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Front cover illustration of male *Leucorrhinia dubia* by S. P. Jones

Leucorrhinia dubia (Vander Linden) at Chartley Moss NNR, Staffordshire, in 1996

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The third consecutive year of studying *Leucorrhinia dubia* at a single site throughout its flight period showed differences from each of the previous two years, illustrating the danger of drawing firm conclusions from a single season, however extensive the recording.

This paper draws together the results of the three years and presents some new behavioural observations from 1996. Methods used are given in Beynon (1997), and the stages 1–4 of emergence defined in Beynon (1995). Chartley Moss and the main site for this study, Shooters Pool, were described by Bailey (1992) and by Beynon (1995, 1997).

Larvae

L. dubia is semi-voltine, at least at this latitude. The cohort which emerged in 1996 was thus predominantly from eggs laid in 1994, whose larvae will have enjoyed the extraordinary summer weather of 1995 during their major period of growth. This could partly account for the remarkable increase of about seventy per cent in the numbers emerging compared with the previous two years.

Libellula quadrimaculata L. likewise showed a huge, fourfold population increase. Its 1996 adults would also have made most of their larval growth in 1995. A considerable number of males (only) were of the form *praenubila*, not seen before on the Moss. The degree of colouring on their wings varied greatly. The occurrence of f. *praenubila* is possibly caused by high temperatures encountered in late larval stages. *Libellula depressa* L. numbers were lower than usual. There was no apparent change in the numbers of the other Odonata species which breed at the site.

Exuviae

Counts of exuviae not associated with active emergers are shown in Table 1. Exhaustive collection is inappropriate because of the nature of the substrate. Visual counting can be extremely accurate as *L. dubia* is the only Darter emerging at the pool until *Sympetrum danae* (Sulzer) begins towards the middle of July.

Early in May emergers were well inside the marginal Common Cotton-Sedge, *Eriophorum angustifolium*, but during the prolonged fine weather of 5–9 June and 14–19 June, exuviae were found in large numbers on the outermost leaves and stems bordering the free water-surface. This mirrored the situation during 5–8 May 1995 in equally hot conditions. During these periods larvae appeared to have chosen the first support encountered, and many had climbed higher than usual, about five per cent being between 15–25cm. In contrast to 1995, only one exuviae was found inland on the *Sphagnum* mat.

Table 1. Summary of the 1996 emergence of *Leucorrhinia dubia*, with observed numbers of individuals at different stages.

Numbered stages are explained in Beynon (1995). Time is BST at start of visit. Hours is duration of visit. X, M, C, P denote exuviae, maidens, cripples and predated individuals. p = present, not counted; e = estimate; ( ) = probably from day before; E = emergers counted; Total = actual or estimated number of emergers.

Date	Time	Hours	X	1	2	3	4	M	C	P	E	Total
12.05	1215	0.5										0
13.05			Emergence starts									2
14.05	1100	1.7	(2)	0	0	1	0	1	0	0	2	4
15.05	1145	0.7	(2)	0	0	1	0	0	0	0	1	1
16.05												e4
17.05												4
18.05	1045	1.1	3	0	0	0	(4)	0	0	0	(4)	0
19.05	1035	1.0	p	0	0	0	((3))	0	0	0	((3))	0
20.05	1020	1.0	0	0	1	1	0	0	0	0	2	8
21.05	0950	2.5	(3)	0	1	18	(2)	0	(1)	0	22	19
22.05												e15
23.05												e25
24.05	1230	1.5	5	0	0	14	2	2	0	0	18	29
25.05	1050	1.0	(5)	0	0	2	2	0	0	0	4	3
26.05												e10
27.05	1515	1.1	7	0	1	18	3	0	1	0	23	30
28.05	1010	1.0	3	1	1	14	1	0	(3)	0	17	20
29.05												e30
30.05												e35
31.05												e35
01.06	1130	1.3	8	0	0	0	11	2	1	1	10	e20
02.06	1045	1.5	37	2	4	23	10	8	(3)	0	47	e65
03.06												e50
04.06												e100
05.06	0925	2.8	246	3	14	48	49	32	8	4	153	e170
06.06												e170
07.06												e170
08.06												e120
09.06	0920	1.9	p	4	12	71	19	2	11	4	118	e130
10.06												e130
11.06												e30
12.06												e70
13.06												e100
14.06												e150

Date	Time	Hours	X	1	2	3	4	M	C	P	E	Total
15.06	1050	1.0	768	0	p	p	p	p	p	p		e100
16.06	0715	3.5	p	9	25	39	12	3	6	5	99	e140
17.06												e120
18.06												e30
19.06	0840	2.1	p	0	2	8	1	4	4	3	22	22
20.06												e20
21.06	0815	2.3	p	1	0	3	4	13	2	1	24	24
22.06	1115	4.5	BDS visit – no count made								1	1
23.06–27.06			5 x e10									e50
28.06–30.06			3 x e5									e15
01.07–02.07			2 x e0									e0
03.07	1530	1.0	13	0	1	0	1	0	1	1	4	4
04.07–05.07			2 x e5									e10
06.07	0845	2.0	13	1	0	1	0	1	0	0	3	e13
07.07	1020	1.0	29	0	0	2	0	1	0	1	4	4
08.07–12.07			5 x e2									e10
13.07	0925	1.4	13	0	0	0	1	0	0	0	1	1
14.07	0905	0.7	p	0	0	0	1	0	0	0	1	1
15.07–18.07			Emergence ends c.16.07									0
								Totals			583	e2319

Non-visit numbers are conservatively estimated, using neighbouring totals and relevant weather conditions. Although only 583 actual emergers were counted, if those seen from 15 June onwards are added to the exuviae count on that day, an absolute minimum of 927 is produced. Some Cs and Ps are from a previous day, as are some 4s, their maidening delayed by a late start or poor weather. This explains why the total on some days is less than the emergers counted. The best estimate for 1994 was 1356; that for 1995 was 1254.

With little wind or heavy rain until the last week of June, exuviae remained far longer *in situ* than in previous years. 768 were counted on 15 June. By the first week of July fewer than 20 could be found. After further emergence, but then heavy rain, only 18 were found on 13 July.

On 1 June a case was found 6cm up on a dead pine stump, 5cm in diameter, projecting from the waterlogged *Sphagnum* on the west edge of the pool. The only previous record of such an atypical support was a single emerger on the identical stump in 1994 (Beynon, 1995). On 5 June there were six cases on the stump, at heights of up to 16cm, and one at 25cm on a neighbouring stump. All except two on the first had disappeared by 9 June. Both were now inverted, and there were two new exuviae on it, one horizontal underneath a twig.

These examples, together with the characteristic clumping of exuviae on their usual supports, suggest that larvae leaving water may leave some trace which induces successors to choose the same stem. Apparently identical neighbouring supports have no exuviae.

Emergence

Weather, especially ambient temperature and sunshine, has a marked influence on dragonfly phenology from emergence onwards. At a given site this will cause variations in the date of the start of emergence, the period of maximum emergence, and the duration of the flight period. The thirteen day interruption in emergence in 1995 (Beynon, 1997) strikingly illustrates the effect of unsuitable weather.

In an average spring at Chartley, emergence begins towards the end of the second week of May, and continues for about nine weeks. The majority of the population emerges over a four week period. Early and late start dates since 1987 have been 2 May and 20 May. The duration in 1994/5/6 was 58, 68 and 65 days. In 1966 it began on 13 May, tapering off in the third week of June, with a few 'good' days later in very fine weather (Table 1). Like 1995, but not 1994, there was a clear morning peak. The last emerger was seen on 14 July. Emergence probably ended two days later.

In periods of good weather many dragonflies start emerging about 0700h BST, with a trickle of others as late as 1600h on the same day. On 14 June the day maximum temperature was 25°C; the night minimum 10°C. On 15 June, numbers had clearly begun to emerge at about 0630h when the temperature was already 16°C. Most had maidened by 1000h, and many were disturbed into second flights from the immediate surrounds of the pool. Near the end of the emergence period many exit the water later in the day. They have made slower growth than their earlier siblings and are perhaps less fit.

Generally the emergers maiden flight is within two to four hours of ecdysis, depending on the weather. Some exude a drop of straw-coloured liquid just before taking off for the first time. However, at any time during the emergence period, some of those starting late in the afternoon will delay maidening until the following day, when they can be identified by their much more advanced coloration. Several were seen on 31 May, and 4 and 19 June, and a few on other mornings. Poor weather occurring later in a day can have the same effect, as on 17 and 20 May. On 17 May, after a mild morning, it became cold and overcast in the afternoon (13°C). Four emergers seen on 18 May, when the maximum temperature reached only 14°C, were clearly from the day before and made no attempt to maiden. Three were still on their supports on 19 May, in a temperature of 10°C and with a stiff, cold breeze. All had reverted to closed wings and moved round to the lee side of their stems to reduce wind resistance. They had gone by 1030h the following day, but had taken at least 60 hours to maiden.

On 9 June, the crippled and dead emergers found were individuals which had started on 7 June, but had been overtaken by an intense thunderstorm late that evening. Wind is the major factor causing crippling, and pre-emergence larvae are reluctant to leave the water on windy days. They can and will emerge successfully in steady, light rain but calm conditions. Some continue to expand their wings, even when their abdomen tip or wingtips are still stuck in the exuviae. A stage 2 on 19 June did just that, and was found dead two days later still with its abdomen tip and three wingtips in the exuviae.

Clumping and even piggy-backing of emergers on the same stem is common. An extreme example was seen in 1996. A late stage 1 had been prevented from reaching stage 2 by

another larva clasping it at thorax level. When found, the stage 1 was dead and well coloured, but the second had emerged successfully. In every other piggy-backed group seen over three years, all appeared to have emerged successfully.

Predation

In contrast to 1995, only one exuviae was found inland of the marginals on the *Sphagnum* lawn, and no primary predation by the ants which live in the *Sphagnum* was recorded. Copulating pairs resting on the lawn often had numbers of ants crawling round them but no contact was ever seen. One corpse only was found in Round-leaved Sundew (*Drosera rotundifolia*) in contrast to both previous years. On 7 July this had been secondarily butchered by ants. In 1996 none was seen to be taken by aeshnids, nor was there any evidence of avian predation.

On 14 June a mature male was seen flying around the pool for some two minutes, dipping its abdomen into the water several times. After briefly perching, it flew around again for about 45 seconds and dipped its abdomen into the water four times in quick succession, before landing in the marginal *Eriophorum* once more. Close examination revealed a small spider attached to the abdomen tip, and it is assumed that the repeated dips were attempts to dislodge it. It remained perched for over an hour, and several photographs were taken. The spider was still in place when the observer had to leave (Graham Sutton, pers. comm.).

Predation of emergers by the wolf spider *Pardosa amentata* (Clerck) was minimal, and appeared to be opportunistic, rather than as it was in 1994. Predation by other spiders increased, particularly of adults by orb weavers. A majority of the victims of *Araneus diadematus* Clerck were copulating pairs, whose laboured flight perhaps makes them more vulnerable. All females of such pairs, both dead and still alive, had small masses of extruded eggs under their abdomens. *Tetragnatha striata* L. Koch builds a very open and more flimsy orb web than *A. diadematus*, and does not wrap its victims in silk. On 5 June a stage 2 was seen in difficulties at 0950h, apparently unable to extract its abdomen fully. At 1230h a female *T. striata* was feeding on it. Some of these spiders showed remarkable behaviour. On 9 June a female extracted a late stage 2 from its exuvial case on one of the two *Eriophorum* stems used as web supports, and carried it to the centre of its web. The spider was stimulated to investigate by the twitching of the emerger as it exited the case. On the same day, another *T. striata* was seen feeding on a stage 3, and another on a stage 1 which had not begun ecdysis. On 16 June at 0720h a female *T. striata* descended the stem it was on and climbed an adjacent one where there was an emerger just starting stage 2. The spider bit the emerger on the anterior dorsal surface of its thorax, and then climbed further up the stem. The emerger kicked and twitched a few times. When the spider descended a little later there was a large drop of liquid weeping from the wound, no doubt accelerated by the pumping which occurs during expansion. The spider then fed at the wound site. By 0915h the spider, like the one on 9 June, had extracted the emerger from its case and taken it up into its web. A much smaller male *T. striata* approached several times but was aggressively driven off. The female fed on the corpse over the next two hours. At 1000h another emerger began ecdysis immediately below the exuviae of the victim, reaching late stage 3 at 1115h, while the spider

continued to feed. It subsequently maidened successfully. On 21 June the same spider had clearly extracted another stage 1 or 2 and carried it into its web. All spiders seen feeding in this manner appeared to be females.

Predation of larvae was discussed in Beynon (1995).

Size of the *L. dubia* population in 1996

The best estimate of the population for 1996 was 2319; best estimates in 1994 and 1995 were 1356 and 1254 respectively. The increase of roughly 70 per cent can perhaps be partly attributed to the larger (c.11 per cent) parental population of 1994, but more to the beneficial conditions for growth occurring during the summer of 1995.

Leucorrhinia is slowly spreading to other pools at Chartley and so its population over the whole Moss is increasing. The total number of all nine anisopterans which emerge from this small pool of about 500 square metres area is noteworthy.

Adults

In an average spring, emergers take about three weeks to mature and return to water. In 1996 the first adult was seen on 1 June at a small pool 250m north of Shooters Pool where *L. dubia* also breeds. On 5 June at Shooters there were five mature males patrolling the margins. This gives a maturation period of 24 days, possibly 22 (1994: 6 June, 27 days; 1995: 6 May, 4 days). The contrast between 1995 and the other two years is another striking example of the effect of temperature and sunshine on development.

The flight period lasts between 13 and 14 weeks (1994/5/6: 90(96), 103 and 98 days). Again note the effect of the summer of 1995. In 1996 the last males seen were seven old, water-stained individuals on 6 August. The last of all was an old female in good condition on 18 August, 33 days after emergence ended (1994: 30(31), 1995: 36).

Early in the morning, adults leave their roosting sites in trees and bushes, which can be over 50m from the nearest pool. At 0800h on 19 June, a roosting male was comatose enough to permit touching; it was perched in a horizontal attitude 2m up on a vertical shoot of Alder Buckthorn (*Frangula alnus*). They prefer to settle on a pale background at ground level. This speeds up body warming through the extra reflected radiation. Birch logs forming paths through the Moss are much favoured. Here males are very tolerant of each other, often gathering in small, close groups. Only later at water do they begin to show territoriality, often as early as 0800h in fine weather. They return to the logs from time to time during the day except in very hot weather, and again become tolerant.

Males will approach maidens but seem to realise their immature state quite quickly, and retreat. The behaviour of copulating pairs has been described before (Beynon, 1995, 1997). In 1996 the first copulating pair, and the first female leaving after ovipositing, were seen on 9 June; the last copulating pairs, in numbers, on 27 July; and the last ovipositing female on 18 August. In fine weather copulating pairs can form as early as 0800h.

The effect of sunshine on adult Odonata is well known. When the sun comes out after cloud, large numbers appear as if by magic. If the overcast period has been prolonged copulating pairs of *Leucorrhinia* will form within seconds of the sun starting to shine.

A significant proportion of pairs separate in flight and inland. Most of the males then fly away while the females remain perched some distance from water, returning later to oviposit alone. Once more, weak non-contact guarding was shown by some males to their ovipositing females. On 16 June, a pair separated on the mat and the immature-looking female remained perched. The male chased away another male and returned to hover over the female. Three more times the male went away and back, sometimes hovering over and sometimes perching near the female. She eventually made four dips only before leaving high and undisturbed. Possibly she was too immature to have yet developed a normal sized batch of eggs. However, in general it seems that the female must begin ovipositing in order to elicit prolonged guarding by the male. Several cases of initially attentive males, sometimes chasing off others and returning to the perched female, ended with the male leaving the female still resting on the spot she had occupied since the wheel was broken. Other males fail to return from their first chase away. On 21 June, a pair separated and the male left the female resting on the mat and went and perched over 50cm away. Because of the intervening vegetation, the female was out of sight. After two minutes she began ovipositing and was now in view. The male immediately flew towards her and began guarding. Over the next few minutes the male chased off two other males, each time returning to hover over the female. On one of the occasions the female had moved some distance away, but the male searched for and found her, perching nearby while she rested. He then hovered over her when she restarted dipping.

A remarkable case occurred on 19 June when a female, left by her initial male, began ovipositing alone. She was immediately caught up by another male, but both fell upside down on to the semi-submerged *Sphagnum*. The male released his grasp and flew up, and the female half recovered and righted herself, but was still held by the meniscus. The male now caught her up again, lifted her clear of the surface, completed the wheel in the air, and the pair went away from the pool and down into the surrounding vegetation.

Even more remarkably, on 20 July a male caught up a female and the tandem pair fell on to the pool surface. The female was upside down with all four wings flat in the water, but the male was clear of the surface and trying to lift the female off. The disturbance the pair created attracted a second male which eventually grasped the original male, and together they managed to release the female. The triple then flew unsteadily away from the pool to land some 1.5m in from the edge, at the base of some birch scrub. A few seconds later a copulating pair flew up and perched in the birch, and a male, presumably the second involved, flew back to the pool. This was only the second triple involving *Leucorrhinia* seen in five seasons; it does not, of course, imply altruism by the second male.

On 6 August, one of the seven *Leucorrhinia* seen, all males, attempted to grasp a male *Sympetrum striolatum* (Charpentier) which landed close by.

On 19 June, in a very stiff breeze, a male caught a female dipping inside the *Eriophorum* band. She was making quite a noise as her wings struck the stems. They separated without completing the wheel and perched close to each other. The failure to complete could well have been because of the wind.

Females dipping alone do so surreptitiously, close to or within the marginals, and always into free water however small a patch. Many rest between bouts of dipping with their

abdomen tip just in the water. Although it is impossible to be certain, it appears that no ovipositing occurs during this resting period - certainly there is no flexing of the abdomen.

On 19 July a female was watched dipping uncharacteristically well out into the pool on the outer edges of the semi-submerged *Sphagnum*. Equally unusually, she dipped no more than two or three times before resting on the surface. This was repeated over fifteen times before a male came close and she fled away over the Moss. The mode of dipping and then stopping could reduce the chances of male interference since, while resting, the female is relatively inconspicuous.

In 1996 the last *L. dubia* seen was a female on 18 August. She dipped a few times before going well inland to perch. When disturbed she flew across the pool and dipped a few times in the semi-submerged marginal *Sphagnum* on the far side before quickly settling again in the fringing *Eriophorum*. At this late date the dipping did not appear to be purposeful.

Females after ovipositing leave in a characteristic fast steep flight (Beynon, 1995). This mode of departure has also been seen in *S. striolatum*, *S. danae*, *L. quadrimaculata* and, at other sites, *S. sanguineum* (Müller). It does not always prevent them from being caught again by a male, often flying up from a perch at ground level. Searching with binoculars will show many Darters, probably mostly males, flying around at heights of up to 60m in fine weather, and some of these will chase and catch departing females.

Behaviour not observed before was seen several times in very hot conditions in June and again in early July. Males participated in short but furious group-chases round the pool in close proximity to each other, sometimes attracting others up from the marginals. The numbers in a group varied from six to eleven and no females were involved.

Access

It is necessary to reiterate that access is by permit only; the Moss is an extremely hazardous site and is privately owned. People persistently entered without permission throughout 1996, putting in jeopardy not only their own safety but access by legitimate visitors.

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Migrant and dispersive dragonflies in Britain during 1996

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Introduction

In recent years there has been growing interest in dragonfly migration, to the extent that the documented sightings in a particular year may now start to give some sort of general reflection of the true nature of immigration in that year. This should allow great advances to be made in the understanding of the nature and wider significance of migration in the Odonata. The present article summarises the many observations of migrant dragonflies reported to the British Dragonfly Society/Odonata Recording Scheme migrant dragonflyproject during 1996. Although somewhat different in nature to the spectacular events which took place in 1995 (e.g. Silsby, 1996; Mendel & Marsh, 1996; Silsby & Ward-Smith, 1997), many of the events of 1996 were only slightly less dramatic. Thus this latter year saw a major invasion of *Sympetrum fonscolombei* (Sélys), a further record of *S. vulgatum* (L.) following the 1995 influx, and the first British record of *Anax parthenope* (Sélys). In addition to documenting these and other non-resident species, the present article also aims to draw together a number of interesting observations suggestive of migration in species with resident British populations. The potential migration of certain of these species is almost totally overlooked at present, and while some of the observations reported here could not be ascribed to immigration (or to long-range dispersal within Britain) with absolute certainty, it was deemed worthwhile documenting them so as to increase fieldworkers' awareness of all the possibilities.

Calopteryx splendens (Harris) – Banded Demoiselle

This species is not normally considered a potential immigrant. There have, however, been a number of interesting recent records. In particular, a male was found roosting in grass near the shoreline along with a small group of *S. flaveolum* at Sizewell, Suffolk, early on the morning of 2 August 1995 (Mendel & Marsh, 1996), during the start of the big *Sympetrum* influx of that year (Silsby, 1996; Silsby & Ward Smith, 1997). Although not conclusive, this and some other records from unexpected localities near the east coast, e.g. one at Gibraltar Point, Lincolnshire, on 4 August 1996 (via PHi), raise the possibility that *C. splendens* may occasionally reach Britain from continental Europe. More detailed observations at coastal sites, particularly those in the south-east, might clarify the issue. Certainly in 1996 the species showed enhanced dispersal within Britain, colonizing new sites on the Solway Firth (Clarke, 1997). Perhaps this might be a response to changes in water level resulting from the relative drought conditions of the last few years, and maybe a similar phenomenon on the Continent might be responsible for an occasional immigrant reaching our shores.

Aeshna mixta Latreille – Migrant Hawker

With this species having become such a common breeder in southern Britain, immigration can be difficult to detect though it is clear that it is still a common occurrence. One was observed coming in off the sea at Gibraltar Point, Lincolnshire, on 31 July 1996, and another was attracted to a UV moth trap at this site on the night of 6/7 August 1996 (KW). There were several late summer reports from areas close to or beyond the recognized NW limit (Merritt *et al.*, 1996) for the species in England, but it is perhaps most likely that these were largely of local rather than immigrant origin. Large numbers at Dungeness, Kent, during early October 1996 (with up to 300 on 4 October) coincided with an influx of *S. striolatum*, and no doubt included migrants (Attridge, 1997).

Anax imperator Leach – Emperor Dragonfly

During late July and early August 1996 the species was recorded from several east coast bird observatories at which it is not resident. At Spurn Point, Yorkshire, one was seen flying south on 26 July 1996, and a further three were noted flying south on 29 July 1996 (BS). Elsewhere, at the very northern limit of its range in Britain, Clarke (1997) reports a number of other unexpected sightings during 1996. While it is likely that most of these records relate to relatively local-scale dispersal, the possibility of immigration should not be ignored; the species has been considered as migratory on the continent, where, for example, there was a probable influx into the Netherlands during 1991, accompanying an arrival of *S. flaveolum* (Wasscher, 1992). Perhaps the best candidate for an immigrant is an individual seen at Spurn on 10 July 1996. This was only the second record of this species for the area (though note the subsequent records in 1996), and the individual concerned arrived in the company of a small group of *Libellula quadrimaculata* L. (again only the second site record) and the site's first *Orthetrum cancellatum* (L.) (BS). This coincidence of unusual records rather suggests an immigrant origin, especially since mid-July was a time of significant migrant activity and *L. quadrimaculata* is a known long-range migrant.

Anax parthenope (Sélys) – Lesser Emperor Dragonfly

A male of this south European dragonfly was recorded at Cinderford, Gloucestershire, on 13 June 1996 (Phillips, 1997), at the height of the massive influx of Painted Lady butterflies (*Cynthia cardui*) and smaller movements of other insects, including *S. fonscolombei* (see below) and other dragonfly species, that took place during June 1996 (Davey, 1997). This is the first British record of the species; fortunately it was found by an observer familiar with *Hemianax ephippiger*, to which it bears some resemblance.

Hemianax ephippiger (Burmeister) – Vagrant Emperor Dragonfly

This currently almost annual visitor was recorded once again in 1996, with a male found at the Caerlaverock WWT Reserve, Solway Firth on 3 November 1996 (DP). This represents the first autumn record since 1988. In recent years summer records have predominated, but

there is a clear suggestion that autumnal records may show some cyclical variation in frequency, due perhaps to changing rainfall patterns in the African part of the species' breeding range (Parr, 1996). A hawker-type dragonfly, seen very briefly during the third week of January 1996 in Reading, Berkshire (AD), could perhaps also have been *H. ephippiger* since it is one of the few that can occur even in mid-winter under normal circumstances (Parr, 1996).

Libellula quadrimaculata L. – Four-spotted Chaser

This species is well known for occasional enormous migrations (e.g. Corbet *et al.*, 1960). While major invasions continue to be recorded on the Continent, there have been few well-documented reports of anything unusual in Britain in recent years. This must, however, in part be due to many arrivals being overlooked. Careful research has revealed that a sizeable influx actually occurred in late May and early June 1963 (Burton, 1996). During 1996 only one observation of note was received. On the Spurn Peninsula, Yorkshire, a group of five individuals seen on 10 July 1996 was only the second site record. Numbers increased to eight on the following day, then gradually dwindled once again until the last on 19 July 1996 (BS).

Libellula depressa L. – Broad-bodied Chaser

In June 1996 the species was unusually common in a number of areas throughout Britain, and there were numerous reports of 'first records for site' from places as far apart as Suffolk and Yorkshire. Clarke (1997) also mentions a 1996 record from Staveley, near Ripon, which is well beyond the recognized range (Merritt *et al.*, 1996) for this species. Although the general abundance may in part reflect good breeding success following the glorious summer of 1995, it is likely that there was also an influx associated with the massive immigration of various insects (Davey, 1997) which occurred during June 1996. Thus at several sites there was a fairly close association between this known invasion and the appearance of *L. depressa*. For instance, in Suffolk on 8 June 1996, at the peak of the first wave of the insect arrivals in S./S.E. England (Davey, 1997), a garden in Lavenham held two *L. depressa* and a definitely immigrant Hummingbird Hawkmoth (*Macroglossum stellatarum*), both first site records (JT). Several other 'new' records for East Anglia also came from around this time period. Slightly later, unusually high counts of *L. depressa* were made in Cornwall on 19 June 1996, at a time when immigrant *S. fonscolombei* were arriving in the county (SJ), and further north at Wintersett, Yorkshire, the first record of *L. depressa* for the area on 25 June 1996 also followed a week after the arrival of the area's first *S. fonscolombei* (SD, MTh *et al.*). Coincident immigration of *L. depressa* and *S. fonscolombei* has been suggested to have occurred in the past (Mendel, 1992).

Orthetrum cancellatum (L.) – Black-tailed Skimmer

This is rarely considered as a potential long-range migrant, though on a more local scale its ability to colonize new areas is well known. Longfield (1937), however, suggested that the relatively few records from Ireland in the early part of this century might refer to occasional immigrants, and the current buoyant and expanding population in the British Isles means that it will often be difficult to detect a low level of immigration. During 1996 there were a number of interesting reports from both inland and coastal sites suggestive of either long-range dispersal or migration. Clarke (1997) mentions several sightings from Yorkshire, well beyond the range for the species shown by Merritt et *al.* (1996). At Dungeness, Kent, a small influx seemed to occur on 17 June 1996, with the peak count for the year being on this date, with mature adults being noted on the sea front, despite the first emergences of the local population being observed only two days previously (Attridge, 1997). Arrivals of migrant *S. fonscolombei* were noted in the area during 16–18 June, supporting a possible immigrant origin for some of the *O. cancellatum*. Later in the year, a record of a single from Spurn Peninsula, Yorkshire, on 10–11 July 1996, represented the first record of the species from this site (BS), and since the individual appeared simultaneously with several other locally notable species, including the known migrant *L. quadrimaculata*, an immigrant may well be involved. Indeed, as the only 1996 record of *O. cancellatum* from Landguard Point, Suffolk (another coastal site at which the species is only very sporadic) was on 9 July (NO), a general arrival may actually have occurred on the east coast around this period. In Cornwall, some 50 male *O. cancellatum* were seen at Marazion Marsh on 27 July 1996, whereas the normal level encountered here is typically only about 3–4 (SJ); possibly these too could have included migrants.

Sympetrum striolatum (Charpentier) – Common Darter

A male caught in a UV moth trap on the night of 30/31 July 1996 at Holkham, Norfolk (MTu) was the only early report of note, though a male *Sympetrum* seen arriving from off the sea at Gibraltar Point, Lincolnshire, on 31 July 1996 (KW) could perhaps also have been *S. striolatum*. A major invasion then took place during early October in the Dungeness area of Kent, with a count of 4000, including many individuals seen coming in off the sea, on 3 October 1996. Signs of immigration continued for the next few days, with 1000 still present on 9 October, but numbers declined rapidly after this (Attridge, 1997). This record extends observations documented in Parr (1996), and indicates that substantial, but often localized, arrivals of *S. striolatum* on the south-east coast of England may be quite regular in autumn.

Sympetrum vulgatum (L.) – Vagrant Darter

A female was photographed near Newtown, Isle of Wight on 4 August 1996 (BA), and remained in the area for three days. Was it possibly locally-bred, following the *S. vulgatum* influx of 1995, or is the species now a more common immigrant than once believed? Certainly there are reports that the breeding population in the Netherlands has increased in recent years (Merritt *et al.*, 1996).

Sympetrum fonscolombei (Sélys) – Red-veined Darter

A major invasion of this species occurred during June, with the first fully documented records being on 9 June 1996 and arrivals continuing over the following ten days. Another smaller group of sightings in early to mid-July perhaps represented a separate influx, and yet a further wave of immigration occurred in mid- to late August. With a total of some 50 individuals recorded from ten counties, this seems to represent the largest documented immigration since at least 1946, though it should be noted that dragonfly recording was at a low ebb during the 1960s when at least one major invasion of *S. fonscolombei* occurred in continental middle Europe (Lempert, 1987). The influx has been described in detail by Parr (1997); records are summarized below:

Berkshire – 1 site	Kent – at least 1 site
Cornwall – 5 sites	Middlesex – 1 site
Dorset – 2 sites	Norfolk – at least 2 sites
Hertfordshire – 3 sites	Suffolk – 1 site
Isle of White – 1 site	Yorkshire – 3 sites

Most records referred to singles or to small groups of individuals, a few larger (up to ten), male-dominated groups were also noted – some of which remained in one area for several weeks. Oviposition was observed at a number of sites, and in early September locally-bred individuals were found at two sites in Dorset (KD, EP), following the rapid development of eggs and larvae for which this species is renowned (Askew, 1988). A single freshly emerged female seen at Dungeness, Kent, on 18 August may also have bred locally (WA). McGeeney (1997) documents the main breeding record; at this site several hundred emergent insects were found (KD), though most rapidly dispersed from the general area. It will be enlightening to see if, and for how long, the current breeding colonies survive. With global warming it is possible that large scale invasions may become common enough, and breeding colonies survive long enough, for the species to become permanently established in Britain, even if not continuously at any one site.

Sympetrum flaveolum (L.) – Yellow-winged Darter

Following the dramatic influx of 1995 (Silsby & Ward-Smith, 1997), attention in 1996 was turned to looking for evidence of successful breeding, there being a possibility that the species might become permanently established as a breeder in this country. A single individual was noted in the act of emergence on 22 July 1996 at one of the Staffordshire mosses (TB), providing the first absolute proof of breeding for the species in Britain, though there is good circumstantial evidence that it has done so on several occasions in the past. Further teneral or immature insects were noted at this site over the next few weeks, and also during July or early August (earliest 6 July, Cornwall) at single additional sites in Cheshire (PHi), Cornwall (SJ), Dyfed (SC), Essex (unconfirmed), Lancashire (SF), Shropshire (via PHi), Staffordshire (PB) and the West Midlands (via PHi). Numbers of insects noted were generally very low, typically from one to five, though it is possible that some dispersing individuals

could perhaps have been overlooked. Larger numbers (possibly 40 or so in total), were noticed in the second half of August at inland sites in Norfolk, principally in the Broads (PHe). Some of these could perhaps have been fresh immigrants, there being signs of light immigration into Britain at this time, but their association with sites where ovipositing was observed in 1995 suggests that some may also have bred locally. Regardless of origin, heavy rains on the Norfolk coast at the end of August (75mm in 24 hours) seemed to kill off many Broadland individuals very prematurely, before reports of any breeding activity were received. Ovipositing was observed in 1996 near Sandwich in Kent, and also during early September in the Norfolk Brecks (AP), both sites having also supported *S. flaveolum* during 1995. The species may hence emerge again at these, and perhaps some other sites, in 1997, but in general the outcome of the 1995 invasion seems rather disappointing. Climatic factors acting on egg and larval survival are perhaps involved, but in addition the continuing relative drought of recent years may also have made many areas favoured by *S. flaveolum* during the initial invasion no longer suitable.

In contrast to 1995, there was apparently only a low level of immigration of *S. flaveolum* into Britain during 1996. Up to four males were reported during mid-August from a Cornish site where breeding was not expected (SJ), a handful of singletons were reported from the Dorset and Norfolk coasts during late August, and there was a sighting of an adult male from Gibraltar Point in mid-July (KW) which, although ovipositing was noted here in 1995, possibly also refers to a migrant since it occurred during a period of migrant activity. The origins of singles observed in Lancashire in late August (DT), Hertfordshire in early September (DS), and Suffolk in mid-September (via PHi) are currently unclear.

Sympetrum sanguineum (Müller) – Ruddy Darter

During early to mid-September 1996 the species showed well, with either unusually good numbers or records from new sites, in several regions in the west of England near to the current limit (Merritt *et al.*, 1996) of its range in this country – namely Cornwall, Cheshire and Lancashire. With an additional report of unexpectedly high concentrations at a site in Dorset at this time, it seems possible that migrants could have been involved, though the local breeding population is clearly also continuing to consolidate and expand (Smith, 1997).

Sympetrum danae (Sulzer) – Black Darter

A female was trapped in a UV moth trap on the night of 15/16 July 1996 at Poltesco, Cornwall (RH). The nearest known breeding site lies some 45km away (SJ), though it is quite possible that the insect originated from even further afield in Britain, or was of continental origin.

Discussion

The year of 1996 was in many ways as eventful a year migration-wise as 1995, with a major invasion of *S. fonscolombei*, a further record of *S. vulgatum*, and the addition of *A. parthenope* to the British list. British-bred individuals of both *S. flaveolum* and *S. fonscolombei*

were also noted during 1996, and close observations of the fate of these breeding colonies should give further insights into the factors which may influence the present and future European breeding distributions of these two species. Observations of some of the less unusual species have also been of great importance in 1996. Further evidence has been obtained for arrivals of *S. striolatum* on our east coast during autumn. These observations, when combined with literature records from further south in Europe (see e.g. Parr, 1996) of *S. striolatum* migrating in a south-west direction in late autumn, raise the possibility that this species shows a 'return' autumn migration in western Europe much as in the way some butterflies and birds do. The possibility that certain other species, most obviously *S. fonscolombei*, could behave in a similar manner clearly merits further investigation. In addition to these observations of known migrants, many records were received, principally from coastal sites, suggesting immigration by species normally regarded as resident. The migrant nature of such individuals can be difficult to prove, but the growing interest in dragonfly recording seems well on the way to providing the answers to whether immigration of such species is actually occurring. Maybe one day we will find that Britain is not such a closed island as is sometimes thought, and we will come to a fuller understanding of the dynamics of a group of insects many of which are potentially highly mobile.

Acknowledgments

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Obituary

Andrew Rodger Waterston O.B.E. (1912-1996)

With the death of Rodger Waterston, Scotland has lost one of its last great scholar naturalists – a distinguished figure, competent and confident to study and publish on the taxonomy and field biology of almost any group of the Animal Kingdom.

He was born at Ollaberry in Shetland, the younger son of James Waterston who became a distinguished entomologist with the Imperial Bureau of Entomology then, after war service, at the British Museum (Natural History). Childhood contact with some of the great names of entomology no doubt encouraged the development of Rodger's entomological interests and he read zoology at Edinburgh University, obtaining his B.Sc. with first class honours in 1934. With several others who were to have notable careers in biology, including Marie Elizabeth Campbell whom he was to marry in 1938, he participated in Edinburgh University Biological

Society's classic 1935 expedition to survey and record the fauna and flora of Barra. This led to Rodger's first odonatological publication, but before this he had published several papers (the first when he was only seventeen), mainly on molluscs.

In 1935 he joined the Natural History Department of the Royal Scottish Museum as an Assistant Keeper to work on the invertebrate collections, and he increasingly came to specialize in entomology.

At the outbreak of war, Rodger was seconded to the Ministry of War Transport until 1942, after which he served with the Royal Scots for a year. In the autumn of 1943 he transferred to the Colonial Office's Middle East Supply Centre in Cairo as Locust Officer and he took charge of the Palestine Anti-Locust Unit in Saudi Arabia. The need for locust control did not end with the war, and Rodger stayed on, travelling widely in the middle East, India and NE Africa to construct an operational framework for monitoring and controlling the pest. He was appointed Chief Locust Officer in charge of operations in the Middle East, Eritraea and Ethiopia in 1947, and from about that time until his return to Scotland in 1952 he was Entomological Advisor to the British Middle East Office and Attaché for Scientific Affairs at the British Embassies in Cairo and Beirut.

In 1952 he returned to the Royal Scottish Museum, becoming Keeper of Natural History in 1958 until retiring in 1973 (but retained for a further four years in a research capacity as Keeper Emeritus). This was a good period in the Museum, not just for entomology but for zoology as a whole. Rodger developed the collections, securing a number of important donations and bequests, improved their accessibility and exhibition, and brought in several new staff. He redirected much of his own entomological research interest from Hymenoptera and Hemiptera to Odonata and Neuroptera in response to a major bequest, the Kenneth Morton collection, that had come to the Museum during the war years and which needed and merited extensive curatorial work. Entomological contacts he had made overseas willingly collected material to develop these fine collections further and, mainly after his retiral, Rodger found time to publish, particularly on the dragonflies of the Middle East. His major study on *Cordulegaster* appeared in 1976 and other important publications about this time were on the fauna and ecology of the Outer Hebrides. As a co-editor of the Scottish Naturalist from just before the war and then again from 1983, he was involved in editorial standard-setting, and he did much as an advisory referee to help the Curwen Press and subsequently Harley Books to achieve their exceptional standards in entomological publication. In fact, blessed as he was with a superb memory and an eye for detail, a strong scientific contribution was made simply through the unstinting help Rodger was happy to give to others.

Although modest by nature, Rodger was an excellent raconteur with a nicely dry sense of humour. His wide intellectual interests and the respect in which he was universally held means that he will be deeply missed: the excellence of his life's work, however, is indelibly embedded in the zoological collections of the National Museums of Scotland and through them we shall continue to respect and enjoy him as a gifted naturalist and scientist.

Odonatological publications

Publications relating to Odonata comprise just a small and mostly later part of Rodger Waterston's contributions to zoology which extended from 1929 to 1990.

1936 (with J. E. Forrest). The fauna, Odonata: 273 *In* The natural history of Barra, Outer Hebrides: the results of a scientific expedition organised by the Biological Society of the University of Edinburgh, 1st to 14th July 1935. Eds Forrest, J. E., Waterston, A. R. & Watson, E. V. *Proceedings of the Royal Physical Society of Edinburgh* **22**: 241–296.

1939 Insects from Colonsay, South Ebudes. *Scottish Naturalist* 1939: 128–131.

1976 On the genus *Cordulegaster* Leach, 1815 (Odonata) with special reference to the Sicilian species. *Transactions of the Royal Society of Edinburgh* **69**: 457–466.

1979 (with A. V. Holden, R. N. Campbell & P. S. Maitland). The inland waters of the Outer Hebrides. *Proceedings of the Royal Society of Edinburgh* **77B**: 329–351.

1979 (with I. H. J. Lyster). The macrofauna of brackish and fresh water of the Loch Druidibeg National Nature Reserve and its neighbourhood, South Uist. *Proceedings of the Royal Society of Edinburgh* 77B: 353–376.

1980 Insects of Saudi Arabia: Odonata. *Fauna of Saudi Arabia* **2**: 57–70.

1981 Present knowledge of the non-marine invertebrate fauna of the Outer Hebrides. *Proceedings of the Royal Society of Edinburgh* **79B**: 215–321.

1981 The dragonflies (Odonata) of Dhofar. *In* The Scientific Results of the Oman Flora and Fauna Survery 1977 (Dhofar). *Journal of Oman Studies, Special Report* **2** (1980): 149–152.

1984 A new genus and species of platycnemidid dragonfly from the Arabian Peninsula (Zygoptera). *Odonatologica* **13**: 139–146.

1985 Insects of Sourthen Arabia: Odonata from the Yemens and Saudi Arabia. *Fauna of Saudi Arabia* **6** (1984): 451–472.

1990 (with A. R. Pittaway). The Odonata or dragonflies of Oman and neighbouring territories. *Journal of Oman Studies* **10** (1989): 131–168.

M. R. Shaw and R. R. Askew

The error in treating the Green Emerald Damselfly *Lestes viridis* (Vander Linden) as a British species

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The inclusion of the Green Emerald Damselfly *Lestes viridis* (Vander Linden) as a British species in the recently published atlas by Merritt *et al.* (1996) is an error which continues to persist in some national sources, e.g. in Hammond (1983).

The sole record on which British status has been afforded to this species is of a male

caught and correctly identified by E. R. Speyer in 1899. The specimen, at one time in the British Museum (Nat. Hist.) at South Kensington, was labelled as having been caught on 11 August at Shenley, Hertfordshire. This location is in the recording area of both the Hertfordshire Natural History Society and the London Natural History Society.

The record was first published in the section on Odonata contributed by A. E. Gibbs in Hopkinson (1911). No further mention of this record appears in the local literature until listed by Hodgson (1959). In notes to the county recorder for Odonata, R. Palmer, in September, 1939, and kindly copied to me by the late P. A. Kingsbury in 1975, B. Lloyd simply states that 'I believe that the species did not occur at Shenley'. The record is thereafter omitted in local lists by Palmer (1940) and Longfield (1949).

The re-publication of the record by Hodgson (1959) prompted Sage (1961) to investigate the matter further. The specimen could not be traced in the National Collection. However Bryan Sage was able to contact Speyer himself who was then working in the Natural History Museum. Speyer advised that during the summer of 1899 he collected in Belgium as well as Hertfordshire and considered it possible that a specimen of *Lestes viridis* was given a St Albans locality label in error. Further both W. H. Lucas and W. H. Kirby, who received the specimen at the museum, whilst confirming its identity questioned its origin.

In conclusion, whilst *Lestes viridis* has yet to be definitely recorded in Britain, its inclusion in Merritt *et al.* (1996) is but a minor error in the context of this excellent and very important work.

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Time-sharing in the male Downy Emerald, *Cordulia aenea* (L.) (Corduliidae)

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Introduction

In southern England, sexually active males of the Downy Emerald, *Cordulia* aenea (L.), are characteristically seen flying along the shore-line of woodland and tree-lined ponds. The low, rapid flight is periodically interrupted by bouts of hovering. When other males are encountered, fierce clashes ensue with the antagonists circling upwards until one is driven away. Throughout the day, males are frequently seen coming and going between the pond and the surrounding woodland. In the present study, we were interested to find out how often individual males were successful in inter-male conflicts and how long they remained at the pond. The observations were made in south-east England at Wake Valley Pond, Epping Forest, Essex where a large population of *C. aenea* is resident. The study is part of a larger project to investigate the ecology of *C. aenea* which we have been undertaking since 1992. Little has been written about the behaviour of *C. aenea* in Europe (for summaries see Robert, 1958; Schorr, 1990) but the ecology and biology of *C. aenea amurensis*, the Japanese subspecies, were investigated in detail by Ubukata (1973; 1975; 1980; 1984). Our results are compared with these studies.

Study site

All the observations reported here were made at Wake Valley Pond (TQ421987), in Epping Forest, south-west Essex. Epping Forest is situated to the north-east of London and is predominantly beech/oak woodland, with large areas of open grassland and many ponds. Wake Valley Pond is one of the larger ponds in the Forest and is roughly rectangular in outline, about 200m long and 55m wide, with a surface area of about 11,000m². There is a deep stream inlet in the north-western and north-eastern corners and a third inlet about half-way along the western bank. All along the banks there are numerous small bays. The pond supports a large population of *C. a. aenea* and is the principal population centre for the species in the Forest. The substrate of the pond is gravel overlaid with leaf litter. The pond is rich in submerged, floating and emergent vegetation and has extensive bankside tree-cover of oak, sallow and alder.

Methods

Males were captured and, using acrylic paint, were marked on the wings with a series of unique coloured spots. The marking methods will be described fully in a later paper. Over

fifty individuals were marked in this way in the five weeks preceding the study. The markings were large enough to ensure that each male could be distinguished from other marked males whilst in flight. Most of the observations reported here were made between 11.10h and 15.37h on 2 July 1994. The study area was at the northern end of the pond in a small bay enclosed on three sides by *Phragmites* stands and bank-side trees. Conditions were humid, warm and sunny.

Observations

R11 refers to an individual marked as number 11 with red paint. Similarly, Y8 is an individual marked as number 8 with yellow paint and Or10 is number 10 marked with orange paint, and so on.

11.10 R11 already occupying bay.

11.11 R11 leaves. Bay vacant (for 14 minutes).

11.25 Y8 occupies bay. Successfully defended 7 times against unmarked males and once against Or10. Patrolling flight path of Y8 overlaps with the flight path of another (unmarked) male holding an adjacent bay. Both frequently clash but return to respective patrol areas.

11.36 Y8 leaves (after 11 minutes).

11.37 Or10 occupies vacant bay. Successfully defends bay twice against unmarked males.

11.45 Or10 leaves (after 8 minutes), vacant bay immediately occupied by Or6. Successfully defends bay against seven unmarked males and also chases male *Libellula quadrimaculata* and *Anax imperator* which intrude into flight space.

11.54 Or6 leaves (after 9 minutes).

12.00 Or6 returns. Chases off R11 during occupancy of bay.

12.05 Or6 leaves (after 5 minutes) and bay occupied by R11.

12.14 R11 leaves bay (after 9 minutes) after successfully defending bay five times against unmarked males.

12.14–12.31 Observations made at other bays along west bank of pond which were being held by males but none of the marked males seen previously were noted.

In the observations that follow, the duration that the bay was held by a marked individual was noted but not the number of times the bay was successfully defended. Nevertheless, clashes were frequent throughout the period of observation.

12.31 On our return to north bay Y8 holding territory. Successfully defends bay against several unmarked males.

12.46 Y8 leaves (after 15 minutes).

12.50 Or6 returns and occupies vacant bay.

12.55 Female begins ovipositing amongst *Phragmites* at eastern edge of bay. Female present for 2 minutes but not approached by Or6 who appears too preoccupied chasing off rival males.

13.05	Or6 leaves (after 15 minutes).
13.08	Or6 returns and successfully defends bay against R11 which is now occupying adjacent bay.
13.09	Or6 leaves (after 1 minute).
13.11	R11 occupies bay, approaches female ovipositing at base of *Phragmites* stand. R11 forces female down to the surface of *Sphagnum* lawn, forms tandem and the pair fly into the surrounding oak canopy, where they settle. Unmarked male immediately occupies the vacant bay.
13.11-13.57	Bay occupied by unmarked males.
13.57	Y10 occupies bay.
14.04	Y10 leaves. Bay unoccupied for 9 minutes after the sun went in and no dragonflies were seen on the wing.
14.13	Or25 occupies bay.
14.16	Or25 catches prey item and leaves (after 3 minutes). Bay unoccupied for 13 minutes after the sun went in and no dragonflies were seen on the wing.
14.29	R11 occupies bay.
14.47	R11 leaves (after 18 minutes). Bay unoccupied for 7 minutes after the sun went in and no dragonflies were seen on the wing.
14.54	R61 occupies bay.
15.02	Or25 occupies adjacent bay, frequently clashes with R61.
15.15	R61 leaves (after 21 minutes).
15.25	R61 returns and resumes clashes with Or25.
15.37	R61 departs (after 12 minutes) to tree tops where it settles.

Territory occupation times

A summary of the territory occupation times on 2 July 1994 in minutes is 11, 8, 9, 5, 9, 15, 1, 7, 3, 18, 21, 12 (mean = 9.9). The periods that the bay was unoccupied in minutes were 14, 1, 4, 9, 13, 7 (mean = 8).

On 27 June 1993 additional observations were made at Wake Valley Pond, but at a different bay, of four marked individuals. Occupation times in minutes were: 14, 19, 12, 27, 10, 12 (mean = 15.6).

The overall mean occupation time for all observation was 12.75 minutes.

Discussion

These observations provide some interesting insights into the behaviour of male *C. aenea*. While at the pond, at peak times of the flight season, patrolling males frequently clash with other males. The clashes are usually brief, lasting only a few seconds, with the intruding male being closely pursued by the resident male. In all our observations the resident male successfully chased off the intruder and returned to patrol the 'home' bay. This suggests that the intruders are not actually challenging the resident male for occupancy of the bay, since the rules of the clash dictate that they will not be successful. Rather, it seems more likely that

these homeless males are cruising the pond in search of suitable unoccupied bays to take possession of. In addition, many of the clashes were between males occupying adjacent patrol areas. Neither male was displaced from its own patrol area but the clashes served to delimit the size of the area. These observations suggest that resident males are 'aware' of their ownership of the patrol areas and that homeless, intruding males 'know' they do not hold a patrol area. For this reason the patrol areas can be regarded as territories.

For 'homeless' males, success at finding an unoccupied bay, particularly at the height of the flight season when space is at a premium, is made more likely by the tendency of males to occupy their bays for a relatively short period of time. From a total of 18 observations, the maximum time a male occupied a bay was 27 minutes and the average time of occupancy was 12.75 minutes. Similar results were reported by Ubukata (1975) who found that adult males of *C. aenea amurensis* stayed at the pond for periods of 1-40 minutes. This behaviour is in contrast to male *Anax imperator* and *Libellula quadrimaculata* which often remain at the pond for long periods. Males were never driven from the pond by intruders but left of their own volition. The tendency of male *C. aenea* to leave the patrol area means that other males are only temporarily homeless and may soon gain a residency.

At times of high population density this behaviour allows a suitable bay to be 'time-shared' by several different males throughout the day and, as a consequence, enables a relatively large numbers of males to utilize the pond. This could be advantageous to a species like *C. aenea* which is apparently relatively poor at dispersing (Brooks, McGeeney & Cham, pers. obs.). In contrast, *A. imperator* males must be forced to search far and wide for unoccupied ponds or risk damage in combat during attempts to oust territorial males. It also follows that assessments of population size made from counts of adult male *C. aenea* present at the pond are likely to underestimate the true figure. Counts of exuviae will be a more reliable measure.

Throughout our observations of the behaviour of adult *C. aenea*, which have occupied many hours during the years 1992-1995, we have only rarely seen prey captured at the pond. Similarly, Ubukata (1975), in his study of the Japanese subspecies *C. aenea amurensis*, only occasionally witnessed prey being caught and consumed at the pond. When prey is taken, *C. aenea* flies into the surrounding tree tops, presumably to consume it. This behaviour contrasts with that of *A. imperator* which regularly feeds on the wing while holding territory. This may enable *A. imperator* to remain in the territory for much longer than *C. aenea*. We have frequently encountered adult *C. aenea* away from the pond hawking for prey in woodland clearings and rides at all times of the day. This behaviour is similar to *C. aenea amurensis* which also forages in woodland (Ubukata, 1973). We therefore speculate that males occupying a patrol area periodically leave the pond in order to feed in the adjacent woodland. Moreover, we think it likely that they do not move far from their 'home' bays when leaving the pond on feeding sorties since the same group of males shared the same bay and returned to it on several occasions throughout the day, and were not seen at other parts of the pond on that day. We have also seen the same marked male occupying the same territory over a period of two weeks. However, males are not usually faithful to a particular bay for long, and from one week to another most marked males occupied different bays around the pond.

Because a male cannot displace another which is already occupying a patrol area, the size

of the patrol area is effectively governed by the density of males present at the pond. We have observed males earlier and later in the season, or early in the morning, when population densities are less. On these occasions males flew parallel to the edge of the pond and one marked male was seen at several different bays within a twenty minute period. When they came to bays they turned towards the bank and hovered for a few seconds before resuming the patrol flight. Presumably they were searching for ovipositing females during this hovering flight. When they encountered another male, after a brief clash, both males usually turned and resumed a reciprocal flight. We have observed single males at small ponds flying round and round the perimeter. Similarly, when two males were present they effectively divided the pond between themselves, often turning on their patrol flight at the point of meeting. At high population densities, a small-mouthed bay is apparently the largest patrol area a male can maintain. Ubukata (1986) found similar behaviour in the Japanese subspecies *C. aenea amurensis*. Similarly, Poethke (1988), in his studies of *Aeshna cyanea*, found that males were highly territorial at times of high male densities but at low densities they made long patrol flights without any territorial attachment.

As well as clashing with rival males of their own species, *C. aenea* was seen to clash with male *Libellula quadrimaculata* and *Anax imperator*. *C. aenea* was not displaced by either of these species. Generally, *C. aenea* was able to occupy the same bay as *Anax imperator* without coming into conflict since *A. imperator* occupied the air space above 1.5m whereas the patrol flight of *C. aenea* was below this. However, clashes with *A. imperator* did occur when rival *C. aenea* males were involved in pursuit flights which often took them to heights of 3m or more into the surrounding trees. The differences in male patrol-flight height of these two species may be related to differences in the ovipositing behaviour of females and the size of territory defended by the male. Female *A. imperator* usually oviposit in floating plants, often away from the banks, whereas *C. aenea* uses emergent vegetation at the edges of bays. Male *A. imperator* may fly high to scan a large area, whereas the low flight pattern of male *C. aenea* enables them to closely inspect the bankside of a smaller area.

Blue damselflies were ignored by patrolling male *C. aenea* but tandem pairs of *Pyrrhosoma nymphula* were chased. This was possibly because they resembled a rival male *C. aenea*. Like male *C. aenea*, tandem pairs of *Pyrrhosoma nymphula* fly low over the water and are similar in size and colour to *C. aenea* which also has reddish reflections on the bronzy abdomen. The behaviour of a pair of *P. nymphula* searching for oviposition sites may also resemble the vertical swinging and escape flight of a female *C. aenea* which Ubukata (1983) found to be important sign stimuli for male *C. aenea*.

Summary

1. Resident males always successfully defended their bays against intruding males.
2. Males occupied bays for an average of 12.75 minutes before leaving the pond.
3. Feeding did not occur at the water. Males may leave their bays in order to feed in adjacent woodland clearings.
4. Males cruise the perimeter of the pond until they encounter another male. The length of the patrol area is therefore determined by the density of males at the water.

Acknowledgments

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Red-veined Darter *Sympetrum fonscolombei* (Sélys), confirmed breeding in Britain in 1996, and notes on exuviae

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Introduction

The Red-veined Darter *Sympetrum fonscolombei* (Sélys) has not been confirmed as breeding in the British Isles since the 1940s (Longfield, 1949) although it has been an erratic immigrant many times since then and is now an almost annual occurrence (Parr, 1996).

At a group of shallow ponds near the Dorset coast, Red-veined Darters were seen flying in the first two weeks of September 1996 by Ken Dolbear (pers. comm.). Several individuals had emerged with damaged wings and a selection of these (three females and five males, all immature), as well as over fifty exuviae, were sent to me for confirmation of identification; this represented only a fraction of the entire population which is estimated to have run into hundreds.

Ken Dolbear made records and took photographs (which I have seen) of *S. fonscolombei* near the site in the last week of May, when they may have arrived as migrants from the Continent. Late May to mid-June 1996 saw the largest numbers of this species for many decades with records from Berkshire, Cornwall, Hertfordshire, the Isle of Wight, Kent, Middlesex, Norfolk, Suffolk and Yorkshire (Parr, 1997). It is possible that some of these were descended from immigrants which arrived in the previous year, but most had probably migrated themselves. It is assumed the conditions at the site must have been favourable enough for the larvae to grow within a few months and emerge as a second generation in September. Two generations a year are common in this species in southern Europe (Robert, 1958). There are accounts of it breeding for a few years in Dorset between 1911 and 1915 (Prendergast, 1991). The mild coastal climate of the area may allow the next generation to survive the winter to emerge next spring. Interestingly, *Anax imperator* Leach was seen flying and two fresh exuviae were found at the site in September. Other species recorded at the site are *Ischnura elegans* (Vander Linden), *Enallagma cyathigerum* (Charpentier), *Libellula depressa* L., *Orthetrum cancellatum* (L.) and *Aeshna mixta* Latreille, all confirmed breeding. Also seen were *Lestes sponsa* (Hansemann), *Aeshna cyanea* (Müller), *Sympetrum sanguineum* (Müller) and *Orthetrum coerulescens* (F.) (Dolbear, pers. comm.).

Identification feature

The descriptions and keys in Askew (1988) and Gardner (in Hammond, 1983) were used to identify the sample of exuviae I had been sent. From a total of 73, nine were *Sympetrum striolatum* and the rest were *S. fonscolombei*. The very short to rudimentary lateral spines on the abdomen (segments 8 and 9) are diagnostic features of *S. fonscolombei* that can be noticed with the naked eye at close range. To check the lack of dorsal spines, a hand lens is needed.

A more obvious diagnostic feature was immediately apparent, also visible with the naked eye from quite some distance, but not mentioned in the literature. Down the medial line of the top of the abdomen are two parallel, tapered, thick, dark lines. Of the 64 specimens, 59 had obvious dark lines and of the remaining five, four were heavily covered in pond debris making examination impossible. Closer examination of the top of the abdomen showed a dark dot on either side of the segment line, and irregular smudgy darker patches on the outer margins of each segment. The thorax had a dark patch on either side of the dorsal split, and a dark line on the side which forked half way along its length. The legs were banded.

This feature is mentioned because it is not found in any of the literature I am aware of, and because it could be of use to any observer visually scanning for exuviae *in situ* at a suspected breeding site. The illustration by Gardener does show a pattern on the abdomen, but it is

indistinct and does not convey the clear contrast of the specimens I examined. Dark markings may fade after extended exposure to sunlight and they may not be so apparent on live larvae, but on fresh exuviae of *S. fonscolombei*, the markings, particularly the two medial lines on the abdomen, would enable an observer to readily distinguish at a distance this rare migrant from other more common *Sympetrum* species.

Acknowledgments

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Records of *Sympetrum fonscolombei* (Sélys) and *Sympetrum vulgatum* (L.) for the summer of 1995

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During the summer of 1995 there was a spectacular influx into the British Isles of the migrant species *Sympetrum flaveolum* (L.). A full report of this migration, and the efforts made to record its extent, are contained in Silsby & Ward-Smith (1997). Taking account of possible duplicate sightings at the point of entry and at subsequent dispersal sites, it was estimated that between 700 and 1000 individual migrating *S. flaveolum* were recorded.

As co-ordinator for *S. flaveolum*, I received records from many sources, and amongst these records were occasional references to observations of other migrants. The purpose of this short paper is to place on record all the sightings of *S. fonscolombei* (Sélys) and *S. vulgatum* (L.) which I received. These are given in Tables 1 and 2. There were 17 sightings of *S.*

fonscolombei reported, and 24, including five females, for *S. vulgatum*. In contrast to *S. flaveolum*, for which several breeding records were submitted, there were no reports of copulation or ovipositing for either *S. fonscolombei* or *S. vulgatum*.

For *S. fonscolombei*, entry was through the coastal counties of Cornwall, Hampshire and Norfolk, with inland dispersal to Surrey and Middlesex. Entry for *S. vulgatum* was confined to the coastal counties of Yorkshire and Humberside, Norfolk, Suffolk and Kent with inland sightings in Hertfordshire and Middlesex. Although the sample size is small, the data indicate distinct trends, with *S. fonscolombei* entering from the south or south-east, whereas *S. vulgatum* entered along the eastern side of the country. These patterns correlate well with the distribution of these species on the continent. Askew (1988) indicates that the European distribution of *S. fonscolombei* is Mediterranean, whilst *S. vulgatum* is a central and northern European species.

Table 1. Records of *Sympetrum fonscolombei* in 1995

County	Site	Grid ref.	First date	Last date	Max.	Fem.	Source	
Cornwall	Lizard	10694169	16/08/95	19/08/95	2		RA72	1
Cornwall	Goonhilly	10731198	06/08/95		2		RA72	2
Cornwall	St Keverne	10808215	19/08/95		2		RA72	3
Hants	Woolton Pond	SZ29	06/08/95	12/08/95	1		KGGoodyear	4
Middx	Mill Hill	TQ29	10/08/95		3		S Murray	5
Norfolk	Yarmouth	TG50	03/08/95		1		AP/EJ	6
Norfolk	Hopton		19/08/95		1		AP:EJ	7
Surrey	Thursley	SU84			3		BDS 28	8

Latest update: 21 March 1996

Table 2. Records of *Sympetrum vulgatum* in 1995

County	Site	Grid ref.	First date	Last date	Max.	Fem.	Source	
Herts	Panshanger	TL21	12/08/95		1		T W Cladwin	1
Herts	Tyttenhanger	TL190050	13/08/95		1		S Smith	2
Kent	Dungeness	TR01	03/08/95	09/08/95	7	2	WA/DW	3
Middlesex	Hounslow	TQ17	09/08/95	24/08/95	2		BDS 28	4
Norfolk	Caister	TG51	05/08/95	06/08/95	1		Bird Pager	5
Norfolk	Yarmouth	TG50	02/08/95	09/08/95	6	1	BDS 28/AP-BP	6
Suffolk	Felixstowe	TM33	04/08/95		1		Bird Pager	7
Suffolk	Newbourne Springs		06/08/95	20/08/95	3	2	Alan Paine	8
Suffolk	North Warren NR	TM45			1		BDS 28	9
Yorks/Humberside	Spurn Head	TA31	05/08/95		1		BTO	10

Latest update: 24 July 1996

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Notes and observations

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Mixed Pairing

On 4 June 1997 at Berrygrove Wood Pond, Aldenham, Herts., a male *Libellula depressa* seized a presumed female *L. quadrimaculata* which entered its territory. The *L. quadrimaculata* attempted several times to complete the wheel position before separating and performing oviposition movements. (SHM)

Diving *Aeshna*

On 19 July 1997 at Chartley Moss NNR, a male *Aeshna grandis* dived into Shooters Pool, completely submerging. It then rose and shook itself, repeating this thrice before flying inland. Was it trying to rid itself of mites? [see also *J. Br. Dragonfly Soc.* 11(1):23] (TB)

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Book reviews

Natürliche Feinde, Parasiten und Fortpflanzung von Libellen
Predators, Parasites & Reproductive Behaviour of Dragonflies

Gunnar E. Rehfeldt

This is the first volume of a series that will contain comprehensive and summarizing papers about dragonflies. This one contains original papers on reproductive systems and on the predation of adult dragonflies, as well as a useful summary (in English) and a very thorough bibliography.

Only a small number of studies appear to have been carried out into the importance of predators in the evolution of reproductive systems and this book is an overview of present knowledge of the influence predators and ectoparasites have on reproductive behaviour and on adult population dynamics.

Dr Rehfeldt's book is written in German. However, the really excellent figures and tables are in English, and their legends and descriptive captions are in both languages. Since almost every page contains at least one of these, it is not difficult to pick up extremely interesting and useful information. To give a few examples, from the figures we can learn that:

(i) at a site on the Canal de Vergière in a given period, *Orthetrum cancellatum* may capture > 50 *Calopteryx haemorrhoidalis* as well as 1–4 *Ischnura elegans, Onychogomphus uncatus, Orthetrum coerulescens* and *Sympetrum fonscolombei; Orthetrum albistylum* may capture

10-49 *C. haemorrhoidalis*; *Anax imperator* can account for 5-9 of both *Orthetrum coerulescens* and *C. haemorrhoidalis*; and *Onychogomphus uncatus*, *Gomphus simillimus*, *Boyeria irene* and *Orthetrum coerulescens* may all take *C. haemorrhoidalis*;

(ii) at the same site, *C. haemorrhoidalis* will be captured by aeshnids, gomphids and libellulids, as well as by praying mantises, ants, wasps, fish, lizards and spiders of four species; and *Coenagrion mercuriale* will be predated upon by most of the above in addition to frogs but not fish;

(iii) during a 24-hour period, *Sympetrum depressiusculum* will spend (approximately) from sunrise until 10am tandem guarding; from 9am until noon copulating, and from 10am until 2pm ovipositing; the rest of the day, until sunset, will be spent feeding; from sunset until sunrise the insects will be at their roosting sites, where most spend the night on long grasses, in tandem.

From the tables we can learn how predation is affected by tandem guarding, non-contact guarding and no guarding; how the height above water of spiders' webs affects predation success; what the sex ratio is of all captures per month in spiders' webs; the frequency of attacks by green frogs of different ages compared to capture success.

Clearly anyone with a greater knowledge of German than I possess would be able to glean immensely more than I have been able to do. But the English summary is helpful and the very extensive bibliography of great value. One complaint is that the 'Glossar' is from English into German: it would have been very much more useful had it been the other way round; and it would also have been an advantage if the table of contents, and the chapter and even sub-chapter headings, had been in both languages.

The price of the book, which is in soft back, is 57DM plus 3DM p. & p. It can be obtained from Gunnar Rehfeldt, Roseggerweg 41, D-38304 Wolfenbüttel, Germany.

Jill Silsby

Dragonflies Naturalists' Handbooks 7 (2nd edition)
The Richmond Publishing Co. Ltd, Slough (1995) 118pp. £16.00 (hardback), £8.95 (softback)

Peter L. Miller

In the nine years since the appearance of the first edition of the late Peter Miller's *Dragonflies*, our understanding of dragonfly ecology has continued to grow. This progress is fully reflected in the second edition. Peter Miller took advantage of this new edition to largely rewrite the text. Although the framework and format is broadly similar to the 1987 version, the new edition is essentially a new book. There are now 34 additional pages. Chapters include an introduction, eggs and larvae, adult life, flight, vision, reproductive biology, guarding and egg-

laying, keys to larvae (by Graham Vick) and adults (by David Chelmick), dragonfly conservation and recording, and methods for studying dragonflies.

In the chapter on eggs and larvae there is a new section on the regulation of salts and much additional information on larval interactions. Other sections that have been substantially expanded include the accounts of vision, territoriality, signalling and oviposition. The book is extremely readable, thorough and thought-provoking. Peter Miller's great ability as a teacher, his deep understanding of dragonfly ecology and his ability to enthuse the reader with his interest in dragonflies comes strongly through the pages. The text is extraordinarily concise and contains a wealth of information in relatively few pages. In common with other books in the Naturalists' Handbooks series, *Dragonflies* is full of suggestions for exploring ideas in the field in order to investigate and understand the complexities of dragonfly ecology.

The colour illustrations of the first edition have been replaced in the new edition with those of R. R. Askew, using some of the colour plates that appear in Askew's *Dragonflies of Europe*, published by Harley Books. Twenty-four of the British species are illustrated but not all the families and genera are represented. Notably absent are *Platycnemis pennipes* and *Cordulegaster boltonii* as well as *Ceriagrion tenellum* and *Brachytron pratense*. As in the previous edition, the delightful marginal line-drawings by Sophie Allington are used and are supplemented by several additional drawings.

This is an excellent book and I would unreservedly recommend it to anyone with an interest in natural history, and dragonflies in particular, including those who already own a copy of the first edition. My greatest regret is that now, due to the author's untimely death, there will never be a third edition.

S. J. Brooks

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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.

Manuscripts should be typewritten using black ribbon, double-spaced, on one side of the page only and with margins at least 25 mm at the left, top and bottom; text pages should be numbered. Footnotes should be avoided.

Words that are to appear in italics (e.g. names of genera and species, though not of families) should be underlined.

Use of these terms is acceptable: 'exuviae' for cast skin or skins (singular and plural); '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 1994.

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 this form:

Hammond, C.O. 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 typed, each on a separate, unnumbered page.

Legends for illustrations should be typed together in sequence on a single unnumbered page.

Illustrations (figures) should be prepared in black ink, and scaled to allow a reduction of 1.5 to 3 times. Lettering should be neat and uniform.

The legend for each table and illustration should allow its contents to be understood fully without reference to the text. The approximate position of each table and figure should be indicated in the text.

SCIENTIFIC AND ENGLISH NAMES OF BRITISH ODONATA

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

ANISOPTERA	DRAGONFLIES
Aeshna caerulea	Azure Hawker
Aeshna juncea	Common Hawker
Aeshna mixta	Migrant Hawker
Aeshna cyanea	Southern Hawker
Aeshna grandis	Brown Hawker

ANISOPTERA	DRAGONFLIES
Anaciaeschna isosceles	Norfolk Hawker
Anax imperator	Emperor Dragonfly
Anax parthenope	Lesser Emperor Dragonfly
Hemianax ephippiger	Vagrant Emperor Dragonfly
Brachytron pratense	Hairy Dragonfly
Gomphus vulgatissimus	Club-tailed Dragonfly
Cordulegaster boltonii	Golden-ringed Dragonfly
Cordulia aenea	Downy Emerald
Somatochlora metallica	Brilliant Emerald
Somatochlora arctica	Northern Emerald
Oxygastra curtisii	Orange-spotted Emerald
Libellula quadrimaculata	Four-spotted Chaser
Libellula fulva	Scarce Chaser
Libellula depressa	Broad-bodied Chaser
Orthetrum cancellatum	Black-tailed Skimmer
Orthetrum coerulescens	Keeled Skimmer
Sympetrum striolatum	Common Darter
Sympetrum nigrescens	Highland Darter
Sympetrum fonscolombei	Red-veined Darter
Sympetrum flaveolum	Yellow-winged Darter
Sympetrum sanguineum	Ruddy Darter
Sympetrum danae	Black Darter
Sympetrum pedemontanum	Banded Darter
Crocothemis erythraea	Scarlet Darter
Leucorrhinia dubia	White-faced Darter

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