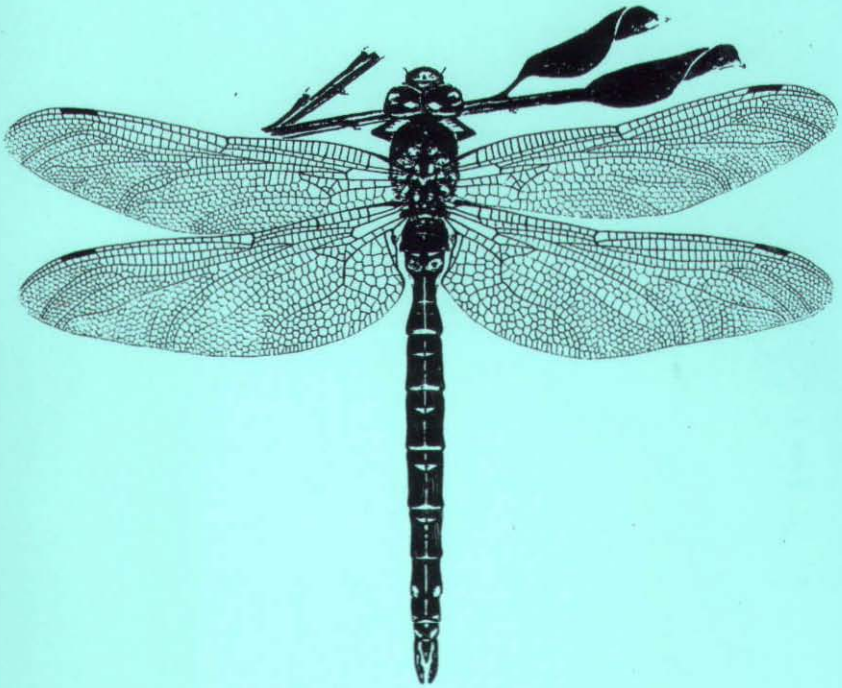
Journal of the British Dragonfly Society

Volume 14 **April**
Number 1 **1998**



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Front cover illustration of male *Aeshna grandis* by Roderick Dunn

A population study of *Coenagrion mercuriale* (Charpentier) in the New Forest. Part 7. Mark/recapture used to determine the extent of local movement

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Introduction

This work was carried out in 1992, on the Crockford stream in the New Forest, the year following an initial study (Jenkins, 1995) in which the area under observation had been treated as a single unit. As work progressed, it had become obvious that this length of stream contained two *Coenagrion mercuriale* (Charpentier) populations, separated by a 200m stretch of the stream with mixed scrub (blackthorn, willow, bramble, etc.) some 2-4m high on the west bank only or on both banks. Small copses isolated the whole site upstream and downstream. No *C. mercuriale* exist further downstream and are very sparse for over 0.5km above the upstream copse, and immigration from the latter seemed extremely unlikely. During the 1991 study and previous 'Pollard' type walks, no *C. mercuriale* had been recorded from the scrubby stretch between the two holding areas, although there is no barrier to flight along the stream. As previously noted, a tributary with good numbers of *C. mercuriale* along most of its length meets the main stream just below the upper study population but is cut off from it by about 10m of scrub on both banks at the junction. However, above this, only a truncated triangle of open Forest lawn separates tributary from main stream with a minimum distance between the two of about 10m. The object of the current work was to use mark/recapture to see if (a) there was any exchange of *C. mercuriale* between the up and down stream areas of the study site and/or (b) exchange between the latter populations and the higher density population on the tributary.

Methods

Conditions and methods were all as reported previously (Jenkins, 1995) except for an improved method of insect retention and release. The earlier technique was to net and mark insects uniquely and release them immediately. Working over periods of up to three hours and with very small numbers of insects involved, it was inevitable that some *C. mercuriale* were netted more than once. Although a few marked insects could be identified while perching and the remainder released immediately after checking in the net, any stress or damage from the latter could be avoided by the new technique. In addition, the previous method did not readily allow random release into the population as required for accurate calculation, although numbers were too small and insects taken from too limited a stretch of water for this to have much effect on the final figures.

In the current work, the technique reported by Parr (1965) was used. For a given population, as many insects as possible were captured, marked and retained in pill

boxes. After a set period of two hours at each site, the insects were released at intervals along the stream. Black and red pens were used to mark the upper and lower populations on the main steam and green for the insects on the tributary. As noted previously, green marks were much less permanent than red or black but it was possible to recognize green or degraded green for about two weeks after application. Mark/recapture was done weekly and all insects were given the same number for a given week, rather than a unique number. Insects remained quiet in the pill boxes and on release, most flew a yard or two to a suitable perch to rest or clean themselves.

Results

In general (Fig. 1) the black and red marked populations on the main stream showed almost identical patterns of emergence. The figures for actual number captured (154, with 81 black, 73 red), calculated total (Fig. 2), and ratio of numbers captured to calculated total were similar to those of the previous year, despite the lower numbers per population resulting from the split into two groups.

This shows that the mark/recapture experiments of 1991 had no serious effect on the overall population. As before, the fluctuation in numbers throughout the season reflected the summer weather pattern, although in complete contrast to 1991, the highest numbers occurred in the first half of the season, with excellent weather in June, followed by a rapid decline in July as poor weather dominated and few insects were on the wing. Figure 3 shows percentage of females captured. A maximum approaching 40 per cent of the overall population at maximum emergence is similar to previous figures, but while the number of females in the 'black' population remained more or less constant through the season, the number in the 'red', although initially higher on average, declined to zero by late July.

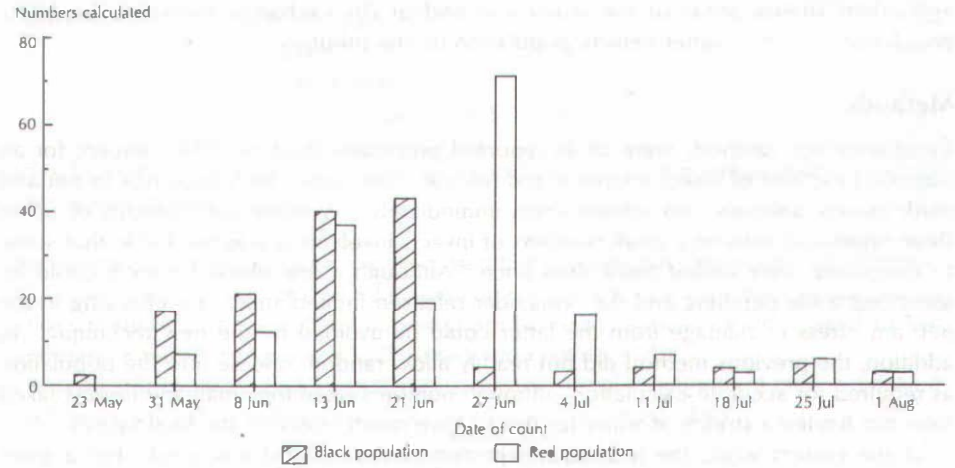

Figure 1. Calculated populations for black and red marked *C. mercuriale* on main stream

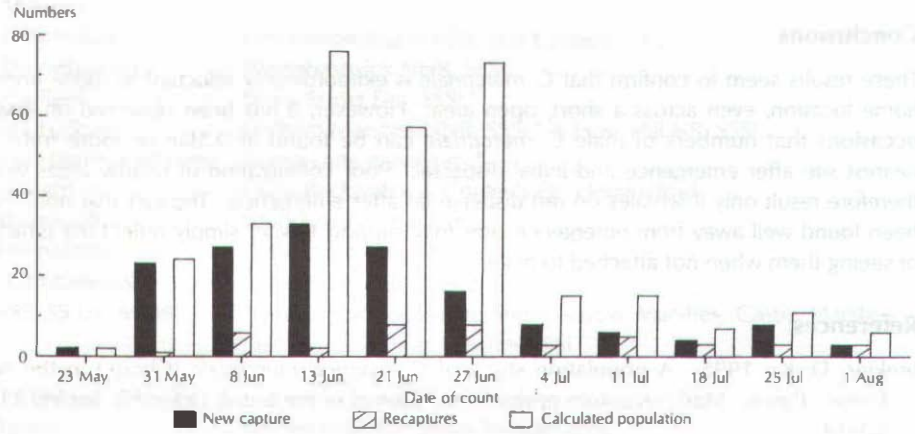

Figure 2. Calculated total population on main stream, 1992

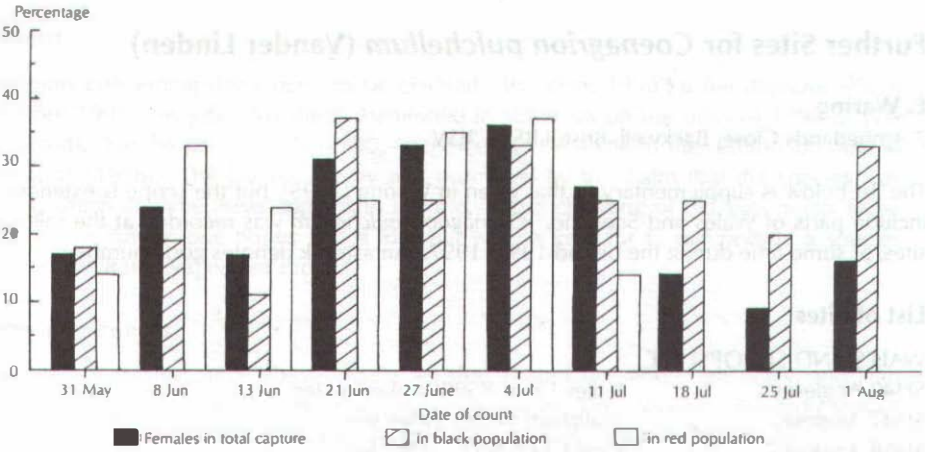

Figure 3. Actual percentage of females for *C. mercuriale* captured on main stream

Only limited marking was done on the 'green' population of the tributary as *C. mercuriale* numbers were relatively high and there was no upstream boundary to limit exchange. However, no marked *C. mercuriale* from the tributary were found amongst the red or black (nearest) populations and of the total of 154 black or red marked insects, only two 'black' were found on the tributary and it is suspected that even these were two insects which had soared uncharacteristically on release in a strong wind blowing towards the tributary. There was no evidence for exchange of *C. mercuriale* between the two groups on the main stream.

Conclusions

These results seem to confirm that *C. mercuriale* is extraordinarily reluctant to move from its home location, even across a short, open area. However, it has been observed on several occasions that numbers of male *C. mercuriale* can be found at 0.5km or more from the nearest site after emergence and initial dispersal. Poor colonization of nearby areas would therefore result only if females do not disperse far after emergence. The fact that none have been found well away from emergence sites may support this, or simply reflect the difficulty of seeing them when not attached to males.

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Further Sites for *Coenagrion pulchellum* (Vander Linden)

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The list below is supplementary to that given in Waring (1995), but the scope is extended to include parts of Wales and Scotland. *Coenagrion pulchellum* was recorded at the following sites, at some time during the period 1991–1997. An asterisk denotes good numbers.

List of Sites

WALES AND SHROPSHIRE	
SH47 Anglesey	Valley Lakes RSPBR, lake and fen.
SH47 Anglesey	Maltreath Marsh, valley fen.
SH58 Anglesey	Cors Goch NNR, vallen fen.
SJ43 Whixall	Whixall Moss area with scrub.
SJ50 Shrewsbury	Berrington Pool.
SS69 Swansea	Crymlyn Bog, near Port Tennant.
SS79 Neath	Canal at Pant-y-Sais fen, and near canal at Briton Ferry.
SOUTHWEST SCOTLAND	
NX46 Newton Stewart	Blairmount Pond, & Gushat Golf Course Pond.
NX55 Fleet Valley	Woodend Loch, near Anwoth.
NX85 Colvend	White Loch.*
NY08 Lochmaben	Upper Loch and Blind Lochs.

EAST ANGLIA	
TG30 Limpenhoe	Limpenhoe Marsh SSSI, and Cantley.
TG31 Woodbastwick	Woodbastwick NNR, SSSI.
TG32 Catfield	Sharp Street Fen, SSSI.*
TG31/41 Ludham	Ludham Marshes NNR, SSSI,* & How Hill NR, SSSI.
TG26/36 Hemingford Grey	Marsh Lane gravel pits.*
TL27 Houghton	Ouse Backwater, & Copley's Pit, Hemingford.
TL28 Woodwalton	Woodwalton Fen, a few.
TL36 Fenstanton	West End gravel pits.*
TM35 Campsey Ash	Marshes by River Deben.
TM39/49/59 Lowestoft	Along the R. Waveney: Shipmeadow Marshes, Castle Marshes (Barnby) & Carlton Marshes SSSI.
SOUTHERN ENGLAND	
ST46 Yatton	Rhynes in Biddle Street Triangle SSSI.
SU85 Aldershot	Ash Embankment and Lakeside, a few.
SU88 Cookham	Strand Water, & White Brook near Maidenhead Court.*
SU91 Barlavington	Burton Mill Pond.

Comment

Some points concerning dates need to be clarified. By 'since 1990' in the previous title is meant from 1991 onwards. No site is mentioned in either list on the basis of 1990 or pre-1990 records. For the period 1975–1990, reference can be made to the distribution map in Merritt *et al.* (1996). The present survey was prompted by the claim that the species was declining, which in some areas appears to be true. More checking of old sites needs to be done. For the future, one hopes that a look-out will be kept for *C. pulchellum*, a species covered by the Rare Dragonflies Project.

Acknowledgements

For the additional information above, thanks are due to Ian Cheeseborough, David and Jean Dell, Adrian Fowles, Phil Heath, Clive Hurford, Jim McCleary, Tim McGrath, Howard Mendel, Brian Milne, David Murdoch, Adrian Parr, John Phillips, Mike Powell and Des Sussex.

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Behaviour of immigrant *Sympetrum flaveolum* (L.) at breeding sites in 1995 and subsequent proof of breeding in 1996

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Nearly twenty hours were spent in August 1995 watching the behaviour of immigrant *Sympetrum flaveolum* (L.) at two of the several sites in Staffordshire where they had become resident: the Daphne Pool, Saltwells LNR, and Cage Pool, Chartley Moss NNR. A majority of the records are from the latter, since the Daphne Pool attracted many visitors, making observation of undisturbed behaviour difficult.

The extraordinary immigration of several species of *Sympetrum* is detailed elsewhere (Silsby, 1995), but it is clear that a small trickle reached this country before the large numbers which left Holland and the Low Countries on 31 July. Two males were seen (one photographed) at Chartley on 11 July, and a male was at Saltwells on 29 July. Probably other early individuals were missed at other sites. Those that came in August moved across the country rapidly. At least eighteen were at Saltwells, some 270km due east of the main landfall at Great Yarmouth, on 2 August. A conservative estimate produces a mean continuous flying speed of over 11kph (7mph) for the whole journey.

It is often stated that males greatly outnumber females in immigrant Odonata. The same could be said erroneously about any of our resident species. The observed disparity in numbers between the sexes is usually only a function of their different behaviour. Males take up highly visible territories or perches around a water body. Females, unless *in copula*, tandem, or ovipositing alone, are either away from the water or resting in the vegetation. Often they are ovipositing inconspicuously to avoid male attention. I would hazard that at least as many females as observed males are present in the vicinity of a site.

Nine tandem pairs, four copulating pairs, and four periods of oviposition were observed at some length. On one occasion the whole process from catch-up to tandem, copulation, oviposition and final departure of the female 53 minutes later was recorded. Although the sample is small there were similarities to and differences from the behaviour shown by familiar related species.

Like *Sympetrum sanguineum* (Müller), the pre-copulation tandem period usually lasted far longer than that seen in *S. striolatum* (Charpentier), *S. danae* (Sulzer) or *Leucorrhinia dubia* (Vander Linden). Indeed, tandem flights during this period resembled post-copulatory flights, and might be mistaken for such until the wheel was seen to form. In very windy conditions little attempt was made to complete the wheel, the pair merely resting low in the vegetation. In the other three species, catch-up normally results in the wheel being formed very quickly, not infrequently while still airborne. Otherwise it is completed soon after the pair lands, particularly in windy conditions. The duration of copulation is similar for all; in reasonable weather about 30 minutes. During the process males rhythmically flex their abdomens for lengthy periods, at about one flex per second, with quiescent intervals in-between.

At Saltwells on 2 August there were at least eighteen *S. flaveolum* present, most seen being males. Many were sky-pointing at an angle of 70-80° in the intense heat of early afternoon (over 30°C). Two tandem pairs which had completed copulation flew off to rest in the vegetation without attempting to oviposit, probably because of the very stiff breeze. The next day, in similar conditions, only three males were seen mid-morning, but there were at least thirty individuals visible in mid-afternoon. Two tandem pairs were stuggling in the stiff breeze. The second dropped into some *Sparganium*, and there completed the wheel. After rising and settling a few times because of the wind (the female was lifted well above the horizontal on several occasions), they resumed the tandem position after sixteen minutes of copulation and flew off to perch up a steep bank, well away from the pool. In all post-copulatory tandem flights observed, the female carried her abdomen in a characteristic drooped, shallow, inverted 'U'.

All oviposition seen was away from water, like *S. sanguineum*, which also commonly oviposits up to 1-1.5m from the water's edge (often in shade). However, *S. flaveolum* seemed to go even further away. In contrast *S. striolatum*, whether alone or in tandem, dips into water almost without exception, *S. danae* commonly dips low on emergent vegetation or pool-edges as often as into clear water, and *L. dubia* appears always to dip into clear water, although this may be only in minute depressions on waterlogged *Sphagnum*.

On 4 August, in hot (28°C) but again breezy conditions, a tandem pair was watched fluttering but not ovipositing low over *Nymphoides peltata* leaves lying on drying mud. After about a minute they moved further inland and began to dip amongst short (less than 10cms) grass and sedge, 5-6m from the water's edge, but just below the normal winter waterline. They continued for three minutes, with the tip of the female's abdomen mostly striking the vegetation. They then separated and the female perched down in the short grass. The male attempted to land nearby several times, hovering within 6cms. Eventually he perched about 20cm away on the top of a stem.

Numbers often in excess of thirty were seen over the next few days by some of the wardens, including tandem pairs again ovipositing well away from water. The last records were on 30 August.

At Chartley, after the two males on 11 July on the E-W Ditch, singles of both sexes were found on 6 August at several sites. The most suitable in terms of habitat seemed to be Cage Pool. This proved to be correct, with up to twelve here at any one time over the next two weeks. Unlike Shooters Pool which is a hole through the peat raft (Beynon, 1995), Cage Pool is a depression in it, with a clear water surface about 6m in diameter. It is surrounded by extensive semi-submerged *Sphagnum* through which grows dense *Eriophorum angustifolium* and some *Carex ovalis*. These continue outwards in a band up to 2m wide towards more solid but still very wet ground. Here they are gradually replaced by the characteristic plants of the Moss, principally *Calluna vulgaris*, *Erica tetralix*, *Vaccinium oxycoccos*, *V. myrtillus*, *Molinia caerulea* and *Deschampsia flexuosa*, with occasional clumps of seedling *Betula pubescens* and *Pinus sylvestris*. The pool is set in a small clearing bounded on three sides by *Betula* and *Pinus* woodland. Recently it has been deepening, and it did not dry out in 1995 (unlike 1993 and 1994).

A male was found at 0945h, and at 1245h a female, with little tangerine on the hind wings. Disturbed from resting in the *Eriophorum*, she flew some 10m away from the edge of the pool and began dipping in the damp hollows between humps and ridges of vegetation. About half the dips were into air; in the remainder her abdomen struck the overhanging vegetation. Eventually she flew off high across the Moss.

On 8 August, in heavy overcast, very few Odonata were moving and no *S. flaveolum* were seen during a three-hour visit. On 11 August numbers of males were seen at different sites, several sky-pointing in temperatures of over 30°C. There were at least ten at Cage Pool, perching all round the clearing. Counting was made reasonably easy as they invariably flew up to investigate passing insects, particularly other Odonata, in typical Darter fashion. The following day there were at least seven males at the site. At 1127h a pair already in the wheel position was disturbed from the *Eriophorum* round the pool. They flew off and settled about 20m away. After 23 minutes they broke the wheel and flew erratically round in tandem for 30 seconds or so, moving towards the pool. They then began dipping about 6m from the water, like the pair above, in the hollows between the vegetation tussocks, sometimes into air but more often striking grass blades, etc. After about 30 + 40 + 56 dips in two minutes with rests between they perched down in a hollow. In the early stages egg masses could be seen forming on the tip of the female's abdomen. They now separated and the female continued to dip; doing 4 + 8 + 20 + 21 over the next three minutes. The male followed her, landing twice, but rising to hover over her when she rested. Single eggs, rather than egg masses, were now occasionally visible on the tip of her abdomen. After she perched for the last time, the male briefly hovered over her and then went off to land 4m away. His behaviour was similar to the non-contact guarding often shown by *L. dubia* (Beynon, 1995). The female eventually flew low away from the pool and out of sight. Eggs were clearly being dropped during the 'air-dipping', as three were found which had fallen into the horizontal web of a tiny spider. The spider, scarcely bigger than an egg, was later photographed eating one.

On 21 August there were at least six males present, revealing themselves again by their flying up to investigate passing Odonata, even aeshnids 5m up. Near midday a female flew almost vertically from the margin, and then off high and away. This appeared to be a post-oviposition flight, identical to that made by female *S. danae* and *L. dubia* when getting away quickly to avoid male attention.

On 22 August, betwen 1030h and 1150h, the temperature rose rapidly from 22°C to 28°C. At 1045h a tandem pair formed low over the pool, flew about in an erratic fashion for ten seconds or so before completing the wheel in the air, and then landing in the vegetation close to the edge. When disturbed they flew off low and settled on an *Eriophorum* leaf about 2m from the pool. The male began flexing his abdomen metronomically at about one flex per second, and continued for the next 30 minutes. During this process, contrasting with the behaviour of other species, no reaction was shown to passing insects. These included a Small White (*Pieris rapae*) and a Common Blue (*Polyommatus icarus*) which came within 20cm, and a Flesh Fly (*Sarcophaga carnaria*) which perched less than 10cm away. The male then stopped flexing and the pair hung motionless for seven minutes. From the head movements the male clearly saw another male flutter past within 25cm, but again showed no reaction. The passing

male may not have seen the pair as they were motionless. Other *Sympetrum* species and *L. dubia* usually flutter their wings as a warning when such encounters occur. The male then began to flex again for about a minute and a half, stopped, and half a minute later broke the wheel. The pair flew off in tandem between and over the heather tussocks, and began to dip about 15-20cm above the substrate just below the overhanging edges of the tussocks, and over 5m from the pool edge. They made 45 + 31 dips with a brief rest in-between, most of the time appearing deliberately to strike the projecting vegetation. Eggs presumably fell into the damp *Sphagnum* in the hollows as none were found on the upper vegetation. They then separated and the male followed the female very closely. There was no obvious dipping at this stage. After about a minute the female perched and the male settled nearby. The female then began to dip again within 30cm of the perched male. A male *S. danae* now intruded and chased the female, both going away from the pool. The male intervened, and both males disappeared across the clearing. The female, alone, flew round some 15m from the pool at a height of 4m, before returning to the same oviposition site and starting to dip again. After a few dips she flew erratically and low around the outer margin, with short hovers here and there as if seeking other suitable sites. Eventually she began dipping very low down, 3m from the pool edge. For three minutes she made 32 + 18 + 5 + 8 (repeated); then for a further two minutes 1 + 1 + 1 (repeated). At each rest, her abdomen tip could be seen to swell and flex, and eggs were extruded on the underside, initially in small masses but later as single eggs only. Finally she settled low down for over two minutes, then fluttered off to perch again briefly before flying away from the pool.

Over the next few days the weather became much cooler, often with light rain. On 28 August the temperature was only 16°C at midday and few Odonata were moving. Only a single, large female *S. flaveolum* was found. She fluttered over the pool and the margins in a very restless manner for over thirty minutes, often landing to bask on patches of dried and whitened *Sphagnum* deep in the vegetation. Even wetter weather now followed and no more were recorded.

Proof of breeding 1996

On 17 July 1996 what were almost certainly two maiden *S. flaveolum* were seen taking their second flight at the Daphne Pool, Saltwells LNR but unfortunately both flew off in the breeze and could not be refound. The views obtained were unsatisfactory, and no definite record could be claimed since both *S. striolatum* and *S. sanguineum* emerged there over the next few days. Later that day, however, a reliable local observer watched an immature female *S. flaveolum* for over an hour at the site. This does not prove that breeding had taken place at the site but it is highly suggestive. Despite several visits over the next two weeks, no further records were obtained.

At 0940h on 22 July at Cage Pool, Chartley Moss NNR, a male *Sympetrum* was seen on its exuviae at stage 3 (body and wings fully expanded but wings still closed). It was about 20cm up an *Eriophorum* leaf amongst other leaves and stems emerging through the semi-submerged *Sphagnum*, towards the inner edge of the pool. Really close examination was impossible without excessive disturbance, but it seemed slightly and subtly different from the few *S. danae*

emergers seen since they were first seen on 7 July. Several photographs were therefore taken. At 1105h it had gone to stage 4 (wings open), and moved just above its exuviae and round to the far side of the leaf. Two more photographs only were taken due to the treacherous nature of the surface. At 1130h it maidened into the marginals. Here it looked superficially identical to a similar stage *S. danae*, with small amounts of saffron at the wing bases and almost white pterostigmata. However, the exuviae could now be collected. With some *S. danae* exuviae from the pool for comparison, it was keyed out and proved to be *Sympetrum flaveolum*. The mid-dorsal spines appear very different in the two species: larger and more robust on segments 6 to 8 in *S. flaveolum*; much smaller and on 5 to 7 (8) in *S. danae*.

It was noticeable that the colour on the wings of the newly emerged adult was saffron, rather than the tangerine of mature adults, and was limited to the wing bases. Presumably as the insect matures the saffron deepens to the adult colour and becomes more extensive.

None was seen at the site on 19, 20 and 23 July, but a thorough search on 27 July yielded a teneral *S. flaveolum* which was put up at 1030h from the marginals about 2m from the pool edge. It went up and away high over the pines to the south. At about 1330h an immature but not teneral male was found and photographed. It had extensive tangerine on the wings and the eyes had attained adult coloration, but the pterostigmata were only a pale buff-brown. On 28 July, in heavy overcast with rain showers, another immature male was found and photographed at 1400h. From the pale cream pterostigmata it could have been little more than a day or two old.

Visits on 3 and 5 August produced no records, but on 6 August at 1500h, in a brief bright period after thunderstorms, an immature female with pale buff pterostigmata was found and photographed. At about 1100h on 11 August another immature male was found with cream pterostigmata and extensive tangerine. Again it could not have been more than a few days old. It was the last seen, despite thorough searches in good weather on 16, 17, and 18 August. None was seen at any of the other sites on the Moss where adults had been recorded (but no oviposition noted) in 1995.

With such a small sample, extrapolation to estimate the number of emergers will be considerably inaccurate. There were at least five at Chartley. At the most there could not have been more than a dozen or so. The small numbers there and at Saltwells are possibly partly due to the oviposition sites chosen. In many cases winter rain did not flood them and ova must have perished. This might explain why populations are not established here for any length of time after immigrations. No instances of copulation or oviposition were seen in 1996 and it is doubtful that they occurred. Emergers were so few that mature survivors returning to water would have been unlikely to find partners. Sadly, failing another large influx, no *S. flaveolum* will be seen at either site in 1997.

Postscript

On 8 August 1997 at least one, and probably two immature *S. flaveolum* were seen at Cage Pool. Both were almost certainly males, and spent much time down in the marginals. One went off away over the trees, the other occasionally flew up to investigate patrolling male *A. juncea* (L). It seems highly likely that the 1996 emergers did breed successfully.

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The size of the 1995 influx of *Sympetrum flaveolum* (L.)

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Silsby and Ward-Smith have recently provided an excellent account of the influx of Yellow-veined Darters (*Sympetrum flaveolum* (L.) into the British Isles in the summer of 1995 (Silsby & Ward-Smith, 1997). They summarized records of about 750 individuals from coastal counties between Cornwall and Yorkshire and about 670 from elsewhere. However, they consider that the sum of these two figures, 1420, is likely to be an overestimate of the size of the influx because many of these individuals would have been recorded more than once; they suggest that 'between 700 and 1000 distinct individuals' is a likely rough estimate of the numbers involved. I believe that the numbers were much higher, for the following reasons:

1. *S. flaveolum* is not so obviously different from other darters that it is instantly recognizable, as for instance *Crocothemis erythraea* (Brullé) would be. As an example, because I was alerted to the influx, I found several individuals at Berrow, Somerset, on 5 August 1995; I pointed them out to an expert local naturalist who had seen them but not realised what they were, whereupon he found 20 more! How often did odonatologists who were not 'in the know' miss them?
2. More importantly, there are relatively few active odonatologists in the country and I cannot believe that more than a small fraction was ever found, particularly as they appeared in a wide variety of habitats. Goodyear (1997) describes finding 'large numbers' by good fortune and comments that he hasn't heard of anyone else finding these individuals. As a comparison, when there are invasions of Waxwings *Bombycilla garrulus*, which are very distinctive, tend to linger round human habitations and arouse the interest of large number of birdwatchers, it is accepted that only a minority of individuals are ever reported. The 'pick-up' rate for *S. flaveolum* will surely be much lower!

Silsby and Ward-Smith have done a great service in collating these records, which will be a valuable comparison when (if!) there is ever another invasion. However, their figure of 700-1000 is speculative; the total of 1420 records received is hard data. I suggest that tens of thousands of individuals were involved - but that is a guess! The best figure

to quote is '1420 records received'; we can continue to debate the likely size of the invasion.

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Dispersion or migration of *Sympetrum danae* (Sulzer) in South Lancashire

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Once thought to be relatively sedentary, the Black Darter *Sympetrum danae* (Sulzer) is now known to have good powers of dispersal and may appear at atypical sites considerable distances from its peatland breeding habitat (Benstead, 1994; Merritt *et al.*, 1996; Parr, 1996).

In Vice-County 59 (South Lancashire), known breeding sites of *S. danae* include peat mosslands in the Mersey valley, of which by far the most significant is Risley Moss Nature Reserve (SJ 670920), near Warrington, where the adult population numbers many thousands (pers. obs). Also important is Red Moss (SD 640100), west of Bolton, where Riley & Haydock (1993) estimated a population of many hundreds in 1991. Away from the peatlands, the only South Lancashire locality for *S. danae* mapped by Merritt *et al.* (1996) is on the Sefton Coast at Ainsdale Sand Dunes National Nature Reserve (SD 21) where two males were seen during the long, hot summer of 1976 (Hall & Smith, 1991).

During routine monitoring of dragonflies in South Lancashire between 1991 and 1997, I had 16 records of adult *S. danae*, involving 54 individuals, remote from known breeding localities. The maximum number seen at a site was fourteen and the mean group size was 3.4. Records were obtained in each year, except 1996 when no observations were made (Table 1). The great majority of sightings (92.6 per cent) was of males, only four females being logged. Table 2 shows that records occurred between late July and late September with indications of a peak in early to mid-September. This accords with the normal flight season of *S. danae* (Merritt *et al.*, 1996). Evidence of possible breeding was confined to two pairs *in copula* at a field pond on 15 September 1991. However, despite frequent visits, there were no further records from this site during the study period.

Table 1. Numbers of *S. danae* adults seen in each year.

Year	No. of records	Males	Females	Total adults
1991	3	24	2	26
1992	1	1	0	1
1993	1	1	0	1
1994	4	8	2	10
1995	5	11	0	11
1996		no observations		
1997	2	5	0	5
Total	**16**	**50**	**4**	**54**

Table 2. Numbers of *S. danae* adults counted in 10-day periods, 1991–1997.

Dates	No. of adults
20 July – 30 July	6
31 July – 9 Aug.	12
10 Aug. – 20 Aug.	3
21 Aug. – 31 Aug.	5
1 Sep. – 10 Sep.	12
11 Sep. – 21 Sep.	14
22 Sep. – 1 Oct.	2
Total	**54**

S. danae was seen at the following habitats: a former clay-pit near Burscough (5 records, 12 individuals); a field pond, probably originally a marl-pit, at Ince Blundell (3 records, 26 individuals); three excavated ponds in sand-dune slacks on the Sefton Coast (7 records, 15 individuals); a recently dug pond in a disused railway cutting near Preston (1 record, 1 individual). These sites lie between 30 and 41km from Risley Moss and 18 to 33km from Red Moss. They are situated in the following 10km grid squares which are not shown as locations for *S. danae* by Merritt *et al.* (1996) – SD 20, 30, 31, 41, and 52.

These observations suggest that *S. danae* adults can be expected to appear annually in South Lancashire at atypical wetlands remote from peatland breeding sites. It is not clear whether these occurrences represent dispersion from nearby mosslands or longer-distance migration. In 1995, five records of eleven male *S. danae* on the Sefton Coast coincided with the appearance of several *S. flaveolum* (L.) in the same area, part of an invasion of both species from the Continent (Pittman, 1996; Silsby & Ward-Smith, 1997). However in other years, there was little sign of long-distance movements by other Odonata into South Lancashire, though a colony of *S. sanguineum* (Müller) did become established here (Smith, 1997).

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An investigation into the affects of bank collapse and cattle trample on Odonata species at Okehurst on the River Arun, West Sussex

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Introduction

The River Arun at Okehurst has been visited in connection with continuing studies into Odonata behaviour. The area is of great natural interest floristically and for its fauna, not least the Odonata. Nationally rare species are found here such as *Libellula fulva* (Müller) and *Brachytron pratense* (Müller), and I have personally recorded seventeen species on this short stretch of river. The land on both banks of the river at Okehurst is not intensively managed, cattle being the primary stock. The banks of the river are subject to collapse, the cattle are then able to access the water, and in doing so, maintain a series of shallow pools and marshy areas.

It appears that those sections of the bank that have collapsed have a higher biomass of Odonata than those sections that have not. The Environment Agency is currently surveying the area for flood prevention measures. It is of concern that those areas that flood (where the bank has collapsed and which provide the better habitat for Odonata), will be precisely those that are targeted for dredging and banking up. Data have been

collected during 1997 with the aim of providing a more cogent argument against potentially damaging works by the Environment Agency.

Method

A series of fifteen plots were located linearly along the water course. These took three hours to survey and, given that in general Odonata are at their most active at higher temperatures when the sun is out, it was felt that a larger number of plots could not be surveyed under the same prevailing conditions on any given day. Each plot was located at a fixed point on the ground to enable the same spot to be surveyed each time. Billingshurst Angling Club have a series of pegs along the eastern bank of the River Arun and these were used to fix some of the plots; others were assigned to prominent landmarks.

Having established the area to be surveyed, the physical characteristics of each plot were described, a cross-sectional diagram of the river was constructed and an estimation of the degree of bank collapse and cattle trample was made using the following three criteria:

Trample category: 0 = Bank vertical, no collapse. 1 = Bank collapsed, moderate signs of trample. 2 = Bank collapsed, heavy trample.

It was decided that the plots were best surveyed by a series of fixed observations at each plot made under similar conditions at regular time intervals. Brooks (1993) recommends the following minimum conditions for a modified 'Pollard Walk'.

(i) The survey should not start earlier than 1100h or later than 1300h.
(ii) The air temperature in the shade should be above 17°C.
(iii) There should be at least fifty per cent sunshine.
(iv) Wind conditions should be light.

It seems reasonable to follow these conditions for the fixed plot survey used here. The site was visited regularly, on a seven-day rotational basis, with the flexibility of a day either side of the target date to try and attain as similar as possible weather conditions on each occasion. The species present at each plot were recorded in five minutes. Two metres on either side of the fixed point were included in the survey, this being the maximum distance estimated to cover a fixed point adequately without the risk of double-counting individuals. Odonata that were copulating, ovipositing, emerging, or present in a plot as larvae or exuviae were counted to provide information on the extent to which each plot was used as a breeding site.

Results

Spring 1997 was atypical for dragonflies. A visit on 30 April revealed already emerged and flying Zygoptera. *Calopteryx splendens* (Harris), in particular, was three or four weeks early. There then followed a number of severe frosts which wiped out these early emergers, and in the second half of June constant heavy rain eliminated two weeks of potential results.

Table 1. Distribution of species of Odonata in fifteen plots on the River Arun in 1997. Presence of species is signified by x.

Species	Plot															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Aeshna grandis	x	x	x	x			x				x	x	x			8
Anax imperator		x		x		x			x	x	x	x	x	x	x	10
Brachytron pratense		x		x	x			x					x	x	x	7
Calopteryx splendens	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Calopteryx virgo															x	1
Coenagrion puella				x								x	x			3
Enallagma cyathigerum	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Erythromma najas	x	x	x	x		x	x		x	x	x	x	x	x	x	13
Ischnura elegans	x	x	x	x		x	x	x	x	x	x	x	x	x	x	14
Libellula depressa							x	x								2
Libellula fulva	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Platycnemis pennipes	x	x	x	x	x	x		x	x	x	x	x	x	x	x	14
Pyrrhosoma nymphula	x	x	x	x	x	x		x	x	x	x	x	x	x	x	14
Sympetrum striolatum		x		x	x	x	x	x	x	x	x	x	x	x	x	12
Unidentifed					(x)									(x)		2
Total	8	11	8	12	7	9	8	9	9	9	10	11	12	10	11	

My relative inexperience in flight identification under the pressure of the five minute deadline for each plot probably meant that some species were under-recorded, especially the blue Zygoptera such as *Coenagrion puella* (L.), because only individuals that were certainly identified were counted. Nevertheless reasonable confidence is felt that the overall results reflect the true status of each plot.

A total of fourteen species was positively identified during the survery (Table 1), of which eight species are Zygoptera. No plot had fewer than seven species (plot 5), and plots 4 and 13 each had twelve species. Species numbers and odonate biomass (Fig. 1) are only weakly correlated.

Plot 12 has the highest biomass, about double that of any other plot, but this is due to an atypically high count on one date, 5 May 1997, when *Enallagma cyathigerum* (Charpentier) was taking advantage of an abundant coverage of Duckweed (*Lemna* sp.) that had built up where a small spate stream entered the river proper. Several tens of square metres were covered, seemingly providing ideal conditions for the blue Zygoptera. However this was only for a brief period, because at the first heavy rainfall all the unanchored vegetation was washed downstream and over the weir. Merely relating the absolute numbers against each plot does not address the question set out in the introduction: does bankside disturbance affect Odonata distribution?

The numbers of species present on the river, the canalized river and the canal, under different degrees of trample, are shown diagrammatically in Figure 2. These data are inconclusive but areas that show some degree of trampling (grades 1 and 2) usually support more species than

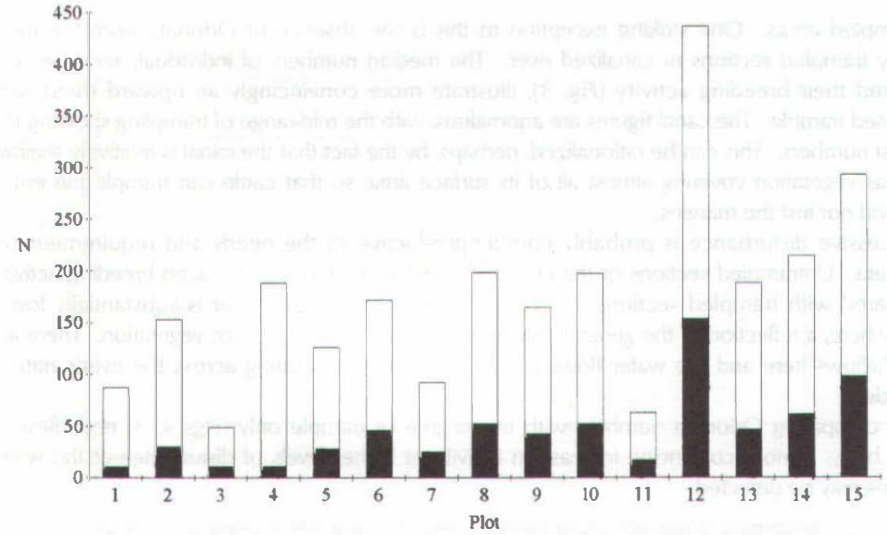

Figure 1. Number of Odonata individuals, with those showing evidence of breeding (solid portion of column), at each of the plots. N = number of individuals.

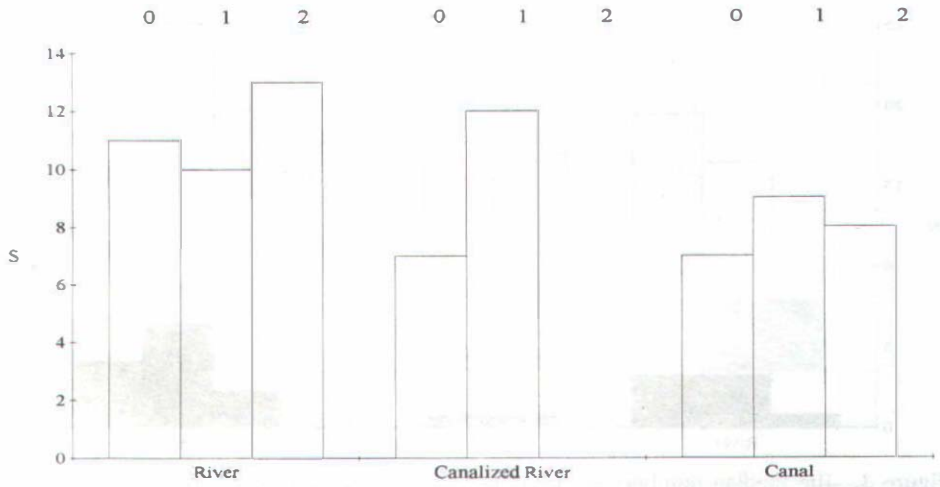

Figure 2. The number of species (S) of Odonata in plots on the river, canalized river and canal in relation to the degree of trampling (graded 0 to 2, see text).

untrampled areas. One striking exception to this is the absence of Odonata from the most heavily trampled sections of canalized river. The median numbers of individuals recorded per day, and their breeding activity (Fig. 3), illustrate more convincingly an upward trend with increased trample. The canal figures are anomalous, with the mid-range of trampling showing the highest numbers. This can be rationalized, perhaps, by the fact that the canal is relatively shallow and has vegetation covering almost all of its surface area, so that cattle can trample the entire area and not just the margins.

Excessive disturbance is probably counter-productive to the needs and requirements of Odonata. Untrampled sections of the river and canal show generally reduced breeding activity compared with trampled sections, but breeding on the canalized river is substantially lower everywhere, a reflection of the generally steeper banks and lack of aquatic vegetation. There are few shallows here and the water flows fast at times of flood, cutting across the river's natural meander.

By comparing Odonata numbers with the degree of trample only (Figs 4, 5) regardless of water body, a more convincing increase in activity at higher levels of disturbance at the water margins may be detected.

Conclusion

The above preliminary results of this survey show in a quantitative way what I felt by observation to be the case. That is, any major bank reconstruction will be deleterious to the well-being of Odonata species.

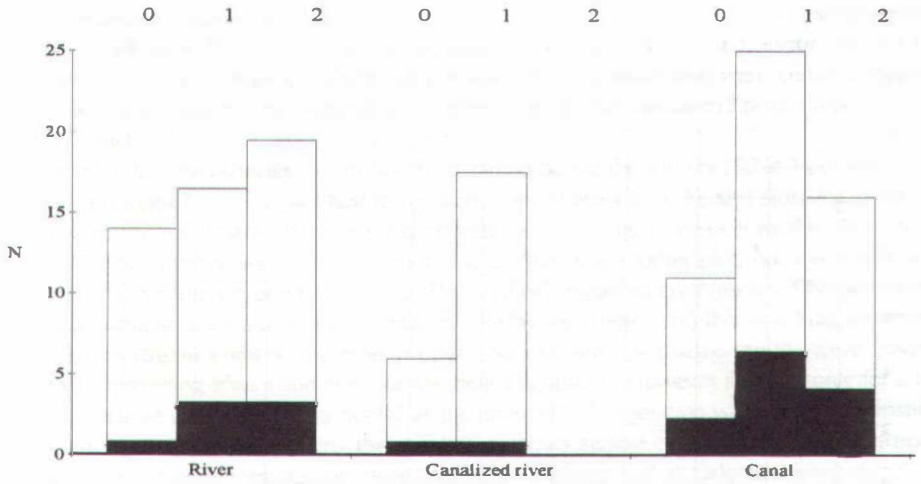

Figure 3. The median numbers of individuals per day (N), and those showing evidence of breeding (solid portions of columns), on the river, canalized river and canal in relation to the degree of trampling (graded 0 to 2, see text).

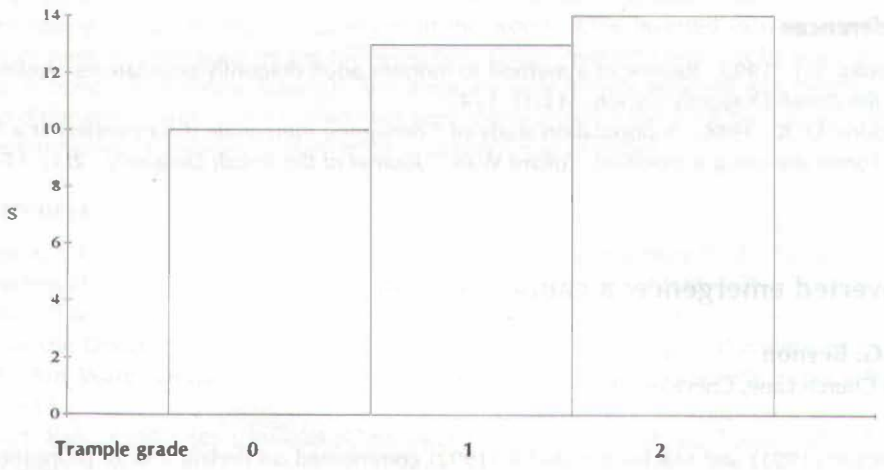

Figure 4. Number of species of Odonata (S) in relation to the degree of trampling.

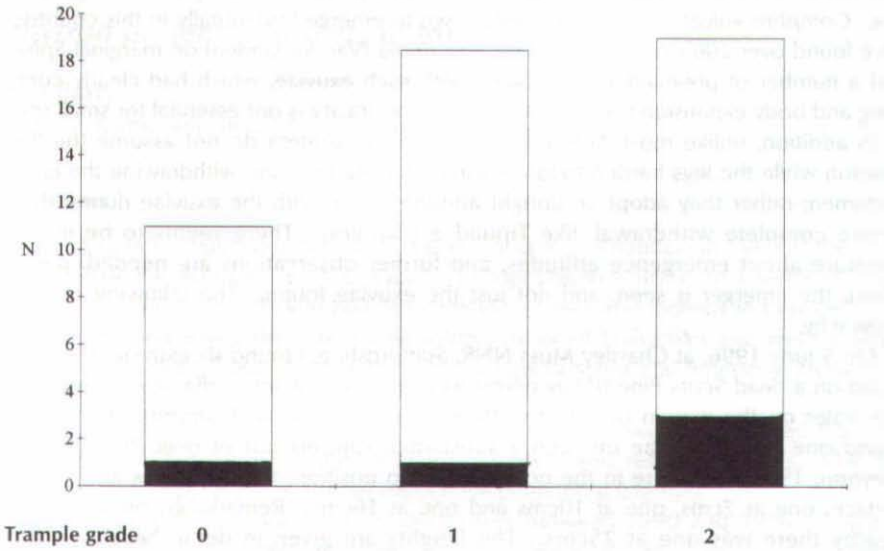

Figure 5. Median numbers (N) observed on a recording day of individual Odonata, and those showing breeding activity (solid portions of columns), in areas with differing degrees of trampling.

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Inverted emergence: a cautionary note

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Thickett (1991) and Mackenzie Dodds (1992) commented on finding a large proportion of the exuviae of *Ischnura elegans* (Vander Linden) head down, indicating that the emerging imago had exited initially in an inverted position, before presumably righting itself to facilitate successful wing and abdomen expansion under gravity.

Corbet (1962) states that some lithophilic Zygoptera can expand their wings horizontally, and quotes Robert (1958), who claimed that Gomphidae are unique in being able to do this. *Gomphus vulgatissimus* (L.) is well known to emerge horizontally in this country, and I have found over 200 exuviae of *Leucorrhinia dubia* (Vander Linden) on marginal *Sphagnum*, and a number of pre-maidens associated with such exuviae, which had clearly completed wing and body expansion horizontally, so perhaps gravity is not essential for small species.

In addition, unlike most Anisoptera, emerging Zygoptera do not assume the 'layback' position while the legs harden before grasping the support and withdrawing the end of the abdomen; rather they adopt an upright attitude in line with the exuviae during the pause before complete withdrawal, like Tipulidae (Diptera). There seems to be little in the literature about emergence attitudes, and further observations are needed, particularly where the emerger is seen, and not just the exuviae found. The following observations show why.

On 5 June 1996, at Chartley Moss NNR, Staffordshire, I found six exuviae of *Leucorrhinia dubia* on a dead Scots Pine (*Pinus sylvestris*) trunk, some 4cms in diameter, projecting from the water on the margin of Shooters Pool. This is an atypical support. I had only ever found one other exuviae on such a substantial support out of over 2000 seen *in situ* (Beynon, 1995). All were in the normal head-up position; three at 5cms above the water surface: one at 7cms, one at 10cms and one at 16cms. Remarkably, on a similar stump nearby there was one at 25cms. The heights are given in detail because in 1996 a substantial proportion emerged well above the usual height of 2–3cms. On 9 June there were two new exuviae on the trunk, but only two of the lowest three seen on 5 June remained, and these were now inverted.

Inversion was almost certainly caused by a severe thunderstorm on 7 June. Prodding

one of the exuviae with a grass stem showed that it was firmly attached, some of the tarsal claws having caught in small irregularities in the wood. One inverted exuviae remained until 21 June, but had gone by the following day. Other inverted cases can be seen on the usual *Eriophorum* or *Juncus* supports, but these are only loosely attached and clearly have been dislodged by wind or rain. Had I not seen the exuviae on the trunk on 5 June, I could have erroneously concluded that inverted emergence had occurred.

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Brachytron pratense (Müller) in Mid-Argyll

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Introduction

The Hairy Dragonfly (*Brachytron pratense*) was discovered in Knapdale in 1989 at the Dubh Loch. Knapdale lies 40 miles south of Oban. Its topography consists of a series of knaps (rocky ridges) running SW/NE with hollows containing mires and lochans in between. The knaps were formed when the intensively folded rocks of Dalradian age were eroded. Generally they are acid Crinan Grits with small pockets of schist and limestone giving local enrichment.

The area was once extensive ancient oak woodland but has been planted from the 1930s onwards. There is a mixture of mature conifers and restocked areas. Oak still survives on the steeper ridges and some mires have been left unplanted.

Lochs in Mid-Argyll were surveyed for dragonflies between 1990 and 1996. A search was made for exuviae and selected lochans were sampled for larvae. *B. pratense* was found just south of the Crinan Canal within an area of 35 x 15 km and breeding has now been proved at eleven lochs. The main population is centred on two sites, the Dubh Loch and Loch Barnluasgan.

Dubh Loch

The main site for *B. pratense* is the Dubh Loch, 120 x 50m in area, lying 30m asl. It has peaty margins but with pH 6.59 is less acid than its name suggests. Set in a clearing amongst mature conifer plantation, it has broad-leafed woodland to the east, and mires lie to the north and south with Greater Tussock Sedge (*Carex paniculata*) dominant. Willow scrub lies to the west. Wide stands of Saw Sedge (*Cladium mariscus*) fringe the western margin. Emergent vegetation includes Bulrush (*Scirpus lacustris*), Bottle Sedge (*Carex rostrata*) and Water Horsetail (*Equisetum fluviatile*). Floating vegetation consists of White water-lily (*Nymphaea alba*) and Broad-leaved Pond weed (*Potamogeton natans*).

Loch Barnluasgan

Loch Barnluasgan lies one kilometre to the north-west of the Dubh Loch at the same altitude. It is a large open loch (500 x 100m) which holds a good population of *B. pratense*. Oak woodland is on the eastern shore, rough grazing land to the west and fringing alder carr to the south.

A small promontory on the north-east shore provides sheltered bays to the north or south dependent on the wind direction. This is a favoured area for *B. pratense* along with the northern and southern bays. Bulrush is present as well as small areas of Saw Sedge but Common Reed (*Phragmites australis*) forms the dominant vegetation in the sheltered areas.

Other sites

The remaining nine sites lie within a 1.5km radius of the Dubh Loch, with Loch Coille-Bharr and Loch Barnluasgan forming the north-western edge. They vary in size from pools to large lochs but all lie within 30–60m above sea level. Two additional lochs in the area at an altitude of 130–150m are not used by *B. pratense*.

An important feature is the presence of floating detritus which *B. pratense* uses for egg-laying. Bulrush is ideal as it has thick stems with many pores, enabling it to float well. It grows in all the main breeding lochs. The three sites without it have only small breeding numbers. Also necessary is a ring of emergent vegetation at the water's edge, or high banks, to trap the floating detritus which would otherwise be washed up at times of high water-levels. A major emergent plant is Saw Sedge, which is not common in Mid-Argyll, but is present in 55 per cent of the breeding lochs. *B. pratense* lays eggs into its fleshy leaves.

Breeding information

From 1991 a detailed study was made at the Dubh loch and Loch Barnluasgan.

Emergence

To establish emergence dates, visits were made every two to four days during May and early June from 1991 to 1996. The main breeding areas were searched thoroughly. Any emergence was recorded and exuviae found were collected and sexed.

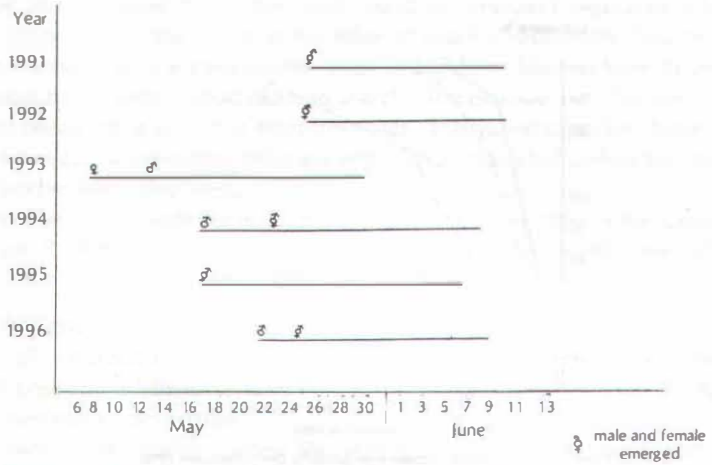


Figure 1. Emergence period for *Brachytron pratense* at all sites

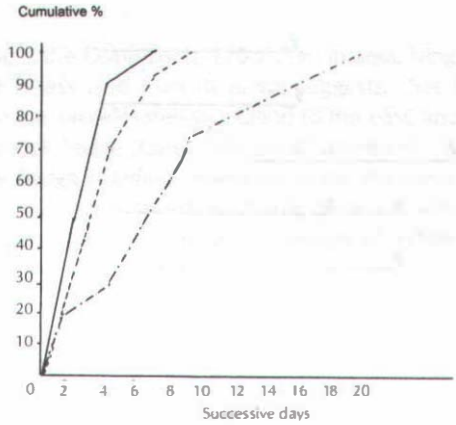
The main emergence period was the third and fourth weeks of May dependent on weather conditions (Fig. 1). Emergence takes place from 21 May onwards even in poor conditions. *B. pratense* can emerge with air temperatures as low as 11°C and water temperature 13°C. On 28 May 1996, during a particularly poor spring, emerging dragonflies were seen in torrential rain. The fully expanded wings were shedding the rain, and water droplets were standing on the hairy body. Emergence had probably started in the early morning before the rain. They had flown by the following morning. The Four-spotted Chaser (*Libellula quadrimaculata* L.) was emerging under similar conditions.

In 1993 early emergence occurred at Loch Barnluasgan. The high water temperature of 17°C and air temperature of 20°C triggered emergence on 7 May which continued until 14 May, stopping when conditions deteriorated, but resuming on 21 May.

Generally over 50 per cent of the population emerge in the first four days of emergence. In 1991 over 90 per cent of the population at the Dubh Loch emerged during this time (Fig. 2). The emergence period at a site can be less than 10 days. However during the poor weather of 1996 this was extended to 19 days with over 50 per cent of the population emerging in 8 days.

Emergence was usually witnessed in warm, muggy weather, rarely in full sunshine. It was most often seen in the morning, having possibly started at dawn, with the imagines flying by midday. However on 22 May 1994 a female was starting to emerge from the exuviae at 1400h and on 19 May 1994 after a cool day, 11°C, a male was still emerging at 1910h. It had barely climbed up the *Carex rostrata* and the hanging wings were just clearing the water. It had not moved by 2030h but had flown by 0630h the following morning.

In half of the six years of observations both males and females emerged at the same time. However the high temperatures of May 1993 triggered female emergence and it was five days later before the first male exuviae was seen. In 1990 a female was observed egg-



Cumulative percentage of noted emergence in 1991, 1993 and 1996
Emergence first noted 24 May 1991, 16 May 1993, 21 May 1996

Figure 2. Emergence pattern at the Dubh Loch

laying on 25 May when males were still emerging. In 1994 and 1996, when conditions were poor, males emerged 3-4 days before females. More male exuviae were found than female with a ratio of 64:53 over six years (Table 1). However the proportions varied so erratically during some of these years that no positive conclusions on sex ratios can be reached.

The Dubh Loch is set in a sheltered clearing, hence the water warms up more quickly than at Loch Barnluasgan, with water temperatures usually being one or two degrees higher at the former site. Emergence was usually earlier here. Within the Dubh Loch itself, it was also earlier in the northern bay where the water was generally 2°C higher than in other parts of the loch.

Table 1. Number of exuviae of *Brachytron pratense* found in the study area from 1991-1996.

	Dubh Loch				Loch Barnluasgan			
Year	**Male**	**Fem.**	**?**	**Total**	**Male**	**Fem.**	**?**	**Total**
1991	8	8	5	21	7	3	0	10
1992	5	8	2	15	1	4	0	5
1993	4	6	2	12	5	9	3	17
1994	10	4	1	15	1	2	0	3
1995	4	1	0	5	2	1	0	3
1996	16	3	0	19	1	4	0	5
Total	**47**	**30**	**10**	**87**	**17**	**23**	**3**	**43**

Exuviae and emerging dragonflies were found on emergent vegetation within one metre from the shore. Often they were at the edge of fringing vegetation close to where detritus had been trapped, or near steep banks where it had been blown closer to the shore. Small inlets in peat banks were a good place to search. The exuviae were between 5-40cm above water-level on anything emerging from the water. This varied from Saw Sedge and Common Reed to Bogbean *Menyanthes trifoliata* and Water Horsetail. Heather stems, roots and willow branches were also used.

The exuviae of *L. quadrimaculata*, emerging at the same time, were closer to the bank. Rarely were *B. pratense* exuviae found on shore vegetation and this was after high water-levels.

General behaviour

Adults usually returned to the loch to breed 2-3 weeks after emergence. However in 1990 and 1992 breeding adults were seen on 25 May and 29 May respectively, having emerged no more than twelve days earlier.

Males were seen patrolling along the edge of fringing vegetation just above water-level from 25 May to mid-June. They were strongly territorial, flying a regular beat and chasing away any intruders including *L. quadrimaculata*. The northern bay of the Dubh Loch and the western fringe of Saw Sedge were the most favoured areas. The males repeatedly patrolled 15-30m of this area then flew up and across the loch to the opposite shaded shore, soon returning to patrol the tall sedges again. A maximum number of 8 territorial males was seen on 7 June 1989. Regularly active were 4 to 6 males, patrolling a loch shore of approximately 300m, with an average territory of 40-80m.

Pairs were seen *in copula* from early to mid-June, with a maximum of 3 pairs on 1 June 1989. They would often fly in tandem to willow or other shrubs. Here they would remain for several minutes before flying off, sometimes into higher tree canopy away from the loch.

Oviposition

Egg-laying females were usually inconspicuous, staying close to the bank or vegetation. Often they were located only by the rustling of their wings. They oviposit in the floating detritus of Bulrush, Water Horsetail and rotting wood. Water-lily and Saw Sedge leaves are also used.

A female was observed for eight minutes on 15 June on a piece of floating Bulrush 6cm long. She grasped it firmly then pierced it with her ovipositor on the top and on both sides moving backwards and forwards. She then moved on a few centimetres to oviposit in the next detritus and then on to submerged Saw Sedge. A male in the same area was independently patrolling.

Oviposition was regularly observed from late May to late June. However a single female was ovipositing briefly on 24 July 1992 which was much later than the usual flight period.

Larvae

Larvae have been found from May to November. They were near the surface amongst trapped detritus, often clinging upside down to the underside of it. When the larvae were disturbed they remained motionless for some time even after being returned to the loch.

Table 2. Measurements of *Brachytron pratense* larvae found in the study area, November 1992–June 1993.

	Size in millimetres						
Date	**16–17**	**18–19**	**20–21**	**29–30**	**31–32**	**33–34**	**35–36**
11/10/92				1	5		
07/11/92	1					2	
07/12/92				none seen			
07/01/93				none seen			
07/02/93				none seen			
01/03/93				none seen			
07/04/93				none seen			
07/05/93						3	5
12/05/93		1					1
22/05/93	1	1				1	
11/06/93		2					

From October 1992 to June 1993 a small section of the Dubh Loch, where emergence occurs, was sampled for larvae every month. The larvae were difficult to find and only the area close to the shore could be sampled. Any larvae found were measured (Table 2).

The larvae were all close to a band of Bottle Sedge 1m from the shore and in water less than 50cm deep. The majority of the larvae found in October and November were in their final instar (31–33mm). None was seen between November and May, having possibly moved to deeper water. By May the larvae had grown to 33–36mm. Metamorphosis had started to occur with histolysis (retraction) of the labium which was visible beneath the larval prementum. This process had just started in some larvae of 34mm and was nearing completion in larvae of 36mm with the adult labium a third of the size of the prementum. Emergence occurred from 1–5 days later.

Measurements of a sample of 40 exuviae were 35–40mm with an average of 37.5mm. Exuviae collected from the same area as metamorphosing larvae were 2mm larger than these larvae, possibly because of stretching of larvae just prior to and during emergence.

Only one small larva (16mm) was found in November but others of 16–21mm were found in May and June suggesting that larvae take more than two years to reach maturity.

Discussion

B. pratense is a southern species. It was first found in Scotland at the Black Lochs near Oban (Smith & Smith, 1984). The Black Lochs is a complex system and, with its neighbouring small lochans, supports a good population. Though only small numbers of adults have been seen at any one time, 17 exuviae were found in one small area of Saw Sedge in June 1992. There is one other site near Oban. As well as the Argyll sites there are also records from four sites in Kirkcudbright.

The Mid-Argyll area, with eleven breeding sites, contains a significant proportion of the Scottish population. The Dubh Loch is the main site in the Knapdale complex having the highest population in what appears to be an ideal habitat. It is sheltered with fringing vegetation to trap floating detritus and bulrush which provides it. Saw Sedge occurs here and in many of the other *B. pratense* lochs, forming dense bank-side vegetation broken by small inlets. It is a fen species, growing in mesotrophic to eutrophic conditions and is uncommon in Scotland. All sites have Saw Sedge and Bulrush or are within close proximity to those that do.

The highest number of adults recorded on one visit was 14 (8 territorial males plus 3 pairs) at the Dubh Loch, the most seen together in Scotland. A maximum of 21 exuviae was found here in 1991 with an average 15 exuviae annually for the six years studied. This represents just part of the total population as it was not possible to search all the loch shore. Loch Barnluasgan also has a good population with a maximum of 17 exuviae found in one year though 3-10 were more usual.

All sites were 30-60m asl. As these sites are near the northernmost end of *B. pratense* distribution in Britain, a sheltered lowland situation is probably essential. It has not yet been seen in the adjacent lochs above this height.

Other species flying with *B. pratense*, in addition to *Libellula quadrimaculata*, were the Azure Damselfly (*Coenagrion puella* (L.)), the Common Blue Damselfly (*Enallagma cyathigerum* (Charpentier)), the Blue-tailed Damselfly (*Ischnura elegans* (Vander Linden)), and the Golden-ringed Dragonfly (*Cordulegaster boltonii* (Donovan)). Other mainly southern species found at the Black Lochs, namely the Variable Damselfly (*Coenagrion pulchellum* (L.)) and the Downy Emerald (*Cordulia aenea* (L.)), are absent.

The emergence dates of *B. pratense* are similar to those given by Corbet *et al.* (1960) and Hammond (1985) though exceptionally early individuals have been recorded in late April elsewhere. Emergence appears to be influenced by day length as it starts by the third week in May despite poor weather conditions. The concentrated emergence period, with over 50 per cent of the population emerging in the first four days, follows the pattern of a Spring species (Corbet *et al.*, 1960). Diapause in the final instar from early autumn ensures this synchronized emergence in spring. High temperatures can trigger early emergence, particularly of females.

Sampling data point to the fact that larvae spend over two years in development in Argyll. Corbet *et al.* (1960) state that over two years is usual for *B. pratense* larvae. The larval behaviour of lying motionless when disturbed was also noted.

Forest Enterprise is aware of the importance of the Knapdale Lochs and they are now included in the Caledonian Forest Reserve complex. Scalloped clearings have been created with unplanted corridors linking lochs. However the area includes extensive new plantations and mature forestry, so future monitoring and management will be required.

Acknowledgements

I am grateful to Howard Embleton and Moira Baptii of Forest Enterprise for their co-operation, to Bob and Betty Smith for their advice and encouragment, and also to Professor Philip Corbet for his advice.

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On the mysterious occurrence of *Coenagrion mercuriale* (Charpentier) at Cothill

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Cothill is a village in Oxfordshire (Watsonian Berkshire, VC 22), two miles north-west of Abingdon. The local geology is Corallian limestone and sand. There are calcareous fens with peat formation in valleys. Areas of odonatological interest include breeding sites in the form of flooded sand-pits, a system of calcareous streams, valley fen with pools and also woodland and hedgerows which may harbour species breeding at more distant water bodies such as the Thames, two miles away. The most important sites are managed as nature reserves. The Berkshire, Buckinghamshire and Oxfordshire Naturalists' Trust (BBONT) manages Dry Sandford Pit, with streams and flooded workings, Hitchcopse Pit, which lacks permanent standing water, Lashford Lane Fen, with streams and Parsonage Moor which is valley fen with streams and boggy pools (Young, 1989). Adjacent to Parsonage Moor the fen continues into Cothill National Nature Reserve (Marren, 1994), formerly known as the Ruskin Reserve (Walker, 1926). The fenland is figured by Ford (1972). The area has been worked by generations of entomologists (Walker, 1926) and specimens from many insect groups are preserved in the Hope Entomological Collections, Oxford. A county mapping scheme (Campbell, 1983) showed Cothill to be of special local importance as the only area for *Ceriagrion tenellum* (Villers) and one of a few localities for *Coenagrion pulchellum* (Vander Linden) in Oxfordshire. In additon there are historic records of *Brachytron pratense* (Müller), *Orthetrum coerulescens* (Fabricius) and *Sympetrum danae* (Sulzer) (Brownett, 1996).

From 1986 to 1991 I made regular visits to the Cothill sites and so developed a working knowledge of the local Odonata, recording the following species: *Pyrrhosoma nymphula* (Sulzer), *Ceriagrion tenellum*, *Ischnura elegans* (Vander Linden), *Enallagma cyathigerum* (Charpentier), *Coenagrion puella* (L.), *C. pulchellum*, *Gomphus vulgatissimus* (L.) (one female in 1987), *Aeshna cyanea* (Müller), *A. mixta* Latreille, *A. grandis* (L.), *Libellula depressa* L., *L. quadrimaculata* L., *Sympetrum striolatum* (Charpentier) and *S. sanguineum* (Müller). In late July 1991 a male *Coenagrion* was seen fluttering over

Figure 1. Second abdominal segment markings of male *C. mercuriale* from Cothill

rough herbage in the vicinity of the Ruskin Reserve pond. It was obviously something out of the ordinary and was caught for closer examination. It was a male *C. mercuriale* with genitalia, pronotum and other anatomical features appropriate to the species. The dark markings were less extensive than those of the form from the New Forest and Dorset but similar to those figured by Mayo & Welstead (1983) from the Hampshire chalkstreams. It was a surprising find as the Cothill district had been worked by generations of entomologists without yielding *C. mercuriale* and there was no verified record of the species from an inland county. Nevertheless, Cothill has visually suitable habitat for *C. mercuriale* in the form of small streams flowing over peat and the district is known for a number of local Odonata and other insects including *Tettigonia viridissima* (Orthoptera: Tettigoniidae), *Forficula lesnei* (Dermaptera: Forficulidae) (Paul, 1989), *Myrmica schencki* (Hymenoptera: Formicidae) (Jarman, pers. com.) and numerous Coleoptera (Walker, 1926).

Returning in 1993 from work overseas, I visited Cothill repeatedly in an effort to confirm the continuing presence of *C. mercuriale* but without success. Searches during 1994 and 1995 were similarly fruitless. In 1994 I visited the Itchen Valley to become acquainted with the chalkstream form. The habitat where *C. mercuriale* occurred was visually similar to streams in the Cothill district and the insects are similar in pattern to the Cothill specimen (Figure 1).

Possible explanations for the Cothill find include: accidental or deliberate introduction; that it was a vagrant from Hampshire; that there is a resident population but at very low density; that it was a stray from an undiscovered colony somewhere in the vicinity. I favour the last explanation. This record illustrates the need for entomologists to expect the unexpected and that even a well-worked locality may yield surprises. It emphasises the entomological importance of the Cothill district. The fenland vegetation at Cothill is vulnerable to trampling and access to the more sensitive areas is by permit only. I thank BBONT for permission to visit these sites.

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Hornet predation on a dragonfly

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On the 27 September 1996, whilst talking to a friend on the edge of Monks Wood National Nature Reserve, Huntingdonshire (TL 2079), I saw a dragonfly falling out of the air. The dragonfly, a female Southern Hawker (*Aeshna cyanea* (Müller)), had been hawking around the edge of the wood for some time. As it approached the lower branches of a young oak tree it dropped suddenly, spiralling down to the ground in a similar fashion to that of a sycamore seed. On closer inspection we observed the dragonfly lying on its back with a hornet (*Vespa crabro* L.) holding on to the dragonfly's thorax. For two to three minutes the hornet could be seen stinging the dragonfly in the thorax, sedating it. The hornet proceeded to bite off the middle and hind legs on the right and the middle leg on the left side. Then, in an apparently systematic manner, the hornet worked from left to right removing the exoskeleton of the thorax, starting at the head end. With the exoskeleton removed, still working from left to right, the hornet ate the contents of the thorax. Standing over the hornet, it was possible to hear the sound of it breaking up the dragonfly's thorax. After approximately fifteen minutes the hornet stopped feeding and flew slowly around the area, obviously heavy from its meal, before flying into the wood.

In the literature I have read following my observations, most cite manoeuvrability as the main mechanism of dragonfly defence against avian predators, although small falcons such as hobbies are the obvious exception (Askew, 1988; Corbet, 1962; Miller, 1987). Examples of predators are given, such as birds, spiders and even crocodiles (Corbet, 1962)! In this case

manoeuvrability was no defence against the hornet which presumably used surprise, and an initial quick burst of speed, to capture its prey. I do not know if the weight of the hornet clinging on to the dragonfly brought the dragonfly to the ground or if the hornet stung it whilst in the air. On the ground it was quite clear that the hornet was avoiding the dragonflies mouthparts, suggesting the possibility that roles could be reversed.

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Notes and observations

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My thanks go to everybody who has supplied information for this section since its start in Autumn 1987. In order to have time to concentrate on other things, I have regretfully decided this will be my last compilation. I have learnt much and made many friends over the years, and hope that whoever follows me will have the same support as I have enjoyed.

Mistaken identity?

On 29 May 1997 at Rushy Pond, Thorncombe Wood, Dorset, two male Broad-bodied Chasers (*Libellula depressa*) holding territories harried a queen Hornet (*Vespa crabro*) which had come to the pond edge for water. Was this a case of mistaken identity for a female *depressa*? (IC)

Food for a Sparrowhawk?

On 1 September 1997 at Saltwells LNR good numbers of Brown Hawker (*Aeshna grandis*) and several Migrant Hawkers (*Aeshna mixta*) and Common Darters (*Sympetrum striolatum*) were hawking around the Settling Pool. A smallish female Sparrowhawk (*Accipiter nisus*) came over the bank and just over the tops of the trees less than 100 feet away and chased something small very acrobatically before dropping down the bank again; it appeared to have been unsuccessful. It was then observed about 130 feet away, again chasing something small which was seen to be an aeshnid, possibly *A. grandis*, not *mixta*. Once again it failed to catch it. (TGB)

Emergence from hard mud

On 15 August 1995 at Seaton Valley Pond, Cornwall, what appeared to be the 'remains' of a Common Darter (*Sympetrum striolatum*), consisting of head and thorax lying upright on the

ground, turned out to be a live dragonfly embedded in dry mud up to its thorax, with the almost undamaged wings just above ground level. The insect tried unsuccessfuly to take off, so the mud was carefully dug away revealing the intact abdomen firmly embedded in the ground. It must have been there some time as the abdomen was red, indicating a male specimen. After about five minutes digging, the Darter was free to fly away without difficulty.

On 14 Septermber 1996 at the same locality a similar incident occurred in identical circumstances. This time however, there were about 20 other 'holes' in the ground, of the same diameter as that recently vacated, and it is possible these were caused in the same way, though no dragonflies were found in them. (LT)

Feeding whilst mating

On 10 August 1996 near Tresemple Pool, Cornwall, a pair of Golden-ringed Dragonflies (*Cordulegaster boltonii*) were noted in the wheel position with the female eating a White-tailed worker bumble bee as she mated. (CDG)

Range expansion

On 15 October 1996 at Great Pool, Tresco, Isles of Scilly, the first record of Golden-ringed Dragonfly (*Cordulegaster boltonii*) for the Isles was made. (CDG)

On 5 May 1997 the Hairy Dragonfly (*Brachytron pratense*) was recorded for the first time at Fowlmere Reserve, Cambridgeshire. There were still 2 present on 28 May, by which time a maximum of 6 had been seen. (RSPB)

Unusual markings

On 10 June 1996 at Polquick, Cornwall, a male Beautiful Demoiselle (*Calopteryx virgo*) was seen which appeared to have distinctive yellow anal appendages.

On 18 June 1996 at Hayle Kimbro Pool, Cornwall, a spectacular example of Four-spotted Chaser (*Libellula quadrimaculata* var. *praenubila*) was seen. The dark wing-patches and golden coloration of the veins were unusually extensive, and the two white stripes on the top of the thorax were quite unexpected. A superb photograph by Steven Jones appears in the CDG Newsletter No. 7 (reviewed in the previous BDS Newsletter). (CDG)

Observers/Sources

(TGB) T. G. Beynon, 34 Church Lane, Checkley, Stoke-on-Trent, Staffordshire ST10 4NJ.
(IC) I. Cross, c/o Dorset Countryside, The Barracks, Bridport Road, Dorchester, Dorset DT1 1RN.
(LT) L. Truscott, 59 Cremyll Road, Torpoint, Cornwall PL11 2DZ.
(CDG) Cornwall Dragonfly Group Newsletter No. 7 (May 1997).
(RSPB) Royal Society for the Protection of Birds.

The Editor welcomes short notes for future publication in this section.

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
Ceriagrion 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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