart attack. Cyril was, however, in fine spirits and anxious to visit more of my Sussex localities for rare species such as Coenagrion pulchellum. We met at Amberley station (Cyril could not drive) during the summer of 1975 and visited the local wildbrooks. I remember it well as out of the corner of my eye I could not help but notice a thin wisp of smoke coming from the Sussex Trust's Nature Reserve. There had been a bonfire on the peat way back in February but surely it couldn't still be burning? I left Cyril to the dragonflies and walked over. Sure enough the site of the bonfire was now an area of almost 100 square metres with turf smouldering on the perimeter. I could do nothing so returned to Cyril who had happily encountered a number of species including the Coenagrion. After a pleasant day I returned Cyril to the station and hardly saw him again. His book was published in 1977 and received somewhat critical reviews from the professional odonatologists (Parr 1978). The book could certainly be criticised for its content but the professionals had missed the point; it was the pictures that the natural history public wanted and from that point of view the book delivered in full – the rest, as the old cliché goes, is history. Cyril died in 1980 in the full knowledge that the publication of his book, and it's a phrase that I hate using, "made a difference" in the Natural History world.

Alan Stubbs is known to the world as a dipterist but, in my opinion, together with Norman Moore they were the two most influential professionals encouraging the study of dragonflies in the UK during the 1970s. Alan was particularly influential on me; his enthusiasm and energy pushed everyone along and it was just such enthusiasm that sent me north in 1976 to search out two of our Scottish rarities: Aeshna caerulea and Coenagrion hastulatum. Those of you of mature years will quickly recall the summer of 1976 – glorious and seemingly endless and it was just the same in Scotland. Our little group drove north stopping in Edinburgh, where I had arranged to meet Rodger Waterston. I located him peering down his microscope in the Royal Scottish Museum: a tall man with wispy hair and a Scottish gleam in his eye which sparkled as he talked of his favoured subject which was the dragonflies of the Middle East. I recall him outlining the finer points and wide distribution of Aeshna rileyi, which was at the very edge of its range in Rodger's area of study. Eventually and with considerable effort I steered the conversation around to Scottish species and, with some irritation, Rodger cast his mind nearer home. "You must visit the Logierait Pond near Pitlochry and go to the southern end". Longfield (1947) was my only reference book which described the resemblance between Enallagma and *Coenagrion hastulatum* as "exceedingly close". "How do you tell them apart", I enquired. "Very easy " said Rodger, "the Coenagrion is green!" Green?? – anyway with these thoughts embedded we headed north and next day visited the said pond and almost immediately picked up *C. hastulatum* which, even at a distance, could be seen as having a greener hue and instantly identifiable. At the other end of the lake there was another net-bearing individual. I walked along the bank to confront the angular frame of Norman Moore hunched over some blue damselflies. These proved to be Enallagma but after a few minutes using Rodger's "green" tip we soon found the Coenagrion and parted happy.

A few months after this successful Scottish trip Alan Stubbs was up to his tricks again and, I suspect on his suggestion, I was invited up to Monks Wood to talk to John Heath about becoming the organiser for the Odonata Mapping Scheme. I remember entering his office and confronting a deep frown and heavy black glasses. This was the man who had done more for the mapping of British insects than anyone, a giant in distribution but a man of few words and an even smaller sense of humour. We discussed what needed to be done and how I might be allowed access to records for rarities. In short, I got the job and, for once, I was in the right place at the right time. Cyril Hammond's book (Hammond, 1977) had just been published, sparking a wave of interest in dragonflies. One of the bonuses of being organiser meant that I had every excuse to track down records for rare dragonflies, the most celebrated of which was, and still is, Oxygastra curtisii. Apart from Norman Moore, the only person that I could think of that knew the insect was Cynthia Longfield, late of the British Museum, author of the only identification guide and doyenne of British Odonatologists. I wrote to her in Ireland with little hope of reply. Almost by return I received an enthusiastic account of this insect and its history on the Moors River written in the spidery and then somewhat arthritic hand of the great lady.

In the late 1970's the mapping scheme was going from strength to strength thanks, in no small measure, to Cyril Hammond's book. The first edition of the atlas had been published in 1978 (Heath 1978), containing records up to May 1977. However, such was the increase in data that we published a second edition in 1979 (Chelmick, 1979) with a 43% increase in the number of records. During this period the first recorders' meeting was held at Nature Conservancy Council headquarters in London in April 1979 (Chelmick 1980). This meeting was followed on 14 June 1980 with a field meeting at Thursley Common where the great and the good of the dragonfly world including Philip Corbet, Peter Mill and Mike Parr rubbed shoulders in the field with keen amateurs like myself, Graham Vick and Bob Kemp. The idea of a BDS had taken shape.

By this time my influence on the recording scheme was already waning. Bob Merritt was doing all the donkeywork on the recording scheme and the demands of my young family were ever reducing my available time. In 1981 Bob took over the recording scheme; in reality I was sacked by Paul Harding over a very pleasant lunch. The change of recorder was one of the most significant events in UK dragonfly history; within two years *Lestes dryas* had been rediscovered in Essex and a new species, *Coenagrion lunulatum*, was recorded from Ireland. Timing never was my strongpoint!

As to the formation of the BDS, I played no part; indeed I was not in favour of it. I always felt that there would be a conflict between the collectors and the observers with battles at dawn with drawn nets. In fact, whilst there have been some conflicts, my fears were not well founded and it is a great relief to me that others with far greater vision and belief were able to form and grow one of the most successful natural history organisations in Britain

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Wing-folding Behaviour in the Golden-ringed Dragonfly *Cordulegaster boltonii* (Donovan)

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Summary

A further observation of a Golden-ringed Dragonfly *Cordulegaster boltonii* folding its wings over its back is reported

Introduction

In a recent article Jenkins (2010) observed a Golden-ringed Dragonfly *Cordulegaster boltonii* fold its wings over its back during a period of light rain. The present paper records a further incidence of this type of behaviour.

Observations

On 26 June 2006 whilst on holiday at Kinlochewe in Wester Ross, I pulled off the road to inspect a known colony of Large Red Damselflies *Pyrrhosoma nymphula*.

Close by, I found a Golden-ringed Dragonfly *Cordulegaster boltonii*. It was perched on heather Calluna vulgaris, on the side of a dry ditch – about 500 mm above the ditch bottom. It was perched with its wings held horizontally. After a few minutes and for no obvious reason it folded its wings over its back. The weather was dry and overcast. I watched the insect for a further five minutes, during which time it never moved. I then left the site after photographing the dragonfly (Plate 1).

Plate 1. Male *C. boltonii* with wings folded over its back.

It is perhaps worthy of note that on the afternoon of 14 June 2008 whilst again on holiday in the Highlands, near Loch Arkaig, I observed another Golden-ringed Dragonfly. It was perched on bracken *Pteridium aquilinum* and in light rain. The bracken was more or less horizontal and about 150 mm above the ground. There was no shelter from the weather. The dragonfly was perched with its wings held horizontally. The rain continued well into the night. I checked the following morning and the insect had not moved; its wings were still held horizontally. In the light of these observations, and since Jenkins (2010) noted this behaviour in only one of the two specimens he was observing during a period of light rain, this wing-folding behaviour would appear not to be related to climatic conditions.

Reference

Jenkins, D. K., 2010. Folding wing behaviour in the Golden-winged Dragonfly *Cordulegaster boltonii. Journal of the British Dragonfly Society* **26:** 32 – 33.

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Species Review 4:

The Scarce Emerald Damselfly *Lestes dryas* Kirby with notes on the family Lestidae in Western Palearctic

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Summary

Lestes dryas is a species of marginal habitats and has a life history adapted to temporary waters that dry out in summer. It has one of the largest overall areas of distribution of any UK dragonfly species and is one of only seven circumboreal species that occur in the Western Palearctic. In lowland areas it is much threatened by agricultural practice but in uplands, which today provide its key habitats in our region, it is probably overlooked.

Introduction

The genus Lestes comprises approximately 100 species of medium to large damselflies, 20 of which are in sub-genera other than Lestes (Bridges, 1994). Lestes is one of the most widely distributed damselfly genera with species ranging through the tropics and almost into the high arctic. In the Western Palearctic Lestes is represented by seven species, four of which have been known to breed in the UK, although only two of these, the Scarce Emerald Damselfly *Lestes dryas* and the Emerald Damselfly *L. sponsa*, can be considered as permanent residents.

L. dryas was first described by Sélys Longchamps (1840) who named the species *L. nympha*. However, Kirby (1890) realised that the name *L. nympha* was already in use and renamed the species *L. dryas*. In the same paper Kirby named a North American species *L. uncatus*. Cowley (1935) recognised the synonymy of the two species.

In the UK, *L. dryas* is nowhere common and was considered to be extinct since the 1950's until it was rediscovered in Essex in two widely separated sites in

1983 (Benton & Payne, 1983). In England it is now known to be locally common in Kent and Essex along the Thames Estuary and is also found in Norfolk, as well as occasionally elsewhere (see below). In mid and southern Ireland it is proving to be locally common and widespread (Nelson & Thompson, 2004; Donnithorne, pers. comm.).

Description

Eggs

The eggs are laid by insertion into the stems of aquatic vegetation, following cuts made by the ovipositor (Plate1). The eggs are sub-cylindrical in shape measuring between 1.7 and 1.89 mm long and 0.33 mm wide and, at the time of laying, are lightly tinged with pale yellow (Gardner, 1952).

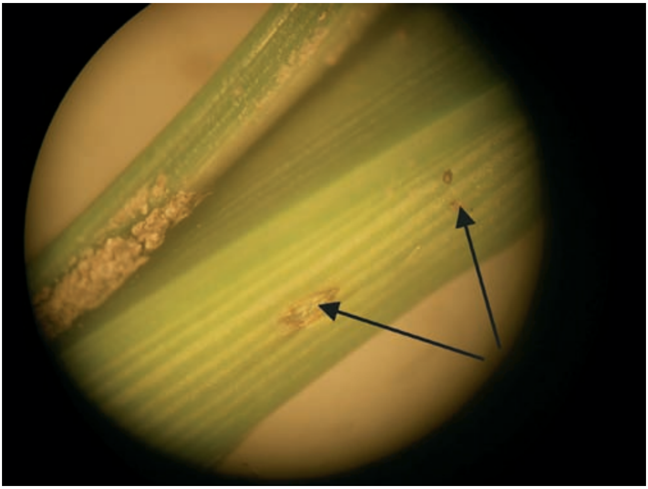


Plate 1. Incisions (→) of the ovipositor in the stem of Sea-Club Rush *Bulboschoenus maritimus* containing *Lestes dryas* eggs.

Larvae

In their final stages the larvae are generally larger than those of the Coenagrionidae, with an overall length including the lamellae of between 26 and 32 mm. The larvae are easy to spot when collected and, from my own observations, appear to have little regard to concealment when threatened. A distinguishing feature of Lestes larvae is the narrowly waisted labial mask (Fig. 1). This is a feature of all species of Lestes in the Western Palearctic with the exception of *L. viridis* and *L. parvidens* both of which have a shorter, normally tapering mask. It is of note that these latter two species are sometimes placed in a separate sub-genus Chalcolestes. The larvae are easy to determine to genus as the shape and shading of the lamellae are diagnostic (Plate 2). The closely related species *L. sponsa* has lamellae that are parallel sided and rounded not pointed as in *L. dryas*. According to Gardner (1952) *L. dryas* has 11 larval instars including the prolarva.

Figure 1. Mask and head of Lestes sp. viewed from below to show the narrow waisting of the mask.

Plate 2. Larval *Lestes dryas* showing the long, pointed lamellae and their cross banding. Photograph by Robert Thompson. (From Nelson & Thompson, 2004).


A


B

Plate 3. Mature (A) and old (B) *Lestes dryas* males, showing the partly open wings at rest. Note the overall green appearance of the mature individual and the deep bronze green of the old one

Adults

The resting position is diagnostic for the genus with the body held at an angle to the vegetation and the wings partly open (Plate 3). *L. dryas* and *L. sponsa* are very similar in appearance and can only be distinguished reliably by the following characteristics:

- the male appendages,
- the female ovipositor
- the pattern on the first abdominal segment of females

These are outlined in more detail below:

Male Appendages *L. sponsa* is the common UK species of Lestes; its appendages are always pointed and never incurved (Fig. 2A). *L. dryas* has incurved lower appendages which are often held open to the point where they are hidden behind the upper appendages (Fig. 2B) or, alternatively, with its appendages meeting (Fig. 2C).

Ovipositor In *L. dryas* the ovipositor extends beyond the end of abdominal segment 10 (Fig. 3A), whereas that of *L. sponsa* just reaches to the end of abdominal segment 10 (Fig. 3B). Although the actual extent of the ovipositor may not be clear in the field, its conspicuous length in *L. dryas* is diagnostic (Plate 4).

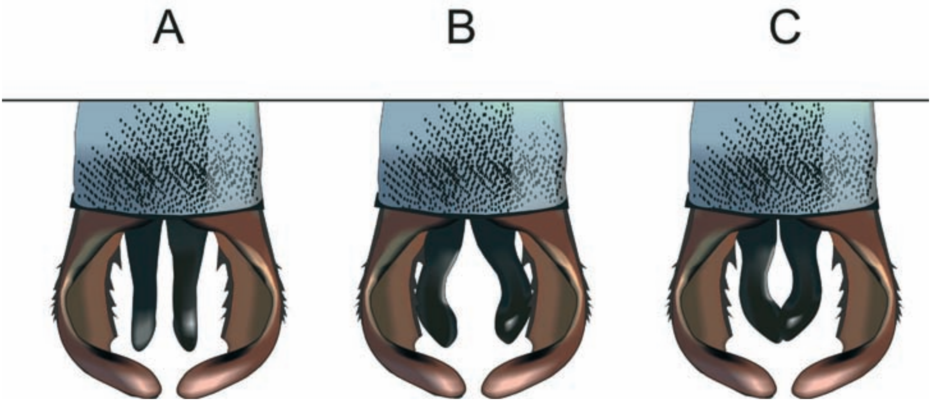


Figure 2. Male appendages of (A) *Lestes sponsa* and (B, C) *L. dryas* from above

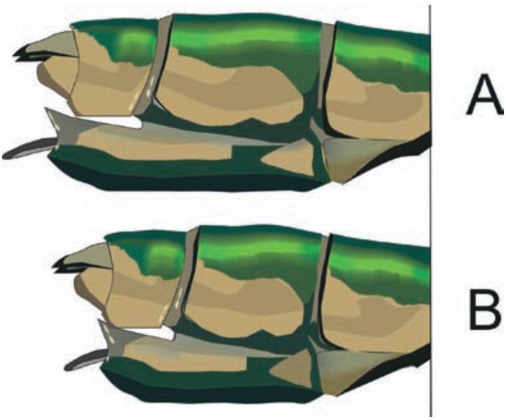


Figure 3. Side view of the posterior end of the abdomen of (A) *Lestes dryas* and (B) *L. sponsa* to show the relative lengths of their ovipositors.

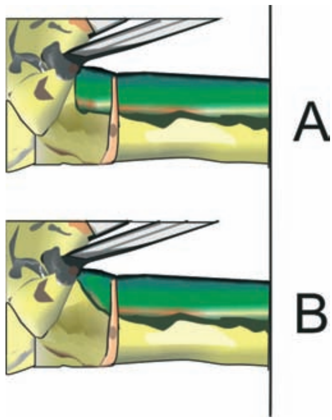


Figure 4. The first abdominal segment of female (A) *Lestes dryas* and (B) *L. sponsa* viewed from the side to show the different shape of the markings on the first abdominal segment.

Female abdominal segment 1 Unusually in damselflies, it is the females of these two Lestes species that provide an additional reliable identification feature: in *L. dryas* the green marking on the side of the segment is square (Fig. 4A) whilst in *L. sponsa* the mark is triangular or rounded (Fig. 4B).

Other features as an aid to identification of males Blue pruinesence develops on male Lestes spp as they mature sexually and is present in four species in the Western Palearctic (Table 1). *L. dryas* and *L. sponsa* share common pruinose features and differ only in the extent of pruinosity on abdominal segment 2. Thus the pruinosity on abdominal segment 2 only extends onto its anterior end in *L. dryas* but tends to completely cover it in *L. sponsa*. *L. dryas* normally has light blue eyes (Plates 3, 4), which remain so throughout life, contrasting strongly with the darkening thorax and abdomen. In *L. sponsa* around 60% of males have rather dark blue eyes. The pterostigma is wider in *L. dryas* than in *L. sponsa*. These features (Table 2) can be used as an identification guide. However, caution must be exercised in using them as they can be unreliable;

Species	Head	Thorax	Abdominal segments 1 & 2	Abdominal segments 8-10
L. macrostigma	yes	Entire thorax covered	yes	yes
L. virens	no	Sides only	no	yes
L. sponsa	no	Sides only	yes	Yes
L. dryas	no	Sides only	All of & part of 2	Yes

Table 1. The presence of blue pruinescense in Lestes spp. in the Western Palearctic.

Feature	*L. dryas*	*L. sponsa*
Eye colour	Light blue normally but dark eyed specimens can occur	Dark blue in 60% of population
Abdominal segments 1 & 2	Segment 1 pruinose; segment 2 pruinose only in top part in almost all cases	Top of both segments pruinose in 80% of population
Pterostigma	wide	narrow

Table 2. Identification features for males of *Lestes sponsa* and *L. dryas*.

the diagnostic characteristics outlined above must be followed up to confirm identification.

Adult insects can vary greatly in colour. Plate 3A shows a mature male with typical bright blue eyes and green appearance, while plate 3B shows an old male that has coloured deep bronze green. Mature females are hard to find alone as they are soon taken by the males. Plate 4A shows an in copula pair of *L. dryas* where the female is bronzy green. However, in Plate 4B, which shows the typical mate-guarding behaviour during oviposition, the female is almost brown.

A

B

Plate 4. (A) Mating pair of *Lestes dryas* – the female is bronzy green. (B) Ovipositing pair of *Lestes dryas* – the female is almost brown.

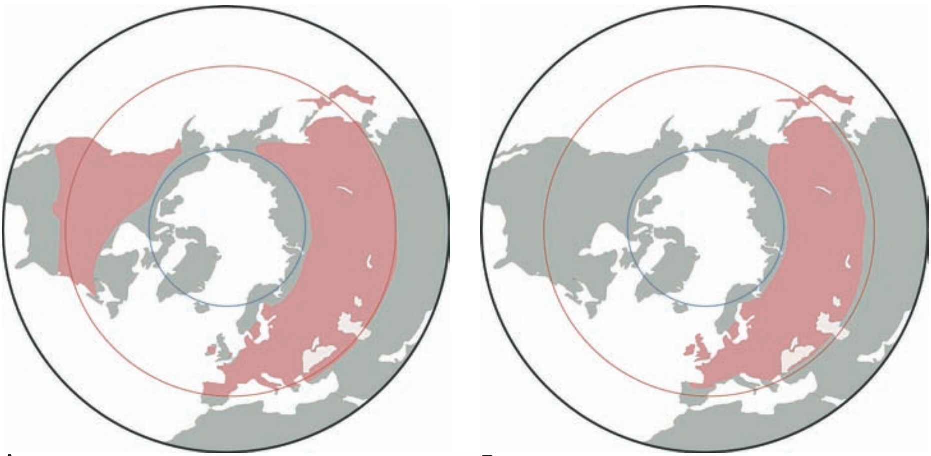
Distribution

The overall range of the two UK resident species is much more extensive in *L. dryas* (Fig. 5A) than in *L. sponsa* (Fig. 5B). Indeed, *L. dryas* is one of only seven Western Palearctic species that can be described as circumboreal (Table 3)

In the Western Palearctic, the range of *L. dryas* is similar to that of the more common *L. sponsa*. However, *L. dryas* has a more southerly distribution and

Species	Range
Lestes dryas	circumboreal
Aeshna juncea	circumboreal
Aeshna subarctica	circumboreal but ssp *elizabethae* in Europe
Somatochlora salberghi	circumboreal but restricted to arctic
Libellula quadrimaculata	circumboreal
Sympetrum danae	circumboreal
Pantala flavescens	migrant found throughout the tropics and north to Turkey and Cyprus

Table 3. Circumboreal and worldwide Western Palearctic species**.**



A B

Figure 5. The world distribution of (A) *Lestes dryas* and (B) *L. sponsa*, showing the 40^{o} (red) and 60^{o} (blue) parallels.

occurs throughout the Iberian Peninsula (De Knijf & Demolder, 2010; this paper) and Italy, whereas *L. sponsa* is present only in the north of Iberia and is virtually absent from Italy (Boudot et al., 2009).

The distribution of *L. dryas* in the UK is somewhat patchy. In England *L. dryas* was considered extinct during the 1950s and 1960s. Received wisdom was that the east coast floods of 1953 had brought about the demise of this insect. In 1983 it was rediscovered in Essex (Benton & Payne 1983; Benton & Dobson, 2007). It is now known from a number of localities from Kent through to Yorkshire. It is, in my opinion, extremely unlikely that *L. dryas* was ever extinct but was simply overlooked and rediscovered thanks to much improved observation following the greatly increased interest in dragonflies since the mid 1970s. In England it is locally common in Kent and Essex along the Thames Estuary and is also found in Norfolk in the pingos. (Fig. 6 – green areas) (NBN Gateway, 2010). The blue patch shown on Fig. 6 in southeast England represents the former Sussex colony in the floodplains of the River Rother etc., which have been detailed in Chelmick & Moore (2009). The situation in Ireland is still far from clear but thanks to Nelson & Thompson (2004) and the work (as yet unpublished) of Donnithorne (pers.comm.) it is proving to be locally common and widespread in mid and southern Ireland and new sites are being discovered there each summer.

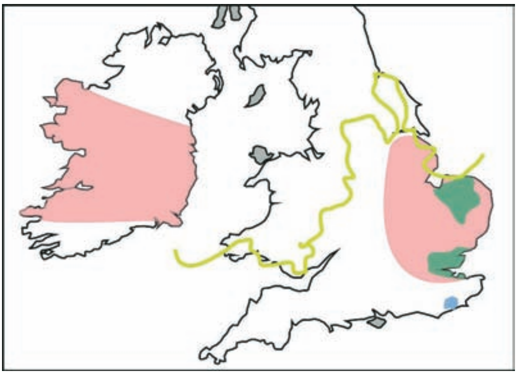


Figure 6. The overall UK and Irish distribution of *Lestes dryas* (pink). The two main UK population centres (the pingos of Norfolk and the Thames estuary) are shown in green. The former Sussex colony is shown in blue. The yellow line indicates the extent of the Devensian glaciations which ended some 10,000 years ago. South of this line periglacial conditions prevailed.

In summary, *L. dryas* is a species of marginal habitats; its numbers can fluctuate hugely year on year depending upon the prevailing weather conditions and the transient nature of its preferred habitat. It can easily, and indeed has been, overlooked and is probably much more common in the UK than records show.

Life Cycle

I can do little better in describing the life cycle of *L. dryas* than by quoting the celebrated American entomologist James G. Needham (1903), writing at the turn of the last century. "I have studied Lestes [two species one of which was *L. dryas*] which are common about my home in Lake Forest, occurring in shallow pools of the springtime that dry out thoroughly every summer and are usually refilled by the rains of late autumn. In these pools..., the eggs, deposited well above the water, develop normally at first and in the course of two or three weeks attain a condition which is apparently almost that in which they will hatch. They then aestivate through the remainder of the summer and early autumn. Development stops entirely and remains stopped until the pools are refilled ...and the stems and leaves, now dead, fall into the water...".

Similarly, in Britain the key habitats in which *L. dryas* breeds are dry by late summer as observed in Essex by Gardner (1952), Drake (1990 and 1991) and myself (in 2007) and in Norfolk by Perrin (1995). In Essex, Drake (1991) found that "larvae were remarkably tolerant of conditions …Together with ten-spined sticklebacks (Pungitius pungitius), Sympetrum sp. and a few species of beetle larvae…[*L. dryas*] larvae were among the most conspicuous and numerous species in isolated, and desiccating pools less than 5 cm deep… [which] were all that remained of four ditches in May 1990…".

Corbet (1999) states that most species of the family Lestidae exhibit egg diapause. Thus, the larva develops in the egg until a recognisable eyespot can be seen; at this point development stops (diapause) and the larva contained within the egg waits for an external stimulus before hatching and completing its life history. In the case of *L. dryas* the conditions required for egg development are provided by the wetting of the eggs (Sawchyn & Gillott 1974). As a consequence of this, the eggs of *L. dryas* are invariably laid above the water surface. From their work in Canada, Sawchyn & Gillott (1974) state that oviposition is usually between 5 and 60 cm above the water surface. I observed *L. dryas* on many occasions in Essex during 2007. Oviposition was always above the water level but often only 2.5 cm above the surface.

L. sponsa differs from *L. dryas* in oviposition behaviour. Bryan Pickess (pers. comm) carried out an analysis on a heathland pond in Dorset in 2007. He observed 32 separate instances of oviposition of *L. sponsa* and recorded as follows:

- 8 ovipositing in pairs below water level (25%)
- 19 ovipositing in pairs above water level (59%)
- 5 ovipositing in pairs both above and below water level (16%)

Clearly the hatching stimulus for *L. sponsa* cannot be the immersion of the eggs as in *L. dryas* but some other factor, possibly water temperature. Sawchyn &

Gillott (1974) state that, in Canada, the diapaused eggs, usually protected by snow, can survive exposures to temperatures as low as –20^{o}C. Hatching in *L. disjunctus* and *L. unguiculatus* (species that are found with *L. dryas*) takes place at 10^{o}C and larval development is completed in 60 days. Corbet (1999) gives minimum larval development time for *L. dryas* as 45 days.

Gardner (1952) bred larvae which hatched on 17 November 1949 and emerged as adults on 31 May 1950. The larval development period was 195 days. Gardner's recorded water temperatures ranged from 8.9^{o}C at hatching to 12.8^{o}C in April 1950 when the final larval instar appeared. The average temperature over this period was 10^{o}C which is the temperature at which hatching takes place in Canada (Sawchyn & Gillott 1974). Clearly the length of larval life from 45 to 195 days is huge and highly dependent upon prevailing weather conditions.

Earliest record	Latest emergence	Last flight	Region	Reference
7 June		24 August	Essex, UK	Benton & Dobson (2007)
8 June		13 September	Ireland	Nelson and Thompson (2004)
24 April	28-July	6 October	Poitou-Charente Region, France	Jourde & Montenot (2009)
End of May	Mid - July	24 September	Alps and Massif Central, France	Deliry (2008)
30 May		6 September	Ontario, Canada	Walker (1953)

Table 4. Flight dates for *Lestes dryas*.

Adult Flight periods tend to be long but are variable (Table 4). Jourde (2007) provides details of overall numbers of days that adults have been recorded in Charente Maritime, France. *L. dryas* achieves 154 days and is ranked as the species with 14th longest flight period of the 64 species in that region.

In Poitou-Charentes, France, Jourde & Montenot (2009) noted that oviposition took place from 28 May to 17 July with a peak during the third week of June and that the eggs hatched the following March to April. The dates are clearly dependent upon weather conditions, in UK oviposition can be observed to the end of the adult flight period.

Thus *L. dryas* is adapted to spending the majority of its life in egg diapause. The only requirement for water is during spring between February and July when the shallow waters are quickly warmed, providing optimum growing conditions for the larvae. The adults then emerge in late spring or early summer and remain until early autumn. The long adult life is required to provide flexibility in the dates, which are dependent upon weather conditions. The overriding feature is that *L. dryas* is perfectly adapted for marginal habitats that are dry for a considerable part of the year, such habitats providing the major advantage to *L. dryas* of reducing competition and predation by other organisms. A question that is begged by this life history strategy is how long can the egg stage survive? Can the diapause eggs exist for more than 1 year during periods of drought?

Associations with other dragonfly species can be very marked. In the UK Sympetrum sanguineum can almost always be found with *L. dryas* (Perrin, 1995 and my own observations). This is also true for the Turloughs in Ireland (Scott & Skeffington 2007). In other parts of the Western Palearctic S. flaveolum and Aeshna affinis are both close associates, the latter species having a very similar life cycle to that of *L. dryas* (Deliry, 2008; Wildermuth et al., 2005). It is of note that the recent records of *A. affinis* in the Thames estuary are all in areas where *L. dryas* also occurs.

Habitat Requirements

The coastal ditches of the Thames estuary provide excellent habitat for *L. dryas*, which by drying in summer limit competition and predation. This drying will tend to increase the salinity. Canning & Canning (1987) have shown that *L. dryas* larvae are reasonably tolerant of saline conditions (up to almost 1,300µS cm^{-2}) based upon measurement of surface conductivity at 25^{o}C in a series of saline lakes in British Columbia, Canada. Schlüpmann (1995), working in Germany, confirmed this level of tolerance. Drake (1990) measured the conductivity in 11 of the ditches where *L. dryas* occurred in Essex, the median value of which was equivalent to about 4.5% (range 2 to 24%) seawater.

The other important lowland habitat in England is the pingos of Norfolk. The yellow line shown on the map in Figure 6 indicates the extent of the Devensian glaciations which ended some 10,000 years ago. South of this line periglacial conditions prevailed, which led to the freezing of lenses of water below the ground surface. As the glaciation retreated so these lenses thawed leaving the pingo pools so favoured by *L. dryas*. The common feature with the coastal ditches of the Thames Estuary is the late summer drying out.

The Irish vernacular name of *L. dryas* is the Turlough Spreadwing (Nelson & Thompson, 2004; ENFO, 2005), implying a habitat link. Turloughs are seasonally dry lakes and occur over the glacially modified carboniferous age limestones of central and western Ireland. They fill and drain with water, through a series of sink holes and fissures in the Turlough floor, often filling with extreme rapidity. Turlough margins are characterised by their rapidly fluctuating water levels. Nelson & Thompson (2004) and Donnithorne (pers. comm.) note that whilst Turloughs provide habitat for *L. dryas* there are many other shallow water habitats that are equally suitable. The numbers of *L. dryas* fluctuate widely from year to year depending upon the weather conditions and how water levels vary (Donnithorne, pers. comm.).

There are relatively few dragonfly species that are associated with particular flora. Jodicke (1997) and Jourde & Montenot (2009) both list twelve species of plant regularly used as oviposition sites by *L. dryas* of which four are in the family Cyperaceae (Sedges, Spike Rushes etc.) including Sea Club Rush (Bolboschoenus maritimus). In the Thames estuary *L. dryas* has a very close association with Sea Club Rush in which it invariably oviposits. In mainland Europe the Bottle Sedge (*Carex rostrata*) is described by Deliry (2008) as the key plant species associated with *L. dryas* on the Ardennes plateau in northern France and Wildermuth et al. (2005) similarly cite Carex spp in the Swiss Alps.

In intensive agricultural areas, which dominate most of the Western Palearctic lowlands, the existence of *L. dryas* is, to say the least, precarious. The marginal habitats for which it is so well adapted are often the first casualties of land drainage schemes and in particular large scale irrigation and pumped drainage. The former UK colonies in Sussex on the river Rother were eliminated when drainage was completed in the valleys in the 1960s, the wild pastures and pools favoured by *L. dryas* now replaced by endless waving cereals (Chelmick & Moore, 2009).

Fortunately, *L. dryas* occurs at altitude which must now be considered its stronghold. Deliry (2008) states that, in the French Alps, *L. dryas* breeds between 900 m and 1600 m above sea level, with isolated males often encountered above 2000m. Wildermuth et al. (2005) state that the species occurs in Switzerland between 350 m and 2233 m with the highest breeding colony at 2090 m. My personal observations in eastern Spain this year were all at altitudes in excess of 700m.

In order to demonstrate the range of upland habitats and how they can be so easily overlooked, I refer here to three sites where I discovered *L. dryas* this year

(2010) in June. I was in eastern Spain with three colleagues: Bryan Pickess, Pete Mitchell and Anthony Winchester. The region was chosen simply because dragonfly records for the area were so few. No specific attempt was made to search for *L. dryas*; these were simply serendipitous encounters. According to Boudot et al. (2009), *L. dryas* is unknown from this region of Spain!

Sierra de Cardena. This Parque Natural is approximately 50 km north east of Cordoba in Andalucia. Driving along a minor road south of the park information centre at an altitude of approximately 770 m I spotted a shallow roadside pool almost completely choked with spike rush (Eleocharis spp.) (Plate 5). Three species of lestid including *L. dryas* were present here.

Plate 5. Roadside pool in the Sierra de Cardena, Spain.

A B

Plate 6. A, B) wet depression adjacent to the River Jucar, Tragacete, Spain. Note the *Lestes dryas* habitat dominated by Carex sp. with little open water.

A

B

Plate 7. A, B) roadside pond near the Laguna de Marquesado, Spain. Note the *Lestes dryas* habitat dominated by Carex sp. with little open water.

Rio Jucar south of Tragacete – the River Jucar here is at an altitude of 1234 m. Alongside the river is a wet depression dominated by Carex sp. (Plate 6). At this locality we found *L. dryas* and *Sympetrum flaveolum*. Both species had recently emerged.

Pond near Laguna de Marquesado – This locality, approximately 30 km east of Cuenca, is at an altitude of 1300m. The shallow pond has dominant surrounding vegetation of Carex spp. and Juncus spp (Plate 7). We found three species of lestid including *L. dryas* together with *Sympetrum flaveolum*.

These three localities share similarities as follows:

- The vegetation at all three sites is similar, with Cyperaceae (Eleocharis, and Carex) species dominating.
- There is little open water
- The shallow waters would almost certainly dry up in mid summer

All three localities are widely separated and are in three distinct water catchments: Rio Guadalquivir, Rio Jucar and Rio Cabriel. The implications of this are that *L. dryas*, previously unknown from this part of Spain, is well distributed here and has simply been overlooked. A male and female of *L. dryas* photographed in Spain are shown in Plate 8. The brown eyes and developing pruinescence of the male show this to be a recently emerged insect (Plate 8A). It is interesting to compare the young and very green female (Plate 8B) with the bronze brown individual shown in Plate 4B.

A

B

Plate 8. A) Young male *Lestes dryas* showing brown eyes and the pruinescence just developing, B) young female L. dryas show the unmistakable, large ovipositor. Both photographs were taken in Spain.

Conclusions

The Pingos in Norfolk (Perrin, 1995), the coastal wetlands of the Thames Estuary and the shallow lakes of upland France and Switzerland (Deliry, 2008; Wildermuth, et al., 2005) show similar habitat characteristics to those outlined here for Spain. It is hoped that the details provided in this paper will encourage greater observation in rarely visited areas which, in future, will demonstrate just how widely distributed this species is in its specific habitat niche.

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The influence of meteorological conditions on the flight activity of the Blue-tailed Damselfly *Ischnura elegans* (Vander Linden), the Azure Damselfly *Coenagrion puella* (Linnaeus) and the Emerald Damselfly *Lestes sponsa* (Hansemann)

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Summary

The flight activity was compared for the Blue-tailed Damselfly *Ischnura elegans*, the Azure Damselfly *Coenagrion puella*, and the Emerald Damselfly *Lestes sponsa* at an exposed pond and a sheltered pond at Rimac, Saltfleetby National Nature Reserve, Lincolnshire in July and August 1998. Meteorological conditions (air temperature, light intensity, cloud cover, wind speed and direction) were investigated in relation to flight activity of the species. Flight activity of all three species increased with rising air temperature, light intensity and declining cloud cover. These factors appear to be the main ones that exert control on day to day variation in flight activity of these three species. Their relative importance varies from species to species, which is most likely to be due to the nature of the exoskeletons (which influences the rate of solar radiation absorption), size (which influences rate of warming and power requirements) and behaviour. Only *Coenagrion puella* showed any relationship between mating activity (tandem wheel flight) and meteorological conditions.

Introduction

It is well known that meteorological conditions control the activity of adult Odonata (Lutz & Pittman, 1970; Pezalla, 1979; Row & Winterbourne, 1981; Shelly, 1982; Waringer, 1982; Voigt & Heinrich, 1983; Banks & Thompson, 1985; Pilon et al., 1985; Papazain, 1994; Hilfert-Rüppell, 1998; Corbet & Brookes, 2008). However, there has been little research which compares the role of particular meteorological aspects on the flight activity in species of Zygoptera.

The purpose of this investigation was to explore the effect of such conditions on the number and length of flights by the Blue-tailed Damselfly *Ischnura* *elegans* (Vander Linden), the Azure Damselfly *Coenagrion puella* (Linnaeus), and the Emerald Damsefly *Lestes sponsa* (Hansemann); three species whose adult life stages broadly overlap. The response of each species was simultaneously compared on two ponds; one shaded and one exposed. The effect of meteorological conditions on flight activity, including mating activity, was assessed relative to meteorological conditions such as air temperature, cloud cover, wind speed and wind chill temperature.

Study Site

The two study ponds were located within an extensive dune slack at Rimac on the Saltfleetby National Nature Reserve, Lincolnshire (TF467916) (Figs 1, 2). The ponds were chosen in order to provide extremes of shelter and exposure. Pond 1 (Plates 1 and 2) was approximately 35 m^2 in surface area whilst pond 2 had an area of 12 m^2 (Plates 3 and 4). Shelter was provided by the presence of hawthorn (*Crataegus monogyna* Jacquin). Both ponds contained emergent vegetation dominated by soft rush (*Juncus effusus* Linnaeus) and sea rush (Juncus maritimus Lamarck), the remnants of salt marsh and fenland plant species. Each pond contained both submerged vegetation and areas of open water. The water table within the ponds is determined by rainfall and runoff from the highly calcareous dune.

Flight activity, including mating behaviour, was recorded simultaneously at the two ponds when population numbers of the individual species were high. At Rimac *I.elegans* is present in significant numbers between late May and the end of August. *Coenagrion puella* is also present from late May but population numbers fall in early August. In contrast *L.sponsa* populations are present from mid July to early September. Thus *Ischnura elegans* was recorded for the period 1 July to 22 August, *C.puella* for the period 1 July to the 31 July and *L. sponsa* for 21 July to 22 August

Methodology

Monitoring of flight activity in relation to meteorological conditions was carried out between 11.00 and 13.00 GMT from the 1 July 1998 to 22 August 1998. Over five days between 5 August and 19 August (5, 8, 13, 18, 19, August) sampling was carried out between 09:00 and 15:00 GMT, in 15-minute blocks, in order to expand the period of sampling to investigate flight activity outside that part of the day considered optimal for odonate activity. Thus the times used

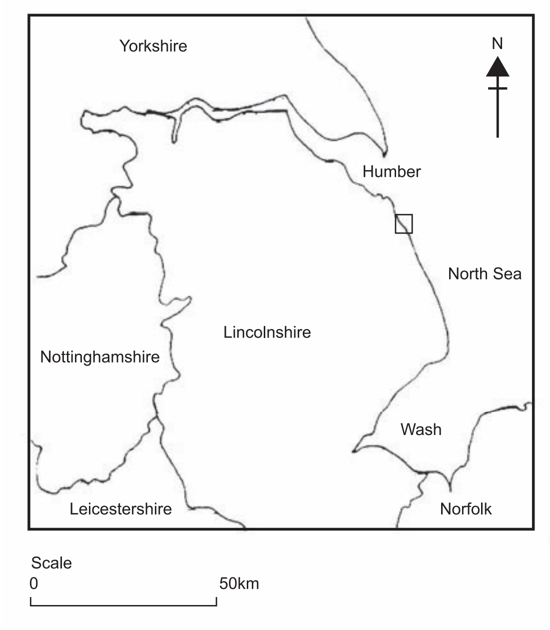

Figure 1. Geographical location of the study suite at Rimac, Saltfleetby National Nature Reserve, Lincolnshire.

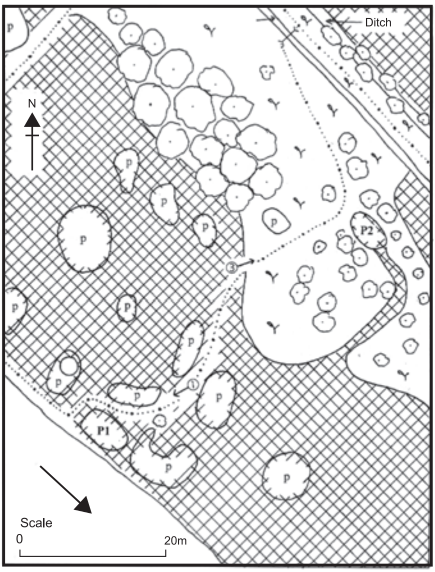

Figure 2. The location of the exposed (Pond 1) and sheltered (Pond 2) study ponds at Rimac, Saltfleetby NNR, Lincolnshire (TF467916).
P1, Pond 1; **P2**, Pond 2; – – – – – – –, footpath; ⟶ , modal wind direction; p, pond; ⨯⨯ rushes (*Juncus* sp.); ☐ tall grass with herbs; ◯ trees and shrubs; o⟶ Position on the board walk where the photographs for Plates 1 and 3 were taken.

Plate 1. The exposed pond (Pond 1). The photograph was taken from the boardwalk as indicated by the encircled 1 with arrow in Figure 2.

Plate 2. The exposed pond (Pond 1). The photograph was taken at the end of the observational period when the water level had fallen to 0.6m.

Plate 3. The sheltered pond (Pond 2). The photograph was taken from the boardwalk as indicated by the encircled 3 with arrow in Figure 2.

Plate 4. Pond 2 sheltered not only by *Crataegus monogyna* Jacquin but also by Juncus sp. The photograph was taken in August, at the end of the observational period.

were 09:00-09:15, 09:40-09:55, 10:20-10:35, 13:25-13:40, 14:05-14:20 and 14:45-15:00.

A Davis Weather Wizard III was located at Pond 1 between 1 July 1998 and 22 August 1998 to record meteorological conditions. It was used to sample mean ambient air temperature (in shade), maximum and minimum temperature every minute, and mean wind speed, wind chill and mean wind direction at 1 metre above ground every five minutes. All meteorological factors were sampled manually three times within the 15-minute sampling periods at Pond 2 between 1 July and 11 August. Wind speed was determined using an LT Lutron AM-4201 digital anemometer (accuracy ± 2%); Wind direction was measured using a thin polythene strip attached to a pole (measured to the nearest 10^0).

At both ponds light intensity (lux) was determined using a LT Lutron LX-101 lux meter (accuracy ± 5% at 23 ± 5 ^{0}C) and an aspirated psychrometer was used to determine relative humidity.

In order to standardise readings between the two ponds psychrometer readings were taken at Pond 1 immediately after readings were taken at Pond 2. These data provided baseline readings against which the continuous temperature readings were corrected. From 11 August to the 22 August a second weather station was located at Pond 2 to measure temperature. It complemented the weather station positioned at Pond 1.

Simultaneous investigation of flight activity, in terms of numbers of flights (including mating), at the two ponds was achieved by video recording at one pond whilst using binoculars to observe activities directly at the second pond over the period of optimal activity (11.00 -13.00 GMT). Video evidence was processed for the 1st, 4th, 7th, 10th and 13th minute of each 15-minute monitoring period. Outside this period (9.00-11.00 and 13.00-15.00 GMT) the study ponds were sampled sequentially because of limitations in the video camera battery power capacity.

The relationship between damselfly flight activity (number and length) and physical conditions was determined using the least squares method of linear regression. A two-sample Z test was used to determine whether the data sets were significantly different.

Results

Meteorological Conditions

The meteorological records indicate that there was no significant difference in mean air temperature and light intensity between Pond 1 (the exposed pond) and Pond 2 (the sheltered pond) over the observational period (Table 1). The sites were dominated by northwesterly winds and the mean wind speed was higher at Pond 2, the sheltered pond, in comparison to Pond 1! The wind direction was 271^0-330^0 for 48% of the study. July was characterised by a mean cloud cover of 6.5 eighths and an average air temperature of 18.46 ^{0}C whilst the August study period had a mean cloud cover of 5 eighths and an average air temperature of 20.76 ^{0}C, i.e. 2.3 ^{0}C warmer than in July.

	Air Temperature ^{0}C	**Light intensity (lux)**	**Cloud Cover (eighths)**	**Wind speed (ms^{-1})**	**Wind Chill Temperature ^{0}C**	**Wind direction (^{0})**
Pond 1 (exposed)						
Mean	19.50	65842.46	5.83	1.45	19.17	228.91
S.E.	0.24	2711.66	0.18	0.08	0.25	8.71
Minimum	13.20	7006.70	1.00	0.00	13.20	0.00
Maximum	26.70	127833.33	8.00	4.11	26.60	350.00
Pond 2 (sheltered)						
Mean	19.61	63609.62	5.85	1.60	No data	189.32
S.E.	0.25	2730.17	0.18	0.10	No data	8.68
Minimum	13.00	8000	1.00	0.10	No data	0.00
Maximum	27.00	126400	8.00	4.70	No data	360.00

Table 1. Summary of the meteorological conditions experienced at the study ponds at Rimac, Saltfleetby National Nature Reserve (NNR), Lincolnshire in July and August 1998.

Ischnura elegans

The data for I.elegans are presented for the whole observational period, 1 July to 22 August and also separated into (a) the period 1 July to 31 July, the flight period for *C.puella* and (b) 1 August to 22 August. Such data presentation allows for comparison of the effects of meteorological conditions on this species in different months.

During the flight period of *I. elegans* the mean air temperature at Pond 1 was 19.5 ^{0}C. (s.d. ±2.81), mean light intensity was 65.84 x10^3 lux (s.d. ±31.85 x10^3) and mean cloud cover was 5.83 eighths (s.d. ±2.09). At Pond 2 the mean air temperature was 19.61 ^{0}C (s.d. ±2.84), mean light intensity was 63.91 x10^3 lux (s.d. 31.49 x10^3) and mean cloud cover was 5.85 eighths (s.d. ±2.10). The minimum air temperature at which flight activity was observed was 14.2 ^{0}C and the minimum light intensity was 22.5 x 10^3 lux over the period 1 to 31 July, whilst for 1 to the 22 August the minimum air temperature for flight activity was 15.3 ^{0}C and the minimum light intensity was 23.1 x 10^3 lux. Flight activity therefore occurred at lower temperatures and light intensity in July than in August.

Significant relationships were observed between flight activity and air temperature and cloud cover throughout the study period, irrespective of whether the pond was sheltered or exposed (Table 2). Flight activity increased with air temperature, with a 2.14 increase in the number of flights for every 1 ^{0}C increase. For a 1x 10^4 lux increase in light intensity the number of flights increased by 1.8. Flight activity peaked during the period 11.00 – 13.00 GMT on only 60% of occasions and the rates of change with variation in physical conditions were lower between 11.00-13.00 GMT than during the preceding and subsequent periods.

Significant relationships were also observed between flight activity and air temperature and cloud cover at the exposed pond (pond 1) when the data were separated between July and August. However, between 1 and 31 July at the sheltered location (Pond 2) only air temperature had a significant effect (Table 2).

Wind speed was not a significant factor at either of the ponds, although a significant relationship was obtained when light intensity was greater than 65.28 x 10^3 lux. Cloud cover fluctuations explained a greater proportion of activity than did other factors for this species. This suggests that *I. elegans* flight activity may be more responsive to general changes in air temperature associated with changing amounts of cloud than it is to short term variations in cloud movement.

However, at pond 1 (the exposed pond), over the study period, wind chill temperature was significant at the 95% level (Table 2). The combined influence of cloud cover and air temperature explained 51.1% of the variation in flight activity, whilst the combined influence of cloud cover and wind chill temperature explained 52.5%.

Coenagrion puella

The minimum air temperature at which flight activity was observed for *C. puella* was 16.2 ^{0}C during the period 1 to 31 July and the minimum light intensity was 22.5 x 10^3 lux. During its flight period the mean air temperature was 18.46 ^{0}C (s.d. ±2.60), light intensity was 60.76 x 10^3 lux (s.d. ±31.52 x 10^3) and the cloud cover was 5.03 eighths (s.d. ±2.26) (Table 3). Flight activity increased as air temperature rose, with a 1.46 increase in the number of flights for every 1 ^{0}C increase (significant at 90% level, $r^2 = 0.1$) and, although its activity did not increase throughout the entire temperature range, it was always observed when the air temperature was above 22 ^{0}C.

Species and observation period	Meteorological factor	Equation for Line of best fit	Confidence Level (%) for significant relationship	R^2
Pond 1 (exposed)				
1 July – 22 August	Air temperature	Y = 2.41X -33.1	95	0.332
	Light intensity	Y = 0.18X -3.5	95	0.313
	Cloud cover	Y = -3.21X + 27.4	95	0.415
	Wind Speed	Y = 0.68X + 7.6	NS	0.004
1 July – 31 July[a]	Air temperature	Y = 1.17X -16.3	95	0.228
	Light intensity	Y = 0.1X – 0.8	NS	0.307
	Cloud cover	Y = -1.12X + 13.3	95	0.135
	Wind chill temperature	Y = 1.14X -15.6	95	0.287
1 August – 22 August[b]	Air temperature	Y = 2.85X – 46.5	95	0.308
	Light intensity	Y = 0.25X – 5.3	NS	0.36
	Cloud cover	Y = -4.1X + 33.3	95	0.498
	Wind chill temperature	Y =2.57X – 39.3	95	0.31
Pond 2 (sheltered)				
1 July – 22 August	Air temperature	Y = 1.14X – 18.6	95	0.289
	Light intensity	Y = 0.07X – 0.6	NS	0.129
	Cloud cover	Y = -1.19X + 10.7	95	0.172
	Wind Speed	Y = 0.44X + 3.1	NS	0.007
1 July – 31 July	Air temperature	Y = 0.86X -12.8	95	0.234
	Light intensity	Y = 0.04X + 1.0	NS	0.056
	Cloud cover	Y = -0.24X + 4.6	NS	0.008
	Wind speed	Y = -0.52X+ 3.9	NS	0.014

Table 2. The relationships between the flight activity of *Ischnura elegans* and the meteorological conditions at two ponds (Pond 1 exposed; Pond 2 sheltered) at Rimac, Saltfleetby NNR, Lincolnshire. a, July data only; b, August data only.

Species and observation period	Meteorological factor	Equation for Line of best fit	Confidence Level (%) for significant relationship	R^2
Pond 1 (exposed)				
1 July – 31 July	Air temperature	Y = 1.46X – 17.9	90	0.10
	Light intensity	Y = 0.26X – 6.5	95	0.448
	Cloud cover	Y = -4.52X + 38.5	95	0.401
	Wind speed	Y = -0.32X + 9.4	NS	0.00
	Wind Chill Temperature	Y = 1.48X - 18	90	0.108
Pond 2 (sheltered)				
1 July – 31 July	Air temperature	Y = 1.02X – 12.3	NS	0.056
	Light intensity	Y = 0.18X – 4.5	90	0.278
	Cloud cover	Y = -1.88X + 18.8	95	0.083
	Wind Speed	Y = 1.98X – 3.29	NS	0.034
	Wind Chill	-	-	-

Table 3. The relationships between the flight activity of *Coenagrion puella* and the meteorological conditions at Pond 1 (exposed) and Pond 2 (sheltered) at Rimac, Saltfleetby NNR, Lincolnshire.

Statistically significant relationships were observed between flight activity and both light intensity and cloud cover. For a $1x\ 10^4$ lux increase in light intensity the number of flights increased by 2.6 and this was the case over the entire range of light intensity, activity not declining during brighter periods. Wind speed was of little importance and wind chill at the exposed pond explained only a slightly larger proportion of the variation than did air temperature. The combined effect of light intensity, cloud cover and wind chill factor explained 49% of the variation in flight activity. Wind speed explained more of the variation in flight activity when air temperature, light intensity and cloud cover was marginal. Activity declined with increasing wind speed when light intensity was greater than 62.5×10^3 lux (90% confidence level) at the exposed pond. Wind speed was not a significant feature at the sheltered pond. Light intensity and cloud cover explained a greater proportion of the variation in flight activity when air temperature was marginal, than over the full temperature range (46.7 and 49.4% compare to 44.8 and 40.1% respectively).

C. puella was the only species for which significant mating activity was observed during the study period. Tandem flight was only observed in 12 monitoring periods (air temperature and light intensity range of 17.2 – 26.0 ^{0}C and 46.6 x 10^3 – 126.7 x 10^3 lux). At Pond 1 air temperature explained 11.1% of the observed variation in the number of tandem flights (95% confidence level).

Data for the optimal flight period of *C. puella* were not statistically significant from activity in the other periods.

Lestes sponsa

The minimum air temperature at which flight activity was observed for *Lestes sponsa* was 16.2 ^{0}C during the period 21 July to the 22 August. During its flight period the average air temperature was 20.34 ^{0}C (s.d. ±2.49), the mean light intensity was 68.15 x 10^3 lux (s.d. ±30.08 x 10^3) and the mean cloud cover was 5.49 eighths (s.d. ±2.15). Flight activity increased with air temperature with a 1.47 increase in the number of flights for every 1 ^{0}C rise. For a 1x 10^4 lux increase in light intensity the number of flights increased by 1.3.

L. sponsa flight activity (Table 4) varied with physical factors in a manner similar to that of *I. elegans*. Significant relationships were observed between flight activity and air temperature, light intensity and cloud cover although light intensity was not a significant factor at Pond 2, the sheltered pond.

Activity appeared to decline at high light intensity and low cloud cover. The combined influence of air temperature and light intensity explained 37.7% of the variation in flight activity. Within the marginal range (17.0-22.0 ^{0}C) air temperature had no significant influence on flight activity, suggesting that *L. sponsa* gained little heat from conduction from the surrounding air.

Cloud cover and light intensity explained 8% and 21% of the variation in flight activity at marginal temperatures, compared to 27.6% and 31% over the full temperature range. Activity increased with rising light intensity and declining cloud cover when air temperature was above the threshold levels. However, the relationship between activity and light intensity was only significant above an air temperature of 17.9 ^{0}C. *L. sponsa* therefore appears to benefit from high ambient temperatures to a greater extent that *I. elegans*. This may be the result of size-related energy demands of *L. sponsa*.

The optimal period for flight activity in *L. sponsa*, was always between 11.00 – 13.00 GMT, and the rates of change of flight activity did not decline.

Species and observation period	Meteorological factor	Equation for Line of best fit	Confidence Level (%) for significant relationship	R^2
Pond 1 (exposed)				
21 July – 22 August	Air temperature	Y = 1.47X -24.6	95	0.272
	Light intensity	Y = 0.13X – 3.5	95	0.31
	Cloud cover	Y = - 1.71X + 14.7	95	0.276
	Wind Speed	Y = 0.26X + 4.89	NS	0.001
	Wind Chill	Y= 1.31X – 20.9	95	0.247
Pond 2 (sheltered)				
21 July – 22 August	Air temperature	Y = 0.89X – 15.9	95	0.273
	Light intensity	Y = 0.06X – 1.4	NS	0.159
	Cloud cover	Y = -0.86X +7.1	95	0.179
	Wind Speed	Y = 1.08X + 0.87	NS	0.083
	Wind chill	-	-	-

Table 4. The relationships between the flight activity of *Lestes sponsa* and the meteorological conditions at Pond 1 (exposed) and Pond 2 (sheltered) at Rimac, Saltfleetby NNR, Lincolnshire.

Discussion

Ischnura elegans flew at a lower air temperature than either *C. puella* or *L. sponsa* during the same flight period. This observation supports Hilfert-Rüpell's experience in northern Germany, where it was noted that flight was at low temperature only when cloud cover was high and light intensity low (Hilfert-Rüpell, 1998). During their flight periods a greater air temperature range was observed for *I. elegans* than for *C. puella* or *L. sponsa*, although *C. puella* showed flight activity over a smaller temperature variation than *L. sponsa*. However, the intensity of light was more variable during the flight period of *C. puella* than for that of *L.sponsa*. Conversely, cloud cover was less variable during the flight period of *C. puella* compared to that of *L. sponsa*.

The flight activity of *I. elegans* increased with air temperature at a faster rate than that of either *C. puella* or *L. sponsa*, so air temperature was a major factor explaining a relatively large proportion of the variation in the flight activity of *I. elegans*. Unlike *I. elegans* or *L. sponsa*, the flight activity of *C. puella* did not increase throughout the entire temperature range. This suggests that air temperature may be of secondary importance and that this species receives a small proportion of its energy through direct air contact.

In C.puella flight activity increased with rising light intensity and declining cloud cover at a faster rate than it did for either of the other two damselflies and it increased over the entire light intensity range which was not the case for either *I. elegans* or *L. sponsa*. This is somewhat surprising because of the metallic colouration of this species, approximately 60% of which is a highly reflective blue colour (Hilfert-Rüpell, 1998). *C. puella* would be expected to absorb a relatively small proportion of solar radiation and, when heat gain by sunlight absorption was sub-optimal, a greater proportion of its internal temperature would be through conduction from surrounding air. Because of the nature of the rest of the body markings the irradiative load causing overheating in *C. puella* is presumably greater than in darker species.

L. sponsa flight activity did not vary with physical conditions as rapidly as did that of *I. elegans*. This may be due to the large size and weight of this species and its relatively light and metallic colouration. In *L. sponsa* the apparent decline in activity at high light intensity (greater than 120 x 10^3 lux) and low cloud cover supports the work of Watanabe and Taguchi (1993) who suggested that forest-dwelling *L. sponsa* seek shade due to high radiation temperature rather than high air temperature.

In terms of general meteorological conditions *I. elegans* and *L. sponsa* activity were most closely related to air temperature, whilst light intensity and cloud cover explained the greatest amount of variation in flight activity for *C. puella*. This is demonstrated particularly well if the results for Pond 1 (the exposed pond) are considered, although physical conditions explained a smaller proportion of the variation in damselfly activity at the sheltered pond than at the exposed pond.

Diurnal variation of Zygopteran flight

No single factor or combination of factors satisfactorily explained variation in activity between 9.00-15.00 GMT over all monitoring days, although air temperature was the most important factor. Significant relationships were observed between *I. elegans* activity and air temperature on four of the monitoring days and between *L. sponsa* activity and air temperature on two of the five monitoring days. Light intensity had no significant influence on flight activity on any of the five monitoring days between 5 and 19 August.

The optimal period for flight activity in *L. sponsa* was always between 11.00 – 13.00 GMT but *I. elegans* activity peaked during this period on only 60% of occasions, which supports the findings of Hilfert & Rüppell (1997). Rates of change of flight activity did not decline for *L. sponsa*, which appeared to have benefited more from the conditions associated with this period than did *I. elegans*, for which the optimal conditions were only occasionally approached and/or exceeded. This variation between species, in response to diurnal changes in air temperature and light intensity, means that sampling within the accepted optimal period for odonate activity does not always provide the most representative data on damselfly population numbers and activity.

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Migrant and dispersive dragonflies in Britain during 2009

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Summary

The 2009 season saw major arrivals of **Red-veined Darter** *Sympetrum fonscolombii* during the late spring and summer, and a significant hot weather movement of many migratory/dispersive species during a short period around the end of June/early July. Other significant finds included the discovery of singleton **Southern Emerald Damselfly** *Lestes barbarus* at three sites on the East Anglian coast during August. The highlight of the year was, however, the discovery of large numbers of **Willow Emerald Damselfly** *Lestes viridis* in southeast Suffolk, under circumstances strongly suggestive of the presence of a recently-established breeding population.

Account of species

Notable sightings reported to the BDS Migrant Dragonfly Project during 2009 are detailed below; background meteorological information is from the Met Office (2010) and WeatherOnline (2010).

Lestes barbarus (Fab.) – Southern Emerald Damselfly

Three singletons were photographed in East Anglia during the course of the summer, *viz*. a male at Winterton Dunes, Norfolk, on 5 August (C. Robson), a male at Old Felixstowe, Suffolk, on 17 August (A. & D. Healey) and a female at Trimingham, Norfolk, on 26 August (A. Chamberlain). Southern Emerald Damselfly has now been seen in the UK during five of the last eight years since its first discovery in 2002 (Nobes, 2003), though 2009 is the first year in which records have come from more than two sites. An apparent breeding colony at Sandwich in Kent (Parr, 2005) was short-lived, but maybe the formation of a new colony is not far off. The species is clearly attracted to the Winterton area, with earlier records during 2002–2004 (Parr, 2005), and maybe this locality is a candidate for a future breeding site.

Lestes viridis (Vander Linden) – Willow Emerald Damselfly

Prior to 2009, this species had been recorded from Britain on only a very limited number of occasions. In the nineteenth century it was listed by McLachlan (1884) as 'doubtful', while a specimen apparently from Hertfordshire in 1899 is believed by some to have been mislabelled, instead being of Continental origin (Gladwin, 1997). The first clear record was not until 1979, when one was found dead at Hankham Clay Pit near Pevensey, East Sussex (Belden *et al*., 2004). An exuvia was discovered at Cliffe Marshes, Kent, during 1992 (Brook & Brook, 2003), though no adults were ever noted, and more recently a female was observed near Trimley, Suffolk, on 17 August 2007 (Brame, 2007). During 2009 well over four hundred individuals were however seen in East Anglia, primarily in an area within 25 km of the 2007 Suffolk sighting, though with outlying records from Marks Hall, Essex (LM) and Strumpshaw, Norfolk (BMH). Further details of these dramatic finds are given in Parr (2009, 2010).

The discovery of at least two tenerals during 2009, plus the very large numbers of individuals involved and the long duration of sightings (1 August – 29 October), is strongly suggestive of the presence of an established breeding population. There is circumstantial evidence that this may have been initiated by immigrants arriving during early August 2007 – around the time of the previous sighting from Suffolk – when it is known that weather conditions did result in a movement of insects across the North Sea from Belgium to the East Anglian coast (Gloster *et al*., 2008).

Coenagrion scitulum (Rambur) – Dainty Damselfly

In the Channel Islands this species was reported from two localities in southeast Jersey during June/early July; these are the first records for the island since 1941 (Perchard & Long, 2009). It is known that the species is currently expanding its European range (Dijkstra & Lewington, 2006), and the Jersey sightings are likely part of this process. In recent years Dainty Damselfly has been recorded as close to the UK mainland as Calais, France (Vanderhaeghe, 1999), and given current trends it seems possible that this species may soon re-colonise England, where it was last seen in 1952 (Merritt *et al*., 1996).

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

This recent colonist showed quite rapid range expansion in the years immediately following its arrival in the UK, but there was then something of a lull during the period 2007–2008. In 2009 a new northerly record for Britain was however set on 11–12 August, with a report from Seamer Tip Pools, North Yorkshire (JH). In Devon, a sighting near Exeter on 7 August (per DS) also set a new westerly record.

There was some suggestion of continuing immigration noted during the year. Six were thus seen amongst Marram grass *Ammophila arenaria* and gorse *Ulex* spp. in the coastal dunes at Minsmere, Suffolk, on 25 July (PG), along with thousands of Seven-spot Ladybird *Coccinella 7-punctata*.

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

Isolated individuals were discovered at two new sites in Devon (Finlake and the Heddon Valley) during late May 2009 (per DS), and at a new site in the Cotswold Water Park, Gloucestershire (per IT). More substantial populations were also discovered at previously unknown sites on Goss Moor, Cornwall (per SJ), near Llanbrynmair in the old county of Montgomeryshire (MW) and at several localities in north Wales (per AB). Although some of these finds, particularly the Welsh ones, may relate to previously overlooked but otherwise well-established populations, it would seem that significant dispersal also took place either during 2009 or in the recent past in the case of the larger finds. The species favours open, shallow waters that frequently dry out and become unfavourable as ecological succession proceeds, so has developed a strong dispersive potential (though this is not always expressed).

Aeshna juncea (L.) – Common Hawker

A female was sighted in the Shetland Isles, apparently on Whalsay, on 14 September, and what was likely the same individual was then found dead the next day (per DS). This is only the second record of the species from the Islands (Pennington, 2009). Common Hawker breeds as close as the Orkneys, but an origin in Scandinavia is also a possibility.

Aeshna mixta Latreille – Migrant Hawker

It was apparently a rather quiet year for movements by this species, though some east coast sites reported increased numbers during mid August; a small influx was for instance noted at Sandwich Bay, Kent, on 17 August (SBBO). The record of a singleton caught in a moth-trap at Cury, Cornwall, on the night of 19 September (FJ) is also of interest; such dragonflies at light are often migrants (Parr, 2006).

Anax imperator Leach – Emperor

One seen on the well-watched Walney Island, Cumbria, on 29 June was only the third site record; then during 4–11 July up to six were present (WBO). Arrivals coincided with the appearance of other unusual migrant/dispersive species, *viz*. Broad-bodied Chaser *Libellula depressa* and Red-veined Darter *Sympetrum fonscolombii*, so could refer to individuals in a joint migration.

Anax parthenope **Sélys – Lesser Emperor**

This species has occurred annually since it was first positively identified in Britain back in 1996. Records were received from some 16 sites during 2009, which is the fourth-highest ever yearly total, though still some way short of the *ca*. 70 sites seen during 2006 (Parr, 2007). Several waves of sightings were noted during the year, often coinciding with appearances of Red-veined Darter *S. fonscolombii*, and the two species are indeed known to frequently migrate together (Parr *et al*., 2004). Over the period 29 May–16 June single Lesser Emperors were noted from the Scilly Isles, Cornwall, Glamorgan, Carmarthenshire and Kent, as well as from Guernsey in the Channel Islands. A second wave of sightings then occurred between 28 June and 18 July. These were typically from more central or northerly regions, such as Leicestershire, Northamptonshire, South Yorkshire, West Yorkshire, North Yorkshire and Lancashire, but did include records from Dungeness, Kent. Finally, later in the season there was another wave of sightings from Dungeness, with records peaking on 6 August when seven individuals including an ovipositing pair were noted (PA). Elsewhere, two males were seen at Bake Farm, Cornwall, on 7 August with a further male at Sheviock Pool a few kilometres away (KP). The last record of the year was on 21 August, when one was reported from Rainham Marshes, Essex (per HV).

Although most individuals seen are likely to have been migrants, the bulk of records coinciding as they did with appearances of Red-veined Darter, reports sometimes occurred at sites where Lesser Emperor was also noted during 2007 or 2008. With the life cycle taking up to two years (Brooks & Lewington, 1999) it is thus possible that a few individuals may have been locally-bred. In particular the series of sightings at Dungeness may include a resident component; the species has been seen at this site every year for the last twelve seasons.

Cordulegaster boltonii **(Donovan) – Golden-ringed Dragonfly**

An individual seen on 15 November at the base of the cliffs at Black Ven, Dorset (RG & EW) is the latest-ever recorded in Britain. Given the coastal location and the occurrence of strong southerly winds in the preceding days (WeatherOnline, 2010) it is quite likely that an immigrant is involved. Its origin is unclear, but since photographs show the individual to be of the nominate subspecies it cannot be from Spain or southern France, where other subspecies occur instead (Dijkstra & Lewington, 2006).

Crocothemis erythraea (Brullé) – Scarlet Darter

This species has become a regular immigrant to the Channel Isles over recent years, and a male was seen at Grouville, Jersey, on 8 July (RP). There were, however, no records from Britain during the year, the last positive sighting of this species here having been in 2004 (Parr, 2005).

Libellula depressa L. – Broad-bodied Chaser

There were a number of records from unusually northern parts of Britain during late June and early July, coincident with arrivals of Red-veined Darter *S. fonscolombii* in these regions (see below) and thus suggestive of some sort of joint movement. On Walney Island, Cumbria, a Broad-bodied Chaser seen on 28 June was only the fourth site record, while on 4 July two were then seen there along with six Emperor *Anax imperator* – another species rarely reported from the Island – and three Red-veined Darter (WBO). Additional records came from elsewhere in Cumbria during the period (per DC), while further north still there were at least two other records – one near Ecclefechan, Dumfries & Galloway, on 5 July (DC) and another in the Rhinns of Kells, Dumfries & Galloway, on 11 July (SP). There are only three previous records for Scotland, all since 2003 (Parr, 2007).

Libellula fulva Müller – Scarce Chaser

Although no very major movements were identified, range expansion continued apace during 2009 with records from new river systems such as the River Gipping in Suffolk (JF, RR), the Rivers Wid and Can in Essex (TC) and the River Eden in Kent (per JGB).

Orthetrum coerulescens (Fab.) – Keeled Skimmer

Several unexpected sightings were made during the hot weather in mid-summer, implying a period of significant dispersal. A male was, for instance, seen outside the species' normal range at Baddesley Colliery, Warwickshire, on 1 July (KW) and 'a couple' of males were noted at Saltwells LNR, West Midlands, around the beginning of July (SR). Two males seen at Glasson Moss, Cumbria, in late July (per DC) were also the first county records outside the Lake District.

Sympetrum danae (Sulzer) – Black Darter

Substantial internal dispersal within central England was observed during autumn 2009. Individuals were thus noted outside their normal range at Wells-next-the-Sea, Norfolk, on 5 September (per PT); near Weston Mill, Northamptonshire, on 10–11 September (DG); Marsh Lane Nature Reserve, Warwickshire, over the period 11 September–12 October (LJ, GR & PR); Upton, Northamptonshire, on 19 September (MT) and at Carr Vale, Derbyshire, on 4 & 6 October (JA). The situation further north was however less noteworthy. Following record-breaking arrivals on the Sefton coast of Lancashire during 2008 there were, for instance, no records at all from the region during 2009 (PS). The differing trends in different areas might be linked to weather patterns. In south-central England many parts were extremely dry during September 2009, with only about a third of the normal rainfall (Met Office, 2010). These dry conditions may have prompted many individuals to disperse away from the normal breeding grounds, whose condition would have likely deteriorated. Further north conditions were by contrast less extreme (Met Office, 2010), which may have resulted in less-pronounced dispersal.

Sympetrum flaveolum (L.) – Yellow-winged Darter

It was a very quiet year for the species. On the east coast of Britain a female/immature was noted at Dunwich Heath, Suffolk, on 25 August (SM) and a male was seen at Filey Country Park, North Yorkshire, on 6 September (JH).

Sympetrum fonscolombii (Sélys) – Red-veined Darter

Once a scarce and erratic visitor to our shores, this species has now become a regular immigrant to Britain. Even by modern standards the migrations of 2009 were however of considerable note, with large numbers of individuals being involved and with several waves of arrivals. The first record of the year was on 24 May, and by the end of July sightings had come from very nearly one hundred sites in Britain. Many of the earliest records came from southern and southeast England, but here individuals rarely seemed to linger. Indeed there were several reports of individuals well away from water, presumably still on active migration. Later in the period many records came from southwest England (see Table 1) and here individuals seemed more settled, with breeding activity frequently reported. This early phase of movements was clearly linked to the even more spectacular migrations of Painted Lady *Vanessa cardui* that were widely reported at the time (Fox, 2010). During the first half of July there was then a separate phase of movement. Although producing fewer records in comparison to the spring influx, sightings were notable in having a strong northerly component (Table 1). In particular there were at least five records from Scotland, as far north as East Lothian (15 July; BH). This is only the third-ever year in which individuals have been seen as far north as Scotland, though the previous occasion was as recently as 2006 (Parr, 2007).

Table 1.

Date	Total number of sites reported	Number of records from different regions (with proportion of weekly total in brackets)				
		Southeast England[1]	Southwest England[2]	Wales	Central England	N. England & Scotland[3]
24–30 May	13	6 (46%)	3 (23%)	1 (8%)	2 (15%)	1 (8%)
31 May – 6 June	35	3 (9%)	20 (57%)	8 (23%)	2 (6%)	2 (6%)
7–13 June	9	3 (33%)	4 (44%)	1 (11%)	1 (11%)	0 (0%)
14–20 June	7	5 (71%)	0 (0%)	0 (0%)	1 (14%)	1 (14%)
21–27 June	4	1 (25%)	1 (25%)	0 (0%)	2 (50%)	0 (0%)
28 June – 4 July	11	4 (36%)	1 (9%)	1 (9%)	1 (9%)	4 (36%)
5–11 July	11	1 (9%)	0 (0%)	2 (18%)	4 (36%)	4 (36%)
12–18 July	5	2 (40%)	0 (0%)	0 (0%)	0 (0%)	3 (60%)
19–25 July	1	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
26 July – 1 August	2	1 (50%)	0 (0%)	1 (50%)	0 (0%)	0 (0%)

Table 1. Numbers of sites in the UK at which Red-veined Darter *Sympetrum fonscolombii* were discovered each week during summer 2009, shown as a function of both time of year and of geographical region. [1]Coastal counties from Hampshire to Lincolnshire, plus Surrey and Greater London; [2]Dorset, Wiltshire, Gloucestershire and areas further west; [3]Cheshire, Yorkshire and areas further north.

Given the early start to immigration, its considerable magnitude and also the favourable weather experienced in many parts of Britain during the summer, it was expected that in southern Britain a second generation of locally-bred individuals would appear in the autumn. This indeed occurred, with sightings of exuviae and/or tenerals from at least seven sites being reported between mid-August and October. Many of these sites were in southwest England and south Wales, and given that these areas have a relatively low density of active dragonfly enthusiasts it is likely that other breeding sites went undiscovered. In addition to records at breeding sites, small numbers of immature Red-veined Darter were also recorded from several other areas during the late summer and autumn. Many of these individuals seem likely to have been long-distance wanderers, though it is difficult to know whether they were ultimately of British or Continental origin.

Sympetrum striolatum (Charp.) – Common Darter

It was seemingly a rather uneventful year for Common Darter migration, though smaller-scale movements can be hard to detect. Early in the season a few almost fully-mature individuals were noted at Middleton, Lancashire, on 1 June (PM); this is a rather early date for such mature individuals and perhaps indicates a joint immigration with the *S. fonscolombii* that also appeared in the region at this time. Later in the season there was an interesting series of records of individuals caught in moth-traps, many of which are likely to represent migrants (Parr, 2006). An immature male was trapped at Sandwich Bay, Kent, on the night of 23 August (SBBO), with other singletons at Portland Bill, Dorset, on 31 August (MC), at Bawdsey, Suffolk, on 17 September (MD) and at Cury, Cornwall, on 26 September (FJ). The species was also recorded from moth-traps at Bradwell-on-Sea, Essex, during the year (SD).

Conclusions

Although there were to be no repeat sightings of Winter Damselfly *Sympecma fusca*, first discovered in Britain the year before, 2009 turned out to be quite an eventful one for migrant and dispersive dragonflies. Particular highlights included a major influx of Red-veined Darter *Sympetrum fonscolombii* that was noteworthy even within the raised expectations of recent years. Southern Emerald Damselfly *Lestes barbarus* was seen at more sites than ever before, and although only isolated individuals were reported at each site it is possible that others went unrecorded, and that the species may currently be attempting to colonise Britain. Probably the major highlight of the year was, however, the discovery of very large numbers of Willow Emerald Damselfly *Lestes viridis* in east Suffolk, under conditions that did indeed suggest ongoing colonisation.

After a prolonged period of relative stability during much of the nineteenth and twentieth centuries, Britain's Dragonfly fauna is clearly now going through a period of considerable flux. Records of unusual or rare species thus take on more than mere curiosity value, and potentially indicate the future for Britain's dragonflies. Continued vigilance by observers is thus required, and further research into factors which influence the movements of mobile species would be of benefit. Various aspects of the role of weather in dragonfly migration/dispersal were indeed apparent in the events of 2009.

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A change in status of the Dainty Damselfly *Coenagrion scitulum* (Rambur) in the United Kingdom

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Summary

The revised list of Odonata in the United Kingdom produced by Taylor *et al*. (2009) contained 42 species in Category A, a further 12 species in Category B and 3 species in Category C (former breeding species not recorded since 1970). The discovery of at least four Dainty Damselfly *Coenagrion scitulum* adults in Kent during June and July 2010 and the identification of two exuviae from the same species, require *Coenagrion scitulum* to be moved from Category C to Category B (vagrant species).

Background

The Dainty Damselfly *Coenagrion scitulum* was first discovered in Britain at a site near Benfleet on 21 July 1946. Its stronghold later proved to be at a small pond a few miles away in the Hadleigh area of Essex. There was reported to be a significant breeding population present here with over 250 individuals present and the species persisted in the area until 1952 (Merritt *et al*., 1996). Unfortunately, the severe floods of early 1953, when coastal defences were breached, severely affected the pond and there were no further records of the species from Essex. After not being recorded in Britain for a number of years, the species was declared extinct in this country.

On the continent, *Coenagrion scitulum* has a predominantly central and southern distribution, but there has been evidence of a northwards range expansion in recent years. The species is now widespread in France, especially in the centre and the west (including Pas de Calais) and is found sporadically in Belgium (Grand & Boudot, 2006). There are also records from the Channel Isles. Thus *Coenagrion scitulum* was recorded on Jersey during 1940 and 1941, followed by an appearance on Guernsey during 1956, when it was believed to have bred (Merritt *et al*., 1996). It was rediscovered on Jersey in 2009, when individuals were noted at two localities during June and early July (Parr, 2010).

It remains to be seen whether *Coenagrion scitulum* can once again establish a sustainable breeding population in Britain. If this could be achieved, it would prompt a further reassessment of its status. For the time being, it is likely to remain a vagrant species and as such is now listed in Category B. Further reassessments of status for other species may need to be made soon. On current evidence the Willow Emerald Damselfly *Lestes viridis* is likely to move within the next few years from Category B to Category A (resident and/or migrant species recorded since 1970).

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Corrigendum

Unfortunately a sentence was curtailed at the bottom of page 22 in volume 26 (1). It should read as follows:

The maximum score was only achieved by one of the exuviae examined in this study.