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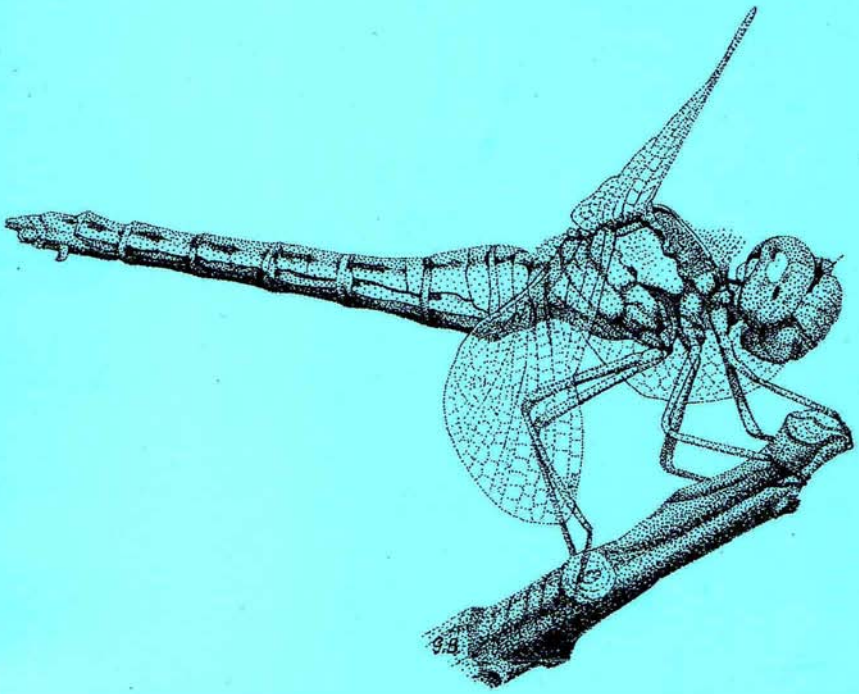

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Front cover illustration: Female Vagrant Darter *Sympetrum vulgatum* by Gill Brook from a photograph by Andrew Chamberlain.

Submergence of both sexes during oviposition in the Large Red Damselfly *Pyrrhosoma nymphula* (Sulzer) in Norfolk

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Summary

A pair of Large Red Damselflies *Pyrrhosoma nymphula* was observed and filmed whilst ovipositing in Norfolk in the summer of 2008. During previous observations, pairs were usually seen on floating Rigid Hornwort *Ceratophyllum demersum* with attached males in the sentinel position contact guarding their respective mates. Females oviposited into the Hornwort with only a part of their abdomens submerged. Similar behaviour was also observed by pairs perched on other plants, including Bog Bean *Menyanthes trifoliata*. On 11 May a pair was observed when the female submerged completely for just over a minute. On 23 May a pair was seen with the female already completely submerged and the male followed. At the same time a second pair was also observed nearby with both sexes submerged. To the best of my knowledge this is the first report of complete male submergence in this species.

Introduction

It is normal for most coenagrionids to exhibit contact guarding during oviposition, with the male adopting the sentinel (vertical) position (Corbet, 1999). In some species complete submergence of the female is the norm, the male waiting at or near the surface, but in other species the male may maintain contact with the female and submerge either partially or completely as well (Corbet, 1999). The greatest depth recorded by a submerged female is 1 m in *Enallagma cyathigerum* (Macan, 1964) and Cham (2004) has recorded a female of this species remaining submerged for upto 30 minutes. In *E. cyathigerum* the male normally remains above the surface, releasing the female as she submerges. However, in very dense populations, the male may also submerge (Cham, 2004).

The Large Red Damselfly *Pyrrhosoma nymphula* is one of the most common and widespread coenagrionids in Britain and Ireland, ranging from the south coast of England to the northern isles of Scotland (Brooks, 1997). As in most other coenagrionids the male contact guards the female who normally only immerses her abdomen upto about halfway while ovipositing. However, recently a case of

complete submergence of the female has been described on the Isle of Lewis, Scotland by Starmore (2008), and has also been observed by Cham (in Starmore, 2008). This paper describes a further occurrence of this phenomenon and, in addition, complete male submergence.

The Location

The location for the current observations was my small garden pond, in a small rural village, surrounded by arable farming a few miles north east of Swaffham in Norfolk. The pond was dug in 1998 in a sunny, sheltered spot and is approximately 4m in diameter with a maximum depth of just over a metre. The aspect is open on the south and west sides with a Yew hedge a few metres away on the east side and some Birch trees just to the north. There is a bog garden on the north east side containing Meadowsweet *Filipendula ulmaria*, Purple Loosestrife *Lythrum salicaria* and Common Fleabane *Pulicaria dysenterica*. Marginal plants include Pendulous Sedge *Carex pendula*, Yellow Flag *Iris pseudacarus*, Soft Rush *Juncus effusus*, Branched Bur-reed *Sparganium erectum*, Flowering Rush *Botomus umbellatus*, Bog Bean *Menyanthes trifoliata*, Marsh Marigold *Caltha palustris*, Water Plantain *Alisma plamtago-aquatica*, Arrowhead *Sagittaria sagittifolia* and Water Mint *Mentha aquatica*. There is an ornamental Lily (species unknown), Rigid Hornwort *Ceratophyllum demersum* and Canadian Pondweed *Eloda canadensis*. The pond becomes overgrown in the summer necessitating removal of vegetation to maintain some open water.

Method

I keep a close eye on my pond throughout the summer and had been taking a special interest as I was trying to film a good emergence sequence with my camcorder. The beauty of a small garden pond is that it is always accessible and the action is never far from the edge. The camcorder used was a Canon XM2 with a Sigma macro filter type lens attached to obtain close ups. The date and time is recorded to the nearest minute and each frame is recorded at 25 frames per second. Thus the time of each frame can be worked out to the nearest second.

Observations

Large Red Damselflies *Pyrrhosoma nymphula* had been emerging at the pond in 2008 since late April. In most cases, pairs were seen ovipositing in floating Rigid Hornwort, with attached males in the sentinel position contact guarding their respective mates and the females with only a part of their abdomen submerged. Others exhibited a similar behaviour ovipositing in other plants, including Bog Bean.

On 11 May at 1227h I started filming one of the first pairs that I had found ovipositing. They were perched on the top of a fresh Water Mint shoot just poking through the water's surface. The male was in the sentinel position as the female disappeared under one of the Mint leaves. He dropped from his upright stance to gain support from the Mint leaves and then fluttered forward dragging the female with him and effectively pulling her clear of the water. She was only underwater for just over a minute and her wings never fully submerged. The male fluttered a few more centimetres and the pair rested for a short time as the female wiped her eyes with her front legs. The male released her shortly after this and flew off.

Table 1. A summary of the sequence of events as a pair of Large Red Damselflies submerged during oviposition.

Time (BST)	Position
1433.00	Female already fully submerged
1434.00	Male's abdomen fully submerged
1437.02	Male flicks his wings, successfully removing a Pond Skater
1438.54	Male's head submerges, wings still partly above the surface
1440.39	Male now fully submerged
1440.51	Pair at maximum depth
1442.56	Pair approaching the surface
1443.19	Male's head breaks the surface
1444.05	Female resurfaces
1444.35	First resting position with male and female on adjacent stems
1447.20	Female moves across to males stem
1448.26	Pair fly off in tandem

On 23 May the weather was sunny and warm and, at approximately 1433h, I noticed another pair on a Branched Bur-reed stem. I started filming at 1434h. The female was ovipositing and was already fully submerged, with the male immersed up to his thorax (Plate 1a). The male's movements attracted the unwanted attentions of a Pond Skater which came into the frame after about 2 minutes (Plate 1b). It moved close to the male's head and moved down his wings. At this point, 1437.02h, the male damselfly vigorously flicked his wings over the surface of the water in the direction of the Skater, causing it to retreat. At 1438.54h the male's head submerged, although his wings were still partly above the surface (Plate 1c, d). At 1440.39h the male was fully submerged and, at 1440.51h, the pair had reached their maximum depth (Plate 1e). At 1442.56h the pair was approaching the surface again and the male's head broke the surface at 1443.19h, having therefore been totally submerged for 2 minutes 40 seconds and with its head under water for 4 minutes 25 seconds (Plate 1f). Shortly afterwards, at 1444.05, the female resurfaced, having been under water for at least 11 minutes. Immediately

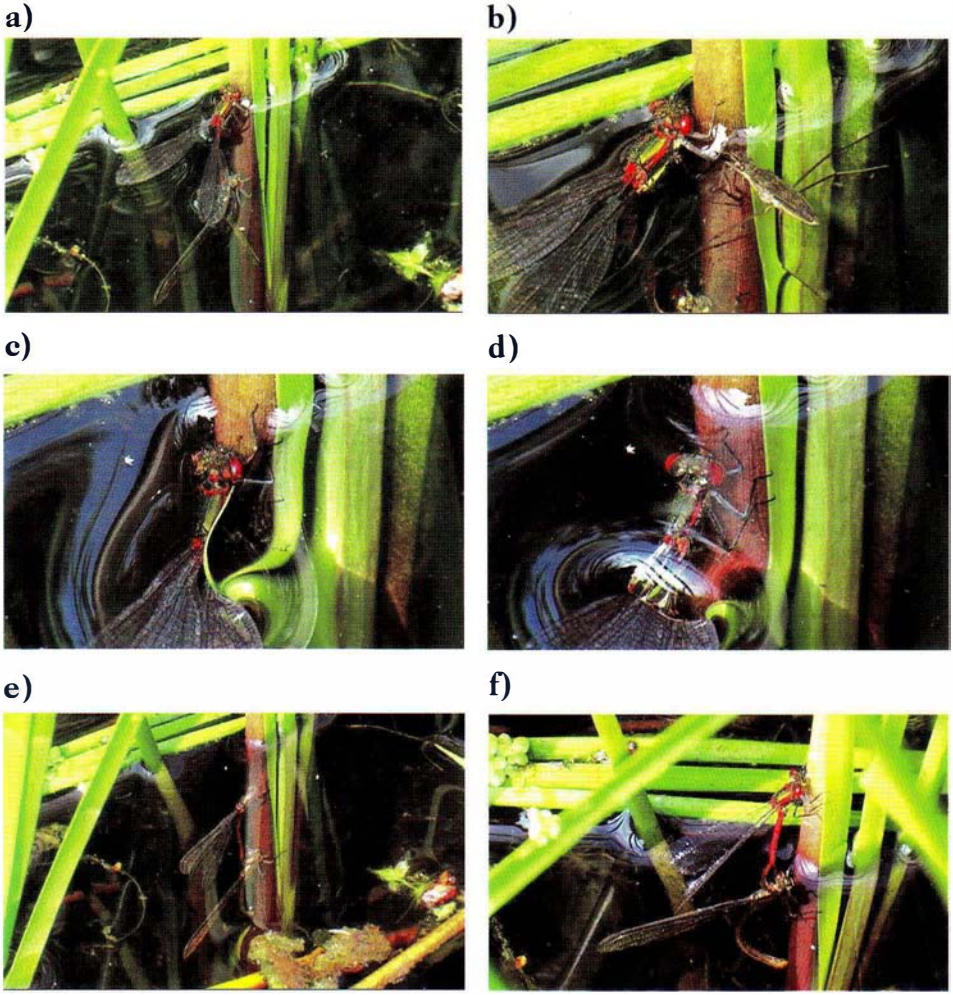

Plate 1. Submergence sequence of a pair of Large Red Damselflies *Pyrrhosoma nymphula*. (a) Female fully submerged (1435.41h), (b) Pond Skater disturbs the pair (1436.44h), (c) Male 1.5 secs before submergence (1438.52h), (d) Male 3 secs after submergence (1438.57h), (e) Pair at maximum depth (1440.51h), (f) Male emerged and female close to the surface (1443.39h).

after surfacing they perched on separate stems, though still in tandem. The female moved across to the male's stem before they flew off together at 1448.26h (Table 1). During filming of this sequence a second pair with the male also submerged was noted.

Discussion

My interest was raised by my initial observations on 11 May. I had no recollection of female Large Red Damselflies submerging whilst ovipositing and Starmore's paper (Starmore, 2008), recording the submergence of an ovipositing female Large Red Damselfly on the Isle of Lewis, made me realise that my observations on 23 May, which included complete submergence of not only the female but also the male, were more extraordinary than I had thought and worth reporting.

I have occasionally observed females ovipositing alone at my pond, even in the company of other pairs, with free males searching for mates. I would assume that this implies that in a small population contact guarding is not always necessary. I have never seen more than half a dozen pairs ovipositing with another half a dozen free males looking for mates.

Contact guarding is thought to provide a number of benefits, particularly to the male, including the male being able to ensure that the female lays eggs that have been fertilized by him (Corbet, 1999). It has been suggested that underwater oviposition may be a mechanism whereby the female improves her avoidance of unwanted male attention and thus further increases her chances of laying more eggs from the most recent mating (Cham, 2008). Complete submergence of one or both sexes may be more likely if the population density is very high and there are many unattached males looking for females (Cham, 2008). However, on 23 May, although I did not count the number of Large Red Damselflies at the pond, I do not think that the density was high. Thus, in a species in which complete female submergence is not thought to be common, let alone male submergence, this raises at least two questions:

1). Why did the female see the necessity to submerge and to stay immersed for over 11 minutes?

2). Why did the male follow and stay submerged for 4½ minutes?

Perhaps the occurrence of females submerging, and indeed males, is more frequent than has hitherto been noted.

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Emergence site selection in the endangered Southern Damselfly *Coenagrion mercuriale* in its UK stronghold, with observations on the Small Red Damselfly *Ceriagrion tenellum*

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Summary

Emergence site selection was compared between the Southern Damselfly *Coenagrion mercuriale* and the Small Red Damselfly *Ceriagrion tenellum* in one of the UK strongholds for the former species. The mean height of exuviae above water level was 3.64 ± 0.36 cm (n=74) for *C. mercuriale* and 2.35 ± 0.18 cm (n=68) for *C. tenellum*. For both species there was a significant difference between observed and expected (based solely on relative abundance) plant species used as emergence perches. The Common Spike-rush *Eleocharis palustris* and the Jointed Rush *Juncus articulatus* were used more, and Marsh St John's Wort *Hypericum elodes* less, often than expected. The national vegetation community in 13 cages was M29 i.e. *Hypericum elodes-Potamogeton polygonifolius* (Bog Pondweed) mire. Two other cages contained S19a and S19b which is *Eleocharis palustris* swamp. Broadly, suitable emergence habitat consisted of semi-submerged communities of *Hypericum elodes* (mean % cover 50 ± 4.4%), *Potamogeton polygonifolius* (mean % cover 5.8 ± 1.9%), *Eleocharis palustris* (mean % cover 19.2 ± 2.6%) and *Juncus articulatus* (mean % cover 3.2 ± 1.1%).

Introduction

The habitat of a species must meet the ecological needs of all stages of the life cycle and, for the Odonata, a group with complex life cycles involving both aquatic and terrestrial stages, habitat is especially complex. In the adult stage it must include provision for foraging, mate acquisition, oviposition and roosting. In the larval stage foraging (over a range of sizes representing each stadium), predator avoidance and emergence sites must be provided. The Southern Damselfly *Coenagrion mercuriale* is threatened throughout its European and North African range. It is listed in the EC Habitats and Species Directive and is one of four British odonate species to be classified as Endangered in the most recent UK Odonata Red List

(Daguet *et al.*, 2008). Thus it is a species with considerable conservation interest in the UK and, under the terms of the EC Habitats and Species Directive, there is a statutory requirement to monitor regularly its status. Rouquette & Thompson (2005, 2007) investigated adult habitat associations concerned with breeding and roosting respectively in the population surrounding the chalk-stream habitat of the Itchen valley. Roosting habitat has rarely been considered by other authors (Corbet, 1999). Purse & Thompson (2009) studied fine scale oviposition site selection by *C. mercuriale* in the more typical boggy stream habitat of its UK stronghold, the New Forest. The aim of the present paper is to provide data on habitat choice for emergence sites at the same scale as that provided for oviposition sites by Purse & Thompson (2009).

In a complementary study of emergence in *C. mercuriale*, Purse & Thompson (2003) attributed daily variation in emergence to both time in season and duration of sunlight on the day before emergence. In this study, emergence between cages stationed throughout prime *C. mercuriale* habitat in relation to a number of habitat variables was investigated. Larval damselflies usually emerge by climbing up plants so the 'plantscape' is likely to be important at this life stage, and the differential use of various plant species for emergence was examined.

Materials and Methods

The study took place from June to August 1999 at Upper Crockford, New Forest, southern England (50.796°N, 1.509°W). Nineteen cages were placed in the Crockford Stream on 9 June where they remained until 2 August. Each cage covered an area of $0.72m^2$ (dimensions 1.00 x 0.72 m) and consisted of a light, A-frame clothes-horse covered by transparent, fine mesh netting. The cages were open from the water for larvae to access, but prevented teneral adults from leaving.

The Crockford Stream is one of the most important sites for the Southern Damselfly *Coenagrion mercuriale* in the UK. It is also prime habitat in places for the Small Red Damselfly *Ceriagrion tenellum* (hereafter *Ceriagrion*) and data on this species are also presented.

To determine how emergence preferences differed between species and sexes and whether these preferences reflected the abundance of different plant species in the cages, the cages were checked daily. Exuviae were removed and preserved in alcohol and the following were recorded: plant species, cage number, whether the stem was in an area of discernible flow and the height of each exuvia above the water surface.

To survey the type of habitat used by emerging *C.mercuriale* and *Ceriagrion*, the area of water enclosed by each cage was treated as a quadrat. Within each quadrat, the following variables were measured: percentage cover of each plant species (determined at the end of the study); peat and water depths (mean of measurements at five positions); flow rate (using an electromagnetic flow meter) where depth was sufficient for measurement.

Results

For *Coenagrion mercuriale* 83.8% and for *Ceriagrion* 98.6% of exuviae were found in areas of discernible flow. The mean height of exuviae above water level was 3.64 ± 0.36 cm (n = 74) for *C.mercuriale* and 2.35 ± 0.18 cm (n = 68) for *Ceriagrion*.

Chi-squared tests were used to compare the frequency of plant use for emergence with plant abundance. The mean percentage cover across emergence cages was computed for all plant species (Fig. 1) and was multiplied by the total number of exuviae to generate the expected frequency that each plant species would be used for emergence by each species. For both species, the difference between observed and expected perch use (Fig. 2a, b) was significant (Table 1; *C.mercuriale*; χ^2 = 285.84, 7 d.f., $p < 0.001$; *Ceriagrion*; χ^2 = 106.90, 7 d.f., $p < 0.001$). For both species the Common Spike-rush *Eleocharis palustris*, the Jointed Rush *Juncus articulatus* and Marsh St John's Wort *Hypericum elodes* contributed most to the total chi-squared value. The first two were used more often than expected and the last was used less often than expected for both damselflies.

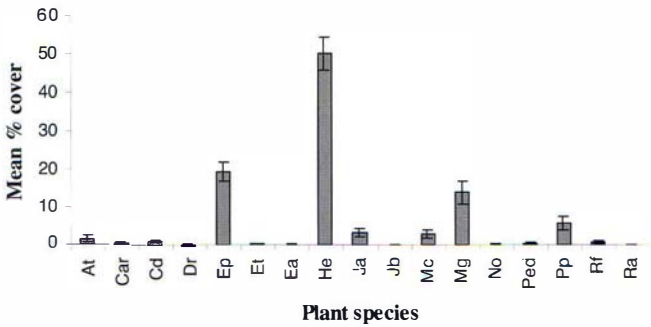

Figure 1 Mean (± s.e.) percentage cover of each plant species in all emergence cages. At - *Anagalis tenella*; Car - *Carex panicea* or *C.echinatum*; Cd - *Cirsium dissectum*; Di - *Drosera intermedia*; Dr - *Drosera rotundifolia*; Ep – *Eleocharis palustris*; Et - *Ericatetralix*; Ea – *Eriophorum angustifolium*; He - *Hypericum elodes*; Ja - *Juncus articulatus*; Jb - *Juncus bulbosus*; Mc - *Molinia caerulea*; Mg - *Myrica gale*; No - *Narthecium ossifragum*; Ped - *Pedicularis* sp.; Pp - *Potamogeton polygonifolius*; Rf - *Ranunculus flammula*; Ra - *Rhynchospora alba.*

Table 1. Chi-squared test of difference between observed (O) and expected (E) use of plant species for emergence: Cd=*Cirsium dissectum*; Ep=*Eleocharis palustris*; He=*Hypericum elodes*; Ja=*Juncus articulatus*; Mc=*Molinia caerulea*; Mg=*Myrica gale*; Pp=*Potamogeton polygonifolius.*

	Frequency of perch use					
	C. mercuriale			*C. tenellum*		
Species	E	O	$(O-E)^2/E$	E	O	$(O-E)^2/E$
Cd	1	4	9.00	1	2	1.00
Ep	13	28	17.31	12	36	48.04
He	35	1	33.03	32	5	22.78
Ja	2	23	22.05	2	10	32.04
Mc	2	4	2.00	2	0	2.00
Mg	9	10	0.11	9	4	2.78
Pp	4	0	4.00	4	6	1.00
			$\chi^2 = 285.84$			$\chi^2 = 106.90$

The frequency with which plants were used as emergence perches was compared between *C. mercuriale* and *Ceriagrion* using a chi-squared test including only the five plant species used by both damselfly species (to eliminate the problem of low expected values). *C. mercuriale* and *Ceriagrion* were significantly different in their use of these five plant species ($\chi^2 = 11.429$, 4 d.f., $p = 0.002$). *Coenagrion mercuriale* used *Juncus articulatus* and *Eleocharis palustris* most frequently whilst *Ceriagrion* used *Eleocharis palustris* primarily (Fig. 2a, b).

It is possible to describe suitable emergence habitat qualitatively. Mean water depth (across cages) was 6.73 ± 6.70 cm and mean peat depth was 22.93 ± 8.24 cm. The national vegetation community in 13 cages was M29, i.e. *Hypericum elodes-Potamogeton polygonifolius* (Bog Pondweed) mire. Two other cages contained S19a and S19b which is *Eleocharis palustris* swamp. Broadly, suitable emergence habitat consisted of semi-submerged communities of *Hypericum elodes* (mean % cover 0 ± 4.4%), *Potamogeton polygonifolius* (mean % cover 5.8 ± 1.9%), *Eleocharis palustris* (mean % cover 19.2 ± 2.6%), *Juncus articulatus* (mean % cover 3.2 ± 1.1%) and Sedge *Carex* sp.

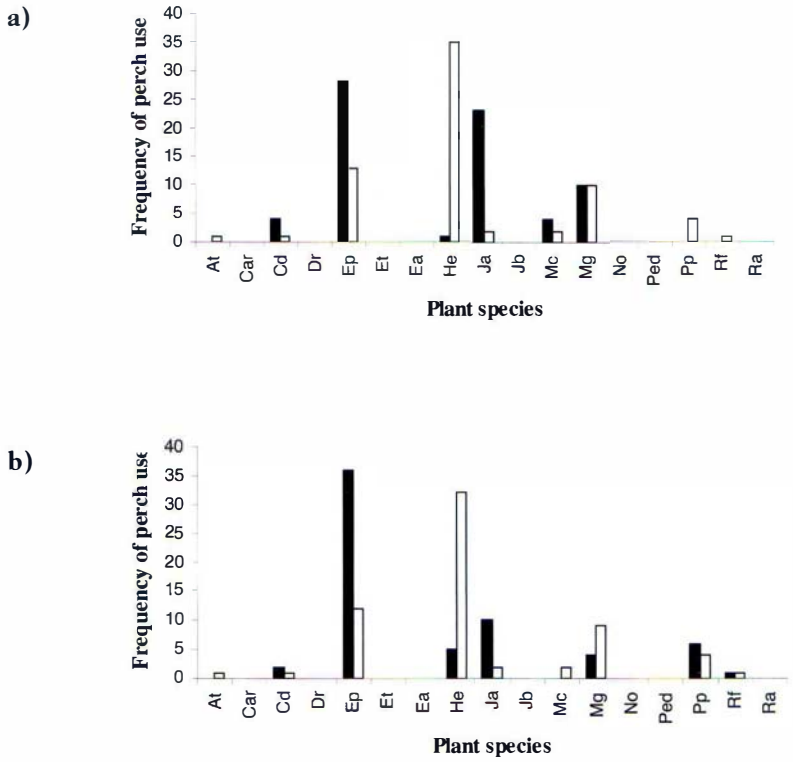

Figure 2 Observed (closed bars) and expected (open bars) % frequency of perch use by a) *Coenagrion mercuriale*; b) *Ceriagrion tenellum*. At - *Anagalis tenella*; Car - *Carex panicea* or *C.echinatum*; Cd - *Cirsium dissectum*; Di - *Drosera intermedia;* Dr - *Drosera rotundifolia*; Ep – *Eleocharis palustris*; Et - *Erica tetralix*; Ea – *Eriophorum angustifolium*; He - *Hypericum elodes*; Ja - *Juncus articulatus*; Jb - *Juncus bulbosus*; Mc - *Molinia caerulea*; Mg - *Myrica gale*; No - *Narthecium ossifragum*; Ped - *Pedicularis sp.*; Pp - *Potamogeton polygonifolius*; Rf - *Ranunculus flammula*; Ra - *Rhynchospora alba.*

Discussion

Coenagrion mercuriale and *Ceriagrion* both emerged in upright positions usually in the morning. Final instar larvae of *C. mercuriale* leave the water by ascending emergent vegetation in shallow water rather than by walking onto shore as has been seen in some other zygopterans. The mean exuviae heights for *C. mercuriale* and *Ceriagrion* are consistent with, if a little lower than, those of other zygopterans, i.e. <10cm from the water surface (Corbet, 1999) though exuviae of *C. mercuriale* were found at 15cm above the water in Baden-Württemberg (Sternberg *et al.*, 1999). It is unclear whether differences in emergence height reflect differences in vegetation height between the two studies.

C. mercuriale and *Ceriagrion* differed in the plants chosen as emergence perches. *Eleocharis palustris* was used most frequently but *C. mercuriale* used *Juncus articulatus* as well. *Hypericum elodes* was the most abundant plant but was rarely used as an emergence perch (see Parr & Parr, 1979), whilst *Eleocharis palustris* and *Juncus articulatus* were used frequently despite their low abundance. *Hypericum elodes* is soft stemmed, with thin cuticular layers lacking in collenchyma and is thus less able to resist movement due to wind and water flow. The large leaves probably represent obstructions to soft-bodied tenerals. *Eleocharis palustris* and *Juncus articulatus* make effective perches since they have rigid upright stems (with collenchyma) which resist movement. The existence of common physical properties shared by plant species used for emergence suggests that the species are used as direct cues in habitat selection. In south-west Germany, exuviae were found on Bog-rush *Schoenus* sp., Blunt-flowered Rush *Juncus subnodulosus*, Alpine Rush J. *alpinus*, and *Carex* spp. (Buchwald, 1989). However, on other German sites emergence perches for *C. mercuriale* included semi-emergents such as Lesser Water-Parsnip *Berula erecta*, Bittersweet *Solanum dulcamara*, Water Mint *Mentha aquatica* and Watercress *Nasturtium officinale* (Sternberg *et al.*, 1999) rather than being restricted to rigid emergents. In Britain, Winsland (1997) stated that any suitable emergence support is used including the stems of grasses and rushes. The contrast between plant species preferred for oviposition such as *Hypericum elodes* (Purse & Thompson, 2009) and emergence bears testimony to the multi-faceted nature of suitable habitat for these and other odonate species, or indeed other organisms with complex life cycles.

Habitat that was broadly suitable for emergence of *C. mercuriale* was unshaded, shallow, open, and slow flowing (between 0.01 and 0.30m/s) and had floating mats of *Hypericum elodes, Potamogeton polygonifolius, Eleocharis palustris, Juncus articulatus*, and *Carex* spp. corresponding to community M29. This community is often found in wet heath-valley mire transitions in situations of fluctuating water levels

(Newbould & Mountford, 1997).

In conclusion, this investigation of the proximate cues used for habitat selection revealed several habitat features to be required by *C.mercuriale* for emergence in its prime habitat in the New Forest, i.e. open, unshaded stream sections that are shallow and slow flowing with some areas of peat substrate. Such sections should contain abundant aquatic vegetation, including both herbaceous, soft-stemmed, perennial (and evergreen) submergent or semi-emergent species for oviposition (Purse & Thompson, 2009) and rigid emergent species for emergence. Tussocks provide sheltered areas for oviposition and emergence.

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Species Review 2:

The Orange-spotted Emerald Dragonfly *Oxygastra curtisii* (Dale 1834)

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Summary

This review deals with *Oxygastra curtisii*, a dragonfly of the family Corduliidae which is locally common in the Iberian peninsular and France south of the 48° parallel. It is endemic to the western Palearctic. In northern Europe it is very local and was last recorded in the UK in 1963. It is the only southern endemic riparian dragonfly to have occurred in the UK and probably became extinct here by a combination of habitat degradation and the extreme winter of 1962/63.

Introduction

Oxygastra is a genus in the family Corduliidae. It contains only one species the Orange-spotted Emerald Dragonfly *O. curtisii* which is endemic to the Western Palearctic. *Cordulia curtisii* was discovered by J. C. Dale at Parley Heath near Bournemouth on 29 June 1820. Dale did not describe the insect until 1834 and was almost beaten to the post by J. F. Stephens who found and named the species *Cordulia compressa* in 1829. However, as Stephens failed to include any description with the name, the later Dale name survives (Chelmick, 1983). Between 1820 and the early 1830s, *O. curtisii* was thought to be endemic to the UK. However, it was then discovered in France and named *Libellula nitens* by Fonscolombe (1837). This synonomy was recognised and the genus *Oxygastra* was raised by Selys-Longchamps in 1870 who used the correct specific epithet raised by Dale; the unique features of the genus relating primarily to wing venation (Selys-Longchamps, 1870).

The Western Palearctic riparian fauna

Using Dijkstra (2006), the Western Palearctic fauna contains 53 species (approximately one third of the fauna) which are largely or entirely restricted to flowing water (riparian) habitats.

Table 1. Riparian dragonflies of the Western Palearctic categorised by family and region.

Family	Vernacular Names	Northern/Eastern			Southern		Overall Total
		total	endemic	**UK**	total	endemic	
Calopterygidae	Demoiselles	2		**2**	3	3	5
Euphaeidae	Odalisques	1					1
Coenagrionidae	Bluetails, etc.	1			4	3	5
Platycnemididae	Featherlegs	3		**1**	3	3	6
Aeshnidae	Hawkers	2			2	2	4
Gomphidae	Clubtails	13		**1**	7	6	20
Cordulegastridae	Goldenrings	7	5	**1**	1	1	8
Corduliidae	Emeralds				2	2	2
Libellulidae	Darters	1		**1**	1		2
Totals		30	5	**6**	23	20	53

In summary, 30 of these riparian species have a northern/eastern distribution, five of which are endemic to the region. In contrast 20 of the 23 riparian species that have a southern distribution are endemic. Only six riparian species occur in the UK all of which are of northern/eastern distribution. *Oxygastra curtisii* was recorded in the UK until 1963; it is the only southern riparian species to have occurred in the UK. Of even greater interest is that *O. curtisii* was originally described from UK material and for some years in the nineteenth century was thought to be endemic to the UK.

Description

O. curtisii is a small emerald dragonfly; with a body length of between 47 and 54 mm (Dijkstra, 2006) it is similar in size to species in the genera *Somatochlora* and *Cordulia*. However, in flight it is of a much more dainty appearance. The principal distinguishing feature from all other emeralds in our region is the yellow/orange spotting which runs the full length of the dorsal surface of the abdomen and from which derives the vernacular English name. The spots are rather variable and usually appear more prominently on females; the spots can usually be seen on the insects in flight. In the southern parts of its range there is little possibility of confusion with any other species since there is only one other southern emerald dragonfly, the Splendid Cruiser *Macromia splendens*, and this differs in both size and colouring from *O. curtisii*.

The newly emerged female shows the characteristic extensive yellow colourings to the wings (Plate 2) which reduce with age. The bronze green colouring of both thorax and abdomen dulls with age in a similar way to the Downy Emerald *Cordulia aenea*.

Plate 1. Newly emerged male of *Oxygastra curtisii.*

Plate 2. Newly emerged female of *Oxygastra curtisii.*

Plate 3. Adult male of *Oxygastra curtisii* in flight showing the distinctive blue eyes.

Plate 4. Pair of *Oxygastra curtisii* in copula.

Plate 5. Final instar larvae of *Oxygastra curtisii.*

Plate 6. Exuvia of *Oxygastra curtisii.*

The eye colour is typically dull brown in the newly emerged adult of both sexes (Plates 1, 2). As the insects mature so their eye colour develops bright green to greenish blue. Indeed, in flight the males appear to have rather blue eyes (Plate 3). The copulating pair shown in Plate 4 show the green eyes of the fully adult insect.

The larvae (Plate 5) have a typical cordulid appearance with a somewhat square head reminiscent of *Orthetrum* spp. (family Libellulidae). The overall length of the last instar larva is approximately 22 mm. The top of the abdomen is without obvious spines but with tufts of hair-like setae at the end of each segment. These tufts are diagnostic. The larvae and exuviae are usually easier to find than the adults.

Distribution

O. curtisii is a southern species endemic to the western Palearctic (Table 1). It is locally common in Southern France, the Iberian peninsular and in western and northern Italy. *O. curtisii* is given the status "near threatened" in the IUCN Red List (IUCN, 2009) with the added comment that the current population is stable.

Northern Europe

Lucas (1900) stated that *O. curtisii* is found as far north as latitude 48° and that "From its continental distribution we should hardly have expected it in England." Indeed, its occurrence north of the Loire and indeed north of the 48° latitude is very local and even today our knowledge of its distribution in this region is probably incomplete. However, there are good records from a number of sites (Fig. 1). Each of the rivers north of the 48° parallel (green line on map) with sites where *O. curtisii* occurs or has occurred are numbered in Fig. 1 and will now be described.

Germany (Fig.1 – 1) The original site in Germany for *O. curtisii* was the river Sieg (shown in green on map). The species was recorded here between 1940 and 1943; it disappeared as a result of habitat destruction. In 1999, *O. curtisii* was discovered quite by chance during a field camp on the River Our, which forms the border between Germany and Luxembourg. This population has been intensively studied during a species protection programme in 2005 and 2006 (Ott *et al.*, 2007).

Belgium and Northern France (Fig 1 – 2,3) River 2 (River Oerthe in Belgium) and 3 (River Meuse in France) both have established populations of *O. curtisii*. The population on the River Oerthe was rediscovered in 1976 (Dumont, 1977). These two rivers are reasonably close to the River Our in Germany (70 km River Ourthe and 90 km – River Meuse). Goffart (2001) describes how surveying of the River Oerthe was carried out using kayaks, with considerable success.

Rivers 1, 2 and 3 are in reasonable proximity to each other. However, they are far from the UK (300 km +). Only isolated records (Eindhoven in 1979 and Amiens in 1997) have been encountered between these rivers and the UK (Ott et al., 2007) (Fig. 1).

France, Marne & Aube (Fig 1 – 4) Records during the early 1990s marked the first appearance of *O. curtisii* in the departments of Marne and Aube. Regular records often of young individuals from the Marais St. Gond adjacent the river Marne indicate that *O. curtisii* is probably breeding in this area.(Coppa, 1992; 1995). There is an established population on the river Aube (Grand & Boudot, 2006).

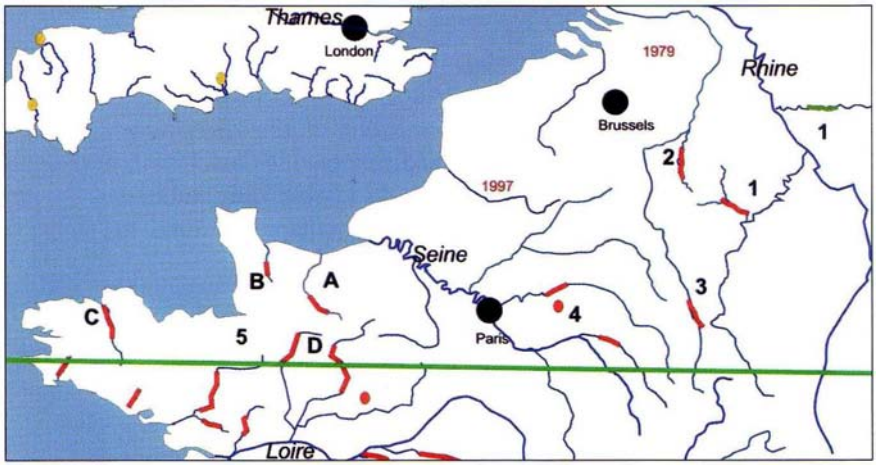

Figure 1. Some of the main rivers of northern Europe and, highlighted in red, those areas where *O. curtisii* is known to occur (Ott *et al.*, 2007). Historical UK sites appear as orange dots. Each of the rivers north of the 48^0 parallel (green line) with sites where *O.curtisii* occurs are numbered: 1, rivers Sieg (green) and Our, Germany; 2, river Oerthe, Belgium; 3, river Meuse, France; 4, rivers Marne and Aube, France; 5, river Orne (A), river Vire (B), rivers in Brittany (C) and rivers Mayenne and Sarthe (D), all in France. 1979 and 1997 refer to isolated records from Eindhoven, The Netherlands and Amiens, France respectively.

France, West of the River Seine (Fig 1 – 5) Each of the four rivers in this area is described separately:

A - *Orne* Lecocq (1995) stated that *O. curtisii* is fairly common in the Orne valley but that more work is needed to establish its distribution in this region.

B - *Vire* Elder & Fouillet (1998) recorded the discovery of *O. curtisii* in 1995. However, they speculate, from their observations over a number of years, that the species fluctuates greatly from year to year. They suggest further that work on the larvae and exuviae is necessary for a realistic study of the exact status of the species.

C – *Brittany* Greff *et al.* (2002) recorded *O. curtisii* from five river systems in Brittany. However, no specific information on strengths of populations etc. is provided. It must be considered from the data that *O. curtisii* is locally common throughout Brittany.

D – *Mayenne & Sarthe* In summary, *O. curtisii* has been recorded on the Sarthe since 1934 (Kerihuel, 1991) and fairly regularly on both rivers since 1990: on the Mayenne (Votat, 1992; 1993) and on the Sarthe (Machet, 1992).

The history of *Oxygastra curtisii* in the UK

Chelmick (1983) provided a detailed account of the discovery, naming and distribution of *O. curtisii* in the UK. In addition to this data I have now analysed the collections in the British Museum (Natural History) and tabulated the known information (Table 2). The localities/river systems mentioned in Table 2 are discussed in more detail:

River Stour and the Moors River The Moors River is a small tributary of the River Stour, which is one of the main rivers of Dorset reaching the sea to the north of Christchurch where it meets the River Avon, forming the estuary which is Christchurch harbour.

Between about 1900 (Fig. 2a) and the present day (Fig. 2b), perhaps the most striking feature is the spectacular reduction of heathland by increases in housing, forestry and industrial development since 1900. It is also important to emphasise that the remaining areas of heath (B. P. Pickess, pers.comm.) are much fragmented by further human activity.

An important aspect of the records (Fig. 2) is how few are close to the riparian habitat. The Goss Records (Goss, 1878, 1887, 1900) (the large green dot at the bottom of Fig.2a, b) are from Pokesdown, which was, in 1900, heathland. This locality was some 1.5 km from the River Stour and a considerable distance from the Moors River. Goss did not discover the exact breeding locality but he did produce a map (Goss, 1900) of his sites; now, alas, lost. Lucas (1930) noted that "Major R B Robertson and others captured [*O.curtisii*] in the neighbourhood of Pokesdown which was the only habitat in England." Lucas (1930) stated further that

Table 2. Details of all known UK Records for *O. curtisii*

Year	River System				Collector/ Observer	Site	Provenance
	Moors River	Stour	Tamar	Braunton Burrows			
1820					J C Dale	discovery on Parley heath	BMNH/ Fraser coll.
1831					Mr Curtis	near Heron Court	Lucas 1900
1834					Mr Cocks		Lucas 1900
1878					Mr Goss	Pokesdown	EMM 15 (1878)
1882		Visited but not found			Mr Goss	Pokesdown	EMM 1887
1886					Mr Goss	Pokesdown	EMM 1887
1890		?			Mr Goss	Pokesdown	EMM 1900
1900		Visited and prepared map			Mr Goss	Pokesdown	EMM 1900
1902						Pokesdown	BMNH. Gardner coll.
1905					Robertson	Bournemouth	BMNH. Gardner coll.
1906	?	?				Bournemouth	BMNH. Gardner coll.
1925						Sopley Common & Ramsdown	BMNH/ Fraser coll.
1941						Hurn	BMNH/ Fraser coll.
1945						Hurn	BMNH/ Fraser coll.
1946					Cynthia Longfield & AE Gardner	North of Hurn Airport	BMNH/ Fraser coll.
1946					OG Watkins	Gunnislake	Merritt *et al.*, 1996
1947						Hurn	BMNH/ Fraser coll.
1949						Hurn	BMNH/ Fraser coll.
1952					Gardner & Fraser	Hurn	BMNH/ Fraser coll.
1953						Hurn in heather	BMNH/ Fraser coll.
1954					N W Moore with F C Fraser	just north of Hurn	Moore 1991
1956						Hurn	BMNH. Gardner coll.
1957					N W Moore	territories Hurn to Pussex Common river becoming very overgrown leaving few adult	Moore 1991 & BMNH Gardner coll.
1958					No data		BMNH. Gardner coll.
1963					B P Moore		BMNH. Gardner coll.

"The probability is that the species breeds in the R. Stour..." The last Pokesdown record in the BMNH collection was from 1905 (possibly 1906). The Pokesdown sites have all been swallowed up by urban development which now approaches the very borders of the River Stour. The once extensive heathlands south of the river Stour have been completely replaced by housing (Fig. 2b).

After 1906 there is a time gap with records recommencing from 1925. *O. curtisii* was then recorded regularly (from 1941) until the final record of a collected specimen in the BMNH dated 19 July1963 taken by a B. P. Moore. Nearly all these records are of specimens taken a considerable distance from the river, which indicates a sizeable population. There is only one UK record of an exuvia taken from the Moors River but with no information relating to date.

Contrary to the statement made by Lucas (1930), all records from 1906 onwards were from or around Hurn village (large orange dot in Fig. 2a & b) which is adjacent to the Moors River. The area has been extensively developed as Bournemouth International Airport and makes for difficult access. Graham Vick (pers. comm) searched for larvae and walked stretches of the Moors River in the 1980s. Moore (1991) carried out a detailed search of the Moors River and some sites on the adjacent River Avon. Most recently Smith (1996) records detailed sampling of aquatic macro-invertebrates from 700 sites across the Wessex rivers including the River Stour and the Moors River. *O. curtisii* was not found by any of these surveys.

Devon – The River Tamar and Braunton Burrows The Braunton Burrows record of 1834 is very tenuous but was accepted by Lucas (1900). The only other Devon record was from the River Tamar at Gunnislake in 1946 (Merritt *et al.*, 1996). I have accessed correspondence between O. G. Watkins who made the find and R. Merritt. Mr Watkins writes as follows: "This was a completely lucky find...I sent my moribund sample...to Cynthia Longfield who was delighted to confirm the identification. At the time I saw two others in flight." No other specimens were ever found. According to Mr Watkins "several high powered entomologists appeared on the scene but did not see [*O.curtisii*]". John Cowley, one of Britain's leading odonatologists', remarked that the "quick runs and stickles" at Gunnislake were just right for the species.

Mr Watkins continued to search the area at least up to the mid 1970s. I visited the area in the late 1970s as did Norman Moore in 1973 and 1975. No further *O. curtisii* were ever found.

Habitat Requirements

Ott *et al.* (2007) provide comprehensive information on habitat requirements for *O. curtisii*; this is particularly relevant as it deals with the insect in Northern Europe at the edge of its range. The River Our (Germany) is a lowland river between 180 and 245 m above sea level (asl); the surrounding hills rising to 450 m asl. with strong flowing and slow current pool-like sections. The areas where *O. curtisii* occurs are heavily tree lined, particularly with Alders (*Alnus glutinosa*). There is no heathland in the adjacent areas which comprise agricultural fields, hedgerows and orchards where adults have been observed in copula.

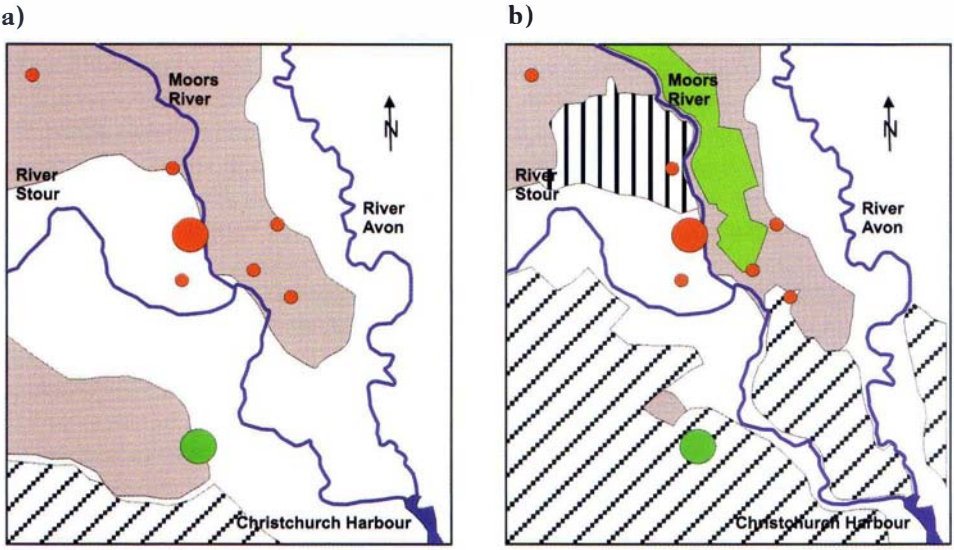

Figure 2. *Oxygastra curtisii* records superimposed on land usage in (a) 1897-1909 and (b) 2006. Land usage data based on the Ordnance Survey. ▨, built up area; ▥, airport development; ▩, forestry; ▩, heathland; ●, *Oxygastra curtisii* site records; ●, *Oxygastra curtisii* Pokesdown record.

Plate 7. A typical stretch of stream in southern Spain where *O. curtisii* breeds. The author is shown in the water giving some idea of its depth in mid summer.

Plate 8. A typical emergence site where exuviae would be found in southern Spain.

My knowledge of *O. curtisii* from France and Spain largely reflects the observations above; the principal requirement being deep slow stretches of river lined with trees/shrubs. In southern Spain even very narrow streams can be suitable, the prerequisite being that they are deep, slow flowing and permanent (Plate 7). The larvae particularly favour emergence sites on sedges growing immediately above the tree roots where the larvae live (Plate 8).

Adult Behaviour

Ott *et al.* (2007) recorded that in 2006 adult emergence on the River Our took place from 19 June to 16 July with 94% of the emergence taking place between 22 June and 7 July. The UK specimens in BMNH were recorded from 8 June up to 25 July, albeit that most specimens (76%) were taken between 29 June and 15 July.

The overall life span on the river Our (Ott *et al.*, 2007) was four weeks (eight days maturing and 20 days as a mature adult). Adult life in France is probably similar to this. However, in southern Spain the season is generally much advanced with the peak of adult activity in early June. This year I visited the River Hozgarganta near Gibraltar on 1 June and *O. curtisii* was abundant with pairs in copula, oviposition taking place and males holding territory even in most unlikely habitats. I revisited the same area on 18 June and there was no sign of any *O. curtisii* activity; indeed the riparian odonate fauna was almost all over. In summary, if you want to study river fauna in southern Spain go early in the summer.

Costa & Santos (1992) state that most corduliid species in South America fly at dawn and for that reason they are not easily seen by entomologists. In southern Spain, *O. curtisii* and *Macromia splendens* (both corduliids) exhibit similar early flight behaviour and are often the only dragonflies on the river until the sun rises above the hills and other species arrive. Male *O. curtisii* can be seen flying low along the banks of suitable rivers holding territories and in search of females. To northern observers the behaviour is similar to that of *Cordulia aenea* (Downy Emerald). In areas where there is a high density of males quite unsuitable stretches of stream and even isolated pools attract males, which often fly in short beats hovering often. Copulation usually takes place away from the river in trees. The females oviposit very quickly, often for only a few seconds, dipping their abdomens in suitable shady deep stretches of river. Males do not appear to accompany the females during oviposition. In my experience, *O. curtisii* does not move far from the river except to fly high into trees for copulation or to hunt in adjacent open land. I have had no observations further than 100 m from the river.

Life Cycle

The life cycle on the River Our is three years (Ott *et al.*, 2007). The larvae are restricted to tree roots and are found only in dense and strong roots of Alder (*Alnus glutinosa*) trees (in some cases Willow (*Salix* spp)). Larvae avoid roots covered with too much detritus. Exuviae are mostly found in dense vegetation (grass, flowering plants), on branches and on the bark of the alder trees. Exuviae were found between 200 mm and 800 mm above the water, although occasionally up to 2.0 m above the water. Exuviae were collected by walking in the water course. Only a few exuviae were found away from the water's edge (Ott *et al.*, 2007). Leipelt & Suhling (2001) found that the larval habitat for *O. curtisii* on three rivers that they studied in Southern France was almost exclusively amongst alder roots. My experience in southern Spain and France is that emergence is usually between 250 and 500 mm above water level, the larvae particularly favouring sedges. Corbet *et al.* (2005) in their review of voltinism in Odonata make no mention of *O. curtisii*. In my opinion, from collecting larvae, the life cycle is at least two years in southern Spain.

The significance of the larval stages in dragonflies and, therefore, the environment's impact upon the dragonfly, is very much understated. This is understandable as the adult insect is usually easier to observe and its habitat requirements would appear to be the most significant. In fact, the only purpose of the adult is to mate and find suitable substrate for oviposition; the significant development of the insect is in its larval stages.

According to Ott *et al.* (2007) the number of eggs laid by a female varies from 45 to 386. Taking the average as 200 and calculating biomass (taking account of even predation and the probable survival rates for adults), the total biomass of one generation can be expressed as:

- Larval biomass - 93.1%
- Adult biomass - 6.9%

With such an emphasis upon larval life the aquatic influences are of far greater importance to the survival of the species than those affecting the adult insects. The aquatic factors can be summarised as water quality and climate.

Water Quality

My own observations of *O. curtisii* in France and Spain are that it tolerates pollution levels very well. Perhaps the best example is the Rio Guadiaro in Southern Spain, which is badly polluted by sewage and pig farm effluent below the town of Ronda, leaving the river somewhat turbid in appearance and, unlike surrounding tributaries, devoid of human bathing spots much favoured by the local resident Andalucians. *O. curtisii* appears to thrive on this polluted river. In France I have witnessed *O. curtisii* ovipositing immediately downstream of village toilets with little left to the imagination between outlet and river. Clearly both of these examples are from the centre of distribution and may not be typical of populations at the edge of range.

On the river Mayenne in Northern France the known location for *O. curtisii* is 30 km downstream of a chemical works which pollutes the river. It is thought that *O. curtisii* survives because the pollution is sufficiently diluted (Votat, 1993). According to Ott *et al.* (2007) the water quality of the River Our in Germany is equivalent to our rating 1 B – very low contamination. However, significant amounts of effluent were registered during the course of the surveying on the Our with, apparently, little impact upon the population. Ott *et al.* (2007) stated that the installation of new sewage plants in the past has greatly increased the water quality.

Climate

The majority of populations of *O. curtisii* in Northern Europe occur within the 10°C annual mean air temperature contour (Steinhausen, 1970) (Fig. 3). Only three populations are outside of this boundary. Much of southern England is contained within this contour, suggesting that this area may be suitable for *O.curtisii*.

Bearing in mind that 93% of the biomass of *O.curtisii* is represented by the larval stages then overall annual temperature may not be as critical as winter air temperature and particularly the effect of the latter upon water temperature. Indeed the majority of the populations are within 50 miles of the 5°C mean February air temperature contour (Fig. 4) and east of the Seine *O. curtisii* is restricted to isolated populations. North of the Channel only the west of England falls within this contour.

Clearly the mean February winter temperature is significant and shows that very little of the UK, indeed only the rivers of the south west, would be suitable for *O. curtisii*. To illustrate this point, temperature readings (December 2008 to March 2009 inclusive) were taken on Rio Genal (southern Spain), which is a breeding river for *O. curtisii*, and also on the River Frome in Dorset (Table 3). Temperatures

taken on these two rivers outside of the winter period show a much closer correlation. However the marked winter differences may well influence the ability of the larvae to survive during this period. Ott *et al.* (2006) stated that full temperature data was kept for the River Our during their study. However, I have been in contact with the authors only to find that the data has been lost.

The extinction and possible re-discovery in the UK

The last record in the BMNH collections is a specimen labelled Hurn, Hants dated 19 July 1963 collected by B. P. Moore and in the A. E. Gardner collection. Even with the greatly increased number of observers since then there have been no confirmed sightings of *O. curtisii* in the UK since that date. The evidence, therefore, is that 1963 was the last year that *O. curtisii* was recorded in the UK.

Table 3. Winter river temperatures on the Rio Genal, Spain and the River Frome, Dorset, UK. Temperatures were taken monthly from December 2008 to March 2009 inclusive.

	Rio Genal, Spain °C	River Frome, Dorset, UK °C
Average	**11.3**	**7.2**
Lowest	8.6	3.7
Highest	14.9	10.1

The popularly accepted reason for the demise of *O. curtisii* on the Moors River is pollution (Chelmick, 1983). It is certainly of interest that the enlargement of the Palmersford sewage works in 1963 is coincidental with the year of this insect's demise; however, having now considered the Wessex Water Authority's version of events (Moors River, 1982) it would seem a somewhat harsh judgement.

In 1982 a day seminar took place to discuss the Moors River as a Site of Special Scientific Interest. In the report of this seminar (Moors River, 1982) Norman Moore stated that "[*O. curtisii*] disappeared in the mid 1960s when the sewage works at Palmersford were greatly enlarged." Mr A. Fouracre of the Wessex Water Authority also spoke at the seminar (Moors River, 1982) stating "..the Moors River with a water quality typical of a lowland catchment, supports a useful rod fishery for coarse fish..." As to water quality, Mr Fouracre stated "...the Palmersford Works ...where the effluent enters the river there is a marginal deterioration in quality. In particular the nitrate values could present a problem with...measurements taken at dry weather flow period almost doubling in value...Nonetheless, the river is still graded as 1B quality in the Palmersford area."

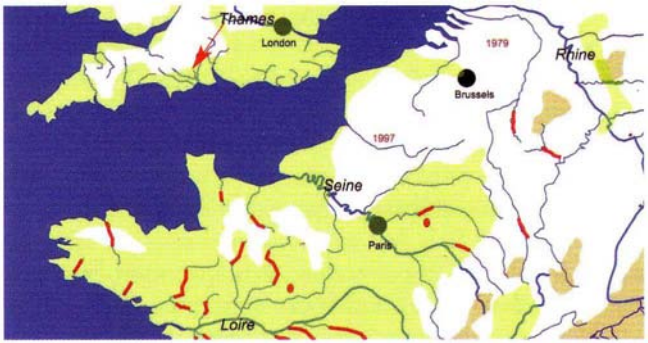

Figure 3. The area with a minimal annual mean air temperature of 10°C (green). Red arrow indicates the position of the Moors River. After Steinhauser (1970).

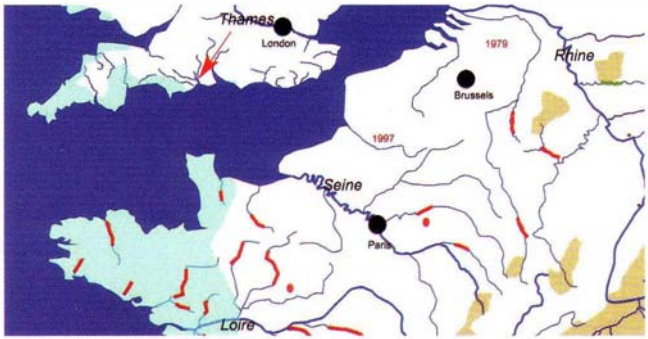

Figure 4. The area with a minimal February mean air temperature of 5°C (blue). Red arrow indicates the position of the Moors River. After Steinhauser (1970).

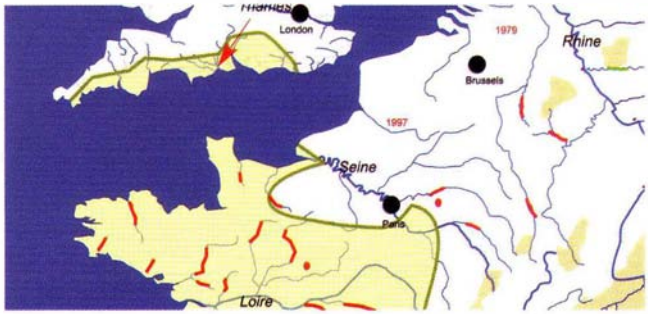

Figure 5. Records of *Oxygastra curtisii* in northern Europe (red) and the current distribution of the Dartford Warbler (yellow). Red arrow indicates the position of the Moors River. Data for the Dartford Warbler from Huntley *et al.* (2007).

Class 1B water is described as slightly lower quality than Class 1A but utilised for substantially the same purposes which are described as:

- water of high quality suitable for potable supply
- game or other high class fisheries
- high amenity value

In other words the water quality may have deteriorated slightly with the expansion of the sewage works but hardly sufficient to have any effect upon the invertebrate fauna. Indeed 1B is a similar water quality to that found on the River Our in Germany where *O. curtisii* has recently been studied (Ott *et al.*, 2007).

If pollution was not the main cause of the extinction, what alternatives are there? Norman Moore (1991) visited the Moors River in 1957 and stated that "trees shaded much of the river such that the amount of available habitat for territorial males was much reduced." When Moore re-visited in 1990 (Moore, 1991) the habitat situation had worsened to such an extent that *Platycnemis pennipes* (White-legged damselfly), a species strongly associated with open lowland rivers and found commonly on the Moors River in the 1950s, was absent. Smith (1996) did not record *P. pennipes* on the Moors River. I have made three trips to the Moors River this year and found no evidence of *P. pennipes* which, I can only conclude, has disappeared as a result of the shading and neglect of the river which is now largely unsuitable for *O. curtisii*. In addition to the greatly increased shading from trees there has been a very significant reduction in heathland which may have had an additional adverse effect upon *O. curtisii*.

The last *O. curtisii* to be taken in the UK was in 1963. Those amongst us of mature years will remember another very important event of that year, namely the winter of 1962 -1963. In southern England the snow and freezing conditions started on Boxing Day and did not improve until the end of March 1963. The Dartford Warbler (*Sylvia undata*), a bird that in the UK is found exclusively on lowland heaths, suffered a catastrophic reduction in its numbers in that year from 450 down to only 11 pairs surviving on a few Dorset heaths and in the New Forest (Bibby & Tubbs, 1975). A comparison of the northern European distribution of *O. curtisii* overlain with the current distribution of the Dartford Warbler (Huntley et al., 2007) is of interest (Fig. 5). The two species show considerable similarity of distribution throughout their geographical range. Could what happened to the Dartford Warbler in 1963 have affected *O. curtisii* similarly? Certainly there had been cold winters before 1962 but the severity of this winter combined with the degradation of its habitat may have meant that the depleted numbers of insects could not cope with the greatly reduced water temperatures and led to the extinction.

Could *O.curtisii* still be in the UK?

One of the fascinating aspects of *O. curtisii* in the UK is not that it is extinct but that it ever occurred in the UK at all. It is the only southern endemic riparian species ever to have occurred here and, in reality, over a period of at least 140 years (before 1820 to 1963) it was known from only a single river system and for most records only over a length of river of no more than 5 km (Moore, 1991). The second point is that, since its demise, there have been no further confirmed records, even of vagrants.

Part of the problem, of course, is that, as many observers have stated (Votat, 1993; Goffart 2001; Ott *et al.*, 2007), the best place to study *O. curtisii* in all its life stages is from the river. Despite the fact that most UK records are from adjacent heaths, this is not my experience as *O. curtisii* does not venture far from its breeding habitat. Throughout Europe rivers are poorly studied for their odonate fauna because of problems of access. Most observations are made from the banks and the use of boats and walking river beds is not common practice. Another problem is that even where rivers are accessible the use of boats is often forbidden, thus hampering study further. It is not impossible that *O. curtisii* survives in Britain in hard to reach stretches of south-western rivers. I would propose that perseverance of observers with the cooperation of riparian landowners could be highly productive. Even if *O. curtisii* were not discovered, the increase in knowledge of our riparian fauna could only benefit.

Acknowledgements

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Migrant and dispersive dragonflies in Britain during 2008

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Summary

The year 2008 was rather a quiet one for dragonfly migration in Britain, probably no surprise given the frequently unfavourable summer and autumn weather. A low level of immigration did however take place, especially during warmer spells in late July and early August. One or two species also appeared to show enhanced dispersal within Britain, whilst other interesting sightings probably related to the consequences of previous migration/dispersion events. The highlight of 2008 must be the discovery towards the end of the year of a female Winter Damselfly *Sympecma fusca*, apparently attempting to hibernate inside a house in south Wales. This represents the first record of the species for Britain, though its appearance had been anticipated.

Account of species

Notable sightings reported to the BDS Migrant Dragonfly Project during 2008 are detailed below; background meteorological information is from the Met Office (2009) and WeatherOnline (2009).

Sympecma fusca (Vander Linden) – Winter Damselfly

On 14 December a female of this species, which is known to hibernate as an adult (Dijkstra & Lewington, 2006), was found indoors near Neath in South Wales by Ms. R. Elliot. This is the first British record, though it is known as a vagrant to Jersey in the Channel Isles (Long & Long, 2000). Winter Damselfly occurs throughout much of southern and central Europe and, although scarcer and fluctuating at the northern fringe of its range, it is here currently expanding rapidly (Dijkstra & Lewington, 2006). Its appearance in Britain has thus been anticipated (Parr, 2005). Further details of this exciting record are given in Parr (2009) and Taylor (2009).

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

Following its first discovery in Essex during 1999 (Dewick & Gerussi, 2000), the range of this now breeding species has expanded considerably, apparently as a result of both internal dispersion and fresh immigration. Records now stretch as far west as Devon and as far north as Hull, East Yorkshire (Parr, 2007). During 2008 there was however little sign of further range expansion.

Aeshna mixta Latreille – Migrant Hawker

There were some limited signs of immigration onto the east coast of England during spells of hot weather in mid summer, with sudden increases in numbers reported from Scolt Head, Norfolk, on 31 July (NL) and from Sandwich Bay, Kent, on 6 August (SBBO). Numbers sufficiently large to attract attention were also noted at the North Kent Marshes during the first few days of August (KOS) and at Pegwell Bay, Kent, on 10 August (per RH). At least some of these apparent arrivals were associated with an increased abundance of Common Darter *Sympetrum striolatum*.

Anax sp.

An unidentified *Anax* with a green thorax and dull abdomen with a bright blue base was seen on St. Mary's, Isles of Scilly, on 16 October. The previous 10 days had seen very major arrivals of American birds to Ireland and western Britain (Batty *et al*., 2008), and there was speculation that, given this background and also the unusually late date, the dragonfly might have been a Green Darner *Anax junius*. The first European records of this American species had come from Cornwall and the Scilly Isles a decade earlier (Pellow, 1999). Views obtained were however rather brief and inconclusive, and the record has not been accepted by the Odonata Records Committee. Claims of one or more 'possible' Green Darners in County Galway, Ireland, were also made during the preceding fortnight, but again the identity of these individuals could not be confirmed (Nelson, 2008).

Anax imperator Leach – Emperor

Up to five were present on Scolt Head Island, Norfolk, on 30–31 July (NL), during a period of hot weather and south-easterly winds. The species is not resident here, and arrivals coincided with the appearance of other migratory/dispersive species such as Migrant Hawker *Aeshna mixta* and Common Darter *Sympetrum striolatum*.

Anax parthenope Sélys – Lesser Emperor

Particularly good numbers of *A. parthenope* were observed in Britain during 2005–2007, with sightings from over 60 sites in 2006 (Parr, 2008), but the year 2008 saw something of a reverse with only single figures recorded (though it is possible that a few individuals may have gone unreported). Records were received from the following sites: Luccombe, Isle of Wight, on 15 June (per SKJ); Sandwich Bay, Kent, on 12 July (GJB); Maxey Gravel Pits, Cambridgeshire, on 24 July (KD); Dungeness, Kent, on 27–28 July (PA *et al*.; at least two individuals); London Wetlands Centre, Surrey/Greater London, on 28 July (RBu); Combley, Isle of Wight, on 28 July (DD); Kenfig, Glamorgan, on 7 August (RP) and Shellingford Pit, Oxfordshire, on 15 August (SB). Most sightings likely refer to primary

immigrants, but a few could refer to British-bred individuals. At Maxey the species had also been noted in 2006 and 2007, with oviposition observed at least in the latter year, whilst records at Dungeness represent the 11th consecutive year in which *A. parthenope* has been reported from the area.

Libellula fulva Muller – Scarce Chaser

This species has been expanding its British range quite extensively over recent years (Parkes, 2009), perhaps primarily due to internal dispersal, though immigration from the Continent might potentially also be involved, particularly for south coastal areas. During 2008 there were several further records well away from previously known centres of distribution, though especially given that some sightings referred to recently-emerged tenerals, not all will necessarily have reflected movements made during the 2008 season. Sightings from new regions included singletons from two sites near Brading on the Isle of Wight (via DD), several from the River Ouse near Barcombe Mills in East Sussex (JL) and small numbers from Curry Moor in Somerset (RBi) and from the Attingham area of Shropshire (JB). The Shropshire records are the most north-westerly for Britain in the current era, though further north an isolated colony once existed in the Askern region of Yorkshire, with the last records in 1911 (Merritt *et al.*, 1996).

Orthetrum coerulescens (Fab.) – Keeled Skimmer

A mature female was photographed at Whelford Nature Reserve in the Cotswold Water Park on 10 July (IT). This sighting, in atypical habitat, is the first record for the Water Park and is some 20–30 km away from known sites for the species.

Sympetrum danae (Sulzer) – Black Darter

Internal dispersal within Britain was relatively noticeable during the year. Although the species is seen only very erratically in the counties, singles were nevertheless reported from Meridan, Warwickshire, on 18 August (RL), from Afton Down, Isle of Wight, on 22 September (SKJ) and from Hartlebury Common, Worcestershire, during September (per MA). One was seen near Marlborough, Wiltshire, on 22–23 August (IM), well away from previously known sites in the County. Elsewhere, a total of 19 individuals were recorded from coastal sand dunes in the Formby area of Lancashire during late September (PS). Although late season records of wandering individuals are not unusual from this area, this was the largest influx since 2004.

Sympetrum flaveolum (L.) – Yellow-winged Darter

One was seen at Canvey Wick, Essex, on 25 June (CW); this is earlier than the majority of British records and conceivably relates to a locally-bred individual, perhaps from a colony established during the big influx year of 2006 (Parr, 2007).

Later in the season three singletons were reported from the East Suffolk coast – from Corton and nearby Gunton on 14 August (RF) and from the Dingle Marshes on 20 August (PG).

Sympetrum fonscolombii (Sélys) – Red-veined Darter

Small numbers of individuals, frequently no more than singletons, were recorded from a scattering of sites in England during the spring and summer, with a peak of sightings in June. Counties involved included Cornwall, Devon, Hampshire, East Sussex, Kent, Essex, Suffolk, Norfolk, Derbyshire and Lancashire (Fig. 1). With sightings during 2007 of *S. fonscolombii* at several of these sites, and reports of breeding activity at some, many individuals would seem likely to have been locally-bred. Immatures were indeed noted at Lower Bruckland, Devon (KW) and near Lee-on-Solent, Hampshire (PW), and an exuvia was discovered at Rye Harbour, E. Sussex, on 30 June (SS). An additional, very low level of immigration however probably also took place, with some East Anglian records in particular being away from likely breeding sites.

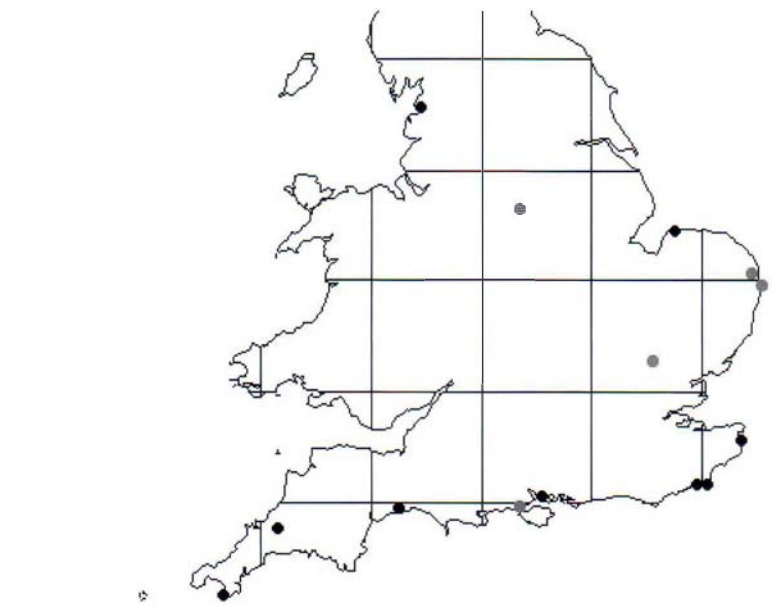

Figure 1. Distribution of British records of *S. fonscolombii* during 2008. Black dots: first sightings during the period 31 May - 1 July; grey dots: first sightings during the period 28 July - 15 August.

In keeping with the low-key events of the first part of the year, there were few late-season sightings. During August – early September, small numbers of immatures were however noted at Keyhaven, Hampshire (PW), suggesting that at this south coast site there may have been a successful autumn generation produced despite the generally poor summer weather.

Sympetrum striolatum (Charp.) – Common Darter

It was an uneventful year for the species with little sign of any large-scale movement, though sudden increases in numbers were noted at Scolt Head, Norfolk, on 31 July (NL) and at Sandwich Bay, Kent, on 6 August, the darters being accompanied by Migrant Hawker *Aeshna mixta*. At Bawdsey on the Suffolk coast a singleton was caught in a UV moth trap on 14 July with a further seven between 28 August and 24 September (MD); such individuals attracted to light are thought to often be migrants (Parr, 2006).

Conclusions

Dragonfly migration during 2008 was relatively low key, though hot spells during late July and early August in particular saw minor influxes. Some species, such as Black Darter *Sympetrum danae,* also showed good levels of internal dispersal within Britain, though the driving forces for this were less clear. Despite the quiet year, the overall pattern of migration remained the same as in the past two decades, with species having a predominantly southern distribution in Europe continuing to show well. Notable amongst these in 2008 was Britain's first ever record of Winter Damselfly *Sympecma fusca*, a species that seems likely to reappear in years to come given current trends in its European distribution and in the general climate.

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The map in this article was prepared using DMAP software from Dr. A. Morton.

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The Beautiful Demoiselle *Calopteryx virgo* (Linnaeus) in Northamptonshire: eastwards expansion & habitats.

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Summary

Northamptonshire is at the eastern limit of the range of *Calopteryx virgo* in the Midlands of England, making this population of regional importance. *C. virgo* is included as a Key County species according to key sites criteria (French & Smallshire, 2008). Historically, *C. virgo* in Northamptonshire has been limited to two river systems, the Rivers Tove and Cherwell, with its range showing few signs of expanding. However, since 2003, it has undergone a significant range expansion and is now recorded on six river systems, adding the Great Ouse near Brackley, the Leam, the Avon and the Nene to the list. While increased recording in the County over this time period will have undoubtedly contributed new records, this is mainly infilling, and a genuine expansion has been noted into new previously well recorded areas. This paper discusses this expansion using a series of dated distribution maps, and reviews the river habitats of all river systems with possible expansion corridors discussed.

Northamptonshire in Context

Figure 1 illustrates the records for *Calopteryx virgo* at 10km resolution for the UK up to and including 2008. It also shows the County boundary for Northamptonshire and the Soke of Peterborough (known as VC32), to set a context for this current study (Tyrrell *et al.*, 2006). Apart from a number of historical records from Leicestershire (Leicestershire & Rutland Dragonfly Group, 2009), and Norfolk (Norfolk Dragons, 2009), Northamptonshire is at the border of the eastern range of *C. virgo* in the Midlands of England, which extends in a diagonal line from Cheshire to Essex. This makes the colonies in the county potential pioneers for further eastwards expansion in this area.

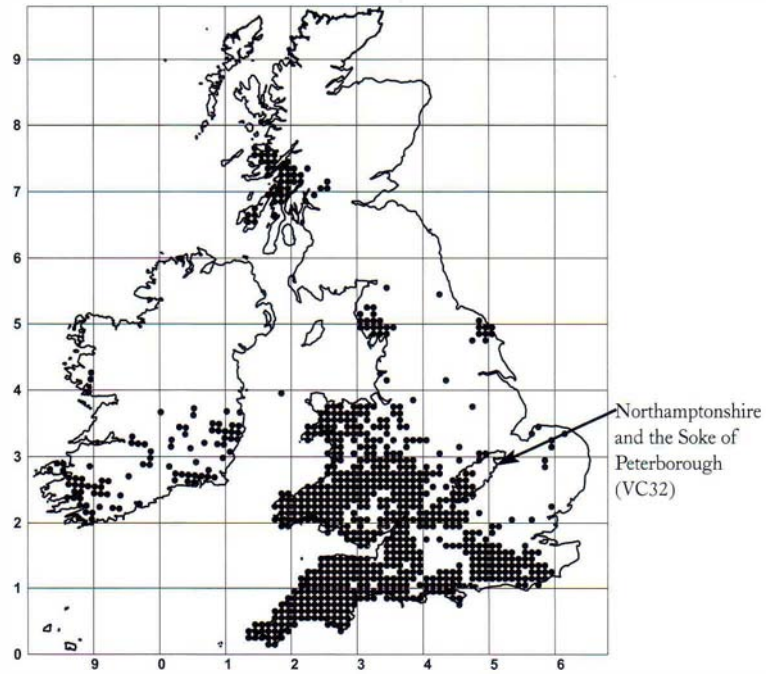

Figure 1. Northamptonshire and the Soke of Peterborough in the context of the UK distribution of *Calopteryx virgo*. The grid is the British National Ordnance Survey Grid 100Km squares.

Historical Status

Survey work for the first British National Atlas of Dragonflies (Merritt *et al.*, 1996), showed populations of the Beautiful Demoiselle *Calopteryx virgo* on two river systems in Northamptonshire, The River Tove west of Towcester and the River Cherwell east of Banbury. At this time, Odonata recording in Northamptonshire was not widespread and records concentrated on presence in 10km squares only. In 2003, a new recording scheme was established to generate increased records at 1km resolution, which began to show a more accurate picture of this species' presence on these rivers (Tyrrell *et al.*, 2006). Figure 2a illustrates the status of *C. virgo* up to and including 2003, corresponding to the start of this new recording scheme, which correspond to the records used in the national atlas (Merritt *et al*, 1996).

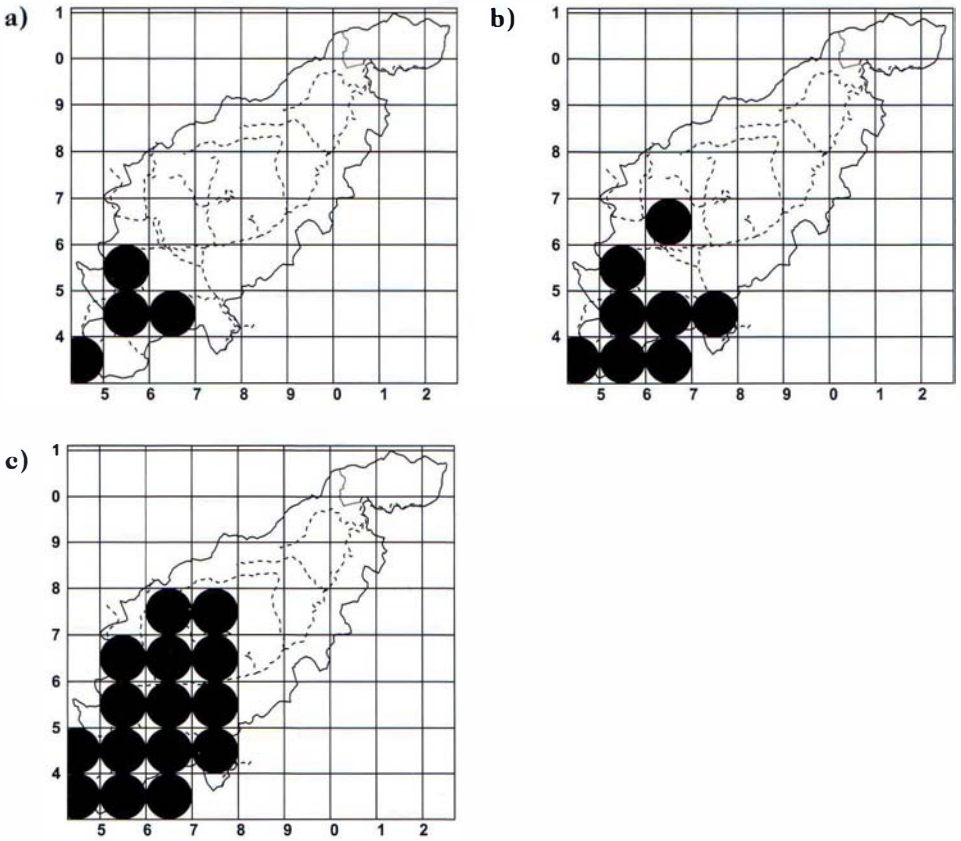

Figure 2. The distribution of *Calopteryx virgo* in Northamptonshire and the Soke of Peterborough (top right). The status (a) at the end of 2003, (b) at the end of 2006 and (c) at the end of 2009. The grid is the British National Ordnance Survey Grid 10km squares.

Expansion from The River Tove

The River Tove is a fast flowing gravelly-bottomed waterway flowing through arable fields. Many sections are tree shaded and show no presence of any odonates. In the downstream sections west of Greens Norton (British National Grid Reference SP687492), only *C. virgo* is present. As the habitat opens up, the river gains emergent vegetation and the reduced flow rates cause pooling of the water. This promotes the presence of several other species, including the White-legged Damselfly *Platycnemis pennipes*. At Greens Norton the Beautiful Demoiselle *C. virgo* can be seen alongside the Banded Demoiselle *Calopteryx splendens*. As the river flows through Towcester (SP685491), engineering work has significantly

reduced flow rates for the protection of housing and businesses and this has effectively presented a barrier to eastwards movement of *C. virgo*, although in some sections this engineering has increased flow rates giving *C. virgo* small pockets of suitable habitat through Towcester. Since 2003, *C. virgo* has been recorded in increasing numbers east of Towcester at Cappenham Bridge (SP715448), where breeding was proved in 2004. This section is faster flowing and provides more suitable habitat for *C. virgo* than the sections through Towcester. Following these records, *C. virgo* was recorded in other sections upstream of Towcester.

Small numbers have regularly been recorded at Burcote Wood (SP689465) between 2000 and 2008 which, although devoid of any flowing water, might offer suitable maturation habitat for adults dispersing from the river. In addition, other woodlands at Bucknell Woods Silverstone (SP652448) and Salcey Forest (SP7950) have had occasional individuals.

By 2005, records began to appear on the Tove where it meets the Grand Union Canal south of Northampton near Roade (SP749481). From here, in the same year, *C. virgo* had travelled north to Long Buckby (SP609657) (Nick Roberts, pers. comm.) where several adults have been recorded in small streams. It appeared the adults may have travelled up the Grand Union Canal and found these new, suitable habitats. Figure 2b illustrates the distribution at the end of the 2006 recording season.

In 2007, the Environment Agency (Richard Chadd, pers. comm.) collected *C. virgo* larvae from the River Nene at Newnham (SP579592), showing that breeding was already well underway on this river system. This prompted a survey along the Nene, where further adults were recorded at several sites up to and including Flore (SP633604). The River Nene between Newnham and Flore shares may of the characteristics of the Tove, with shallow, fast flowing, narrow streams, and bears little resemblance to the Nene further east which is wide, slow flowing, muddy and navigable and hosts significant breeding colonies of Scarce Chaser *Libellula fulva*. In 2009 (Fig. 2c) *C. virgo* had reached the Swan Valley M1 services area of Northampton (SP721586) and was subsequently recorded in many sections between Flore and Kislingbury (SP715594). It now occurs in many 1km squares from Newnham to Kislingbury, with scattered colonies further east. Records of single adults at Pitsford Reservoir (SP785705) (Phil Horsnail, pers.comm.) and the River Nene Brampton Valley Way (Jenny Wallace, pers. comm.) continue to demonstrate further attempts at expansion. It is believed that these individuals have all come from the River Tove colonies.

The Swan Valley sightings involved several individuals frequenting recently cleared

drainage channels associated with an area of industrial development. These canalised channels are shallow with slow moving, almost stagnant, water and are poorly vegetated. In this habitat the commonest dragonfly is the Broad-bodied Chaser *Libellula depressa*, the presence of which in such unfavourable habitat is believed to indicate pioneers dispersing eastwards along the river valley.

Regular sightings have been made since 2006 in Nobottle Woods (SP6863), a broad-leaved woodland some 3 km to the north-west of Northampton. This wood has only shallow and shaded drainage ditches that dry out most summers, with the nearest watercourse the Nene some 3-4 km to the south. Either these records indicate considerable dispersion each year or the species is surviving in atypical habitat.

The River Cherwell

The River Cherwell around Edgcote (SP5048) travels through arable fields, which are typical of the west of Northamptonshire, and shows similar characteristics to the Tove with very shallow, fast flowing sections, tree shaded areas and gravelly bottoms. This river flows from Northamptonshire into Oxfordshire near Banbury. The current database on the NBN Gateway (National Biodiversity Network, 2009) shows no direct-recorded link with colonies here and in Oxfordshire. As the Cherwell flows into Oxfordshire its characteristics do not change significantly although it does widen. Western stretches host Banded Demoiselle *C. splendens* and White-legged Damselflies *Platycnemis pennipes*, showing that the river base becomes muddier and flow rates are slightly reduced.

A large colony exists on the Cherwell around Farthinghoe Nature Reserve (SP518404), which possibly hosts the largest colony in the County (Tim Pridmore, pers. comm.). This branch of The River Cherwell flows across the Oxford Canal near Nell Bridge (SP4933), just inside the County boundary with Oxfordshire. The river joins the canal as a single channel and then flows out of the canal as two separate channels that join within 50-100 m of the canal. It is at this point that *C. virgo* is found on the canal. They have been recorded here since at least the 1980's. The main demoiselle on the canal is *C. splendens* as it is slow flowing, linear and muddy. The White Legged Damselfly *Platycnemis pennipes* is also recorded here, and further north it becomes the dominant species.

Other River Systems

In 2004, records began to appear on the River Great Ouse at Turweston and Whitfield, near Brackley (SP596373 and SP618393), on the border with

Buckinghamshire. The river rises near here from multiple sources, and in common with many rivers close to their source, it is shallow, narrow and fast flowing, and barely resembles stretches much further downstream. There are no clear colonies further downstream in Buckinghamshire, nor as the river re-enters Northamptonshire at Passenham (SP7739), near Milton Keynes, where it hosts *C. splendens* and *P. pennipes*, so these may represent westwards expansion from the River Tove or eastwards expansion from the River Cherwell.

A small section of the River Leam (SP532645) runs through the north-west section of Northamptonshire and *C. virgo* was recorded here in 2008, joining with colonies on this river in Warwickshire (Warwickshire Dragonfly Group, 2009). Again this stretch of river also supports *C. splendens* and *P. pennipes*,

Future Expansion Possibilities

Northamptonshire has many river systems that currently offer suitable stretches of habitat that could offer breeding sites to *C. virgo.*

The River Ise west of Kettering shares many of the characteristics of the Tove, Cherwell and faster flowing sections of the Nene. It rises near Naseby and is designated SSSI between SP860831 and SP860891 (English Nature, 1988). It is a tributary of the Nene, which may provide a dispersion route, or adults may find their way from the Long Buckby colony. *C. splendens* dominates on most sections and, south of Kettering at Wicksteed Park (SP884772), *P. pennipes* appears.

A single adult has already been recorded on the Brampton Valley Way (SP7153), the northern sections of which fulfil the habitat criteria and may be the next river colonised.

The River Welland forms the County border with Leicestershire and is dominated by *C. splendens* and *P. pennipes* (Tyrrell *et al.*, 2006). Further expansion up the Grand Union Canal may see adults reach this river in the future.

Willow Brook (SP99) is the most easterly river and again offers suitable habitat in sections close to its source. This is some distance from the nearest colony though.

Conclusions

Historically, the Beautiful Demoiselle *C. virgo* had a limited range in Northamptonshire, restricted to two fast flowing rivers close to their source, where it was the only species present. Over the last six years, an eastwards expansion has

been noted where this species appears to have jumped unsuitable stretches of these rivers to colonise sections exhibiting its favoured characteristics further downstream. At the same time, it has filled in the gaps between suitable sections and can now be seen sharing many sites with *C. splendens* and *P. pennipes*. This movement has also seen it find small streams and ditches that offer suitable habitat. Scattered records of individuals at sites well away from known colonies suggest that it may yet find additional streams further east in the county in which to breed, of which there are several possibilities.

Acknowledgements

The authors would like to thank Nick Roberts, Richard Chadd, Doug Goddard, Jenny Wallace, Darryl Sutcliffe and Phil Horsnail for additional records, and Steve Prentice for supplying the 10km data for the current UK status map shown in Figure 1. The distribution maps were plotted using Dr Alan Morton's DMAP software.

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Corrigenda

1) Unfortunately there was an editorial error in the paper by Ken Crick (Variations in key features of the final instar larvae and exuviae of the Azure Damselfly Coenagrion puella (Linnaeus)) in Volume 25 (1). The information regarding the shape of the labial masks of the two species was transposed. Please note the corrections (in blue) below:

- The stout setae on the lateral field of the prementum are a variable feature. Ignoring the relative length of the setae there are nine combinations. 48% of the specimens had five setae and 28% had four setae on each side of the centre line. The two specimens with 1+1 mimic the Small Red Damselfly *Ceriagrion tenellum* but the shape of the labium in this latter species is less tapered (Plate 5).

- The real value of the setae on the lateral field of the prementum may lie in the included angle formed by two notional straight lines projected through the follicles of the major setae. In all but one of the 173 specimens the included angle was between 80° and 90°

Plate 5. Underside view of the labial masks of the Azure Damselfly *Coenagrion puella* (left) and the Small Red Damselfly *Ceriagrion tenellum* (right).

2) On page 60 of Volume 25(1) the scientific name of the Vagrant Emperor should read *Anax ephippiger*.

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 format 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 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 2009.
- 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. 0. 1983. *The dragonflies of Great Britain and Ireland* 2nd edition (revised by R. Merritt). Harley Books, Colchester. 116 pp.

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

SCIENTIFIC AND ENGLISH NAMES OF BRITISH ODONATA

ZYGOPTERA	DAMSELFLIES
Calopteryx splendens	Banded Demoiselle
Calopteryx virgo	Beautiful Demoiselle
Lestes barbarus	Southern Emerald Damselfly
Lestes dryas	Scarce Emerald Damselfly
Lestes sponsa	Emerald Damselfly
Lestes viridis	Willow Emerald Damselfly
Sympecma fusca	Winter Damselfly
Coenagrion armatum	Norfolk Damselfly
Coenagrion hastulatum	Northern Damselfly
Coenagrion lunulatum	Irish Damselfly
Coenagrion mercuriale	Southern Damselfly
Coenagrion puella	Azure Damselfly
Coenagrion pulchellum	Variable Damselfly
Coenagrion scitulum	Dainty Damselfly
Erythromma najas	Red-eyed Damselfly
Erythromma viridulum	Small Red-eyed Damselfly
Pyrrhosoma nymphula	Large Red Damselfly
Enallagma cyathigerum	Common Blue Damselfly
Ischnura elegans	Blue-tailed Damselfly
Ischnura pumilio	Scarce Blue-tailed Damselfly
Ceriagrion tenellum	Small Red Damselfly
Platycnemis pennipes	White-legged Damselfly

ANISOPTERA	DRAGONFLIES
Aeshna affinis	Southern Migrant Hawker
Aeshna caerulea	Azure Hawker
Aeshna cyanea	Southern Hawker
Aeshna grandis	Brown Hawker
Aeshna isosceles	Norfolk Hawker
Aeshna juncea	Common Hawker
Aeshna mixta	Migrant Hawker
Anax ephippiger	Vagrant Emperor
Anax imperator	Emperor Dragonfly
Anax junius	Green Darner
Anax parthenope	Lesser Emperor
Brachytron pratense	Hairy Dragonfly
Gomphus flavipes	Yellow-legged Club-tail
Gomphus vulgatissimus	Common Club-tail
Cordulegaster boltonii	Golden-ringed Dragonfly
Cordulia aenea	Downy Emerald
Somatochlora arctica	Northern Emerald
Somatochlora metallica	Brilliant Emerald
Oxygastra curtisii	Orange-spotted Emerald
Leucorrhinia dubia	White-faced Darter
Leucorrhinia pectoralis	Large White-faced Darter
Libellula depressa	Broad-bodied Chaser
Libellula fulva	Scarce Chaser
Libellula quadrimaculata	Four-spotted Chaser
Orthetrum cancellatum	Black-tailed Skimmer
Orthetrum coerulescens	Keeled Skimmer
Crocothemis erythraea	Scarlet Darter
Sympetrum danae	Black Darter
Sympetrum flaveolum	Yellow-winged Darter
Sympetrum fonscolombii	Red-veined Darter
Sympetrum pedomontanum	Banded Darter
Sympetrum sanguineum	Ruddy Darter
Sympetrum striolatum *	Common. Darter *
Sympetrum vulgatum	Vagrant Darter
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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