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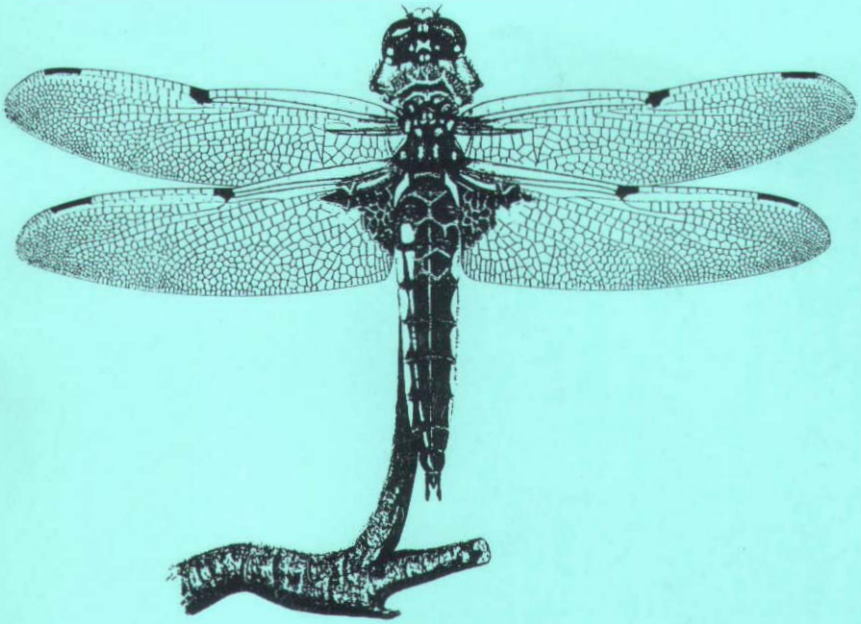

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ADDRESSES

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Front cover illustration of male *Libellula quadrimaculata* L. at rest by Roderick Dunn

The outpost populations of the Banded Demoiselle *Calopteryx splendens* (Harris) in the Solway Firth area, Cumbria: historical perspective and recent developments

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The Solway plain of Cumbria holds the most north-westerly populations of this species in Britain (Map 1). These occupy an extremely isolated position and, strangely, the species seems never to have been recorded in more southerly parts of the county. There are only two very old and uncertain records further north, in Scotland. The nearest colonies on the west of the Pennines are some 120km to the south of the Solway, on the River Lostock near Preston, Lancashire. The latter is itself on the northern edge of the main range of this species of sluggish lowland rivers.

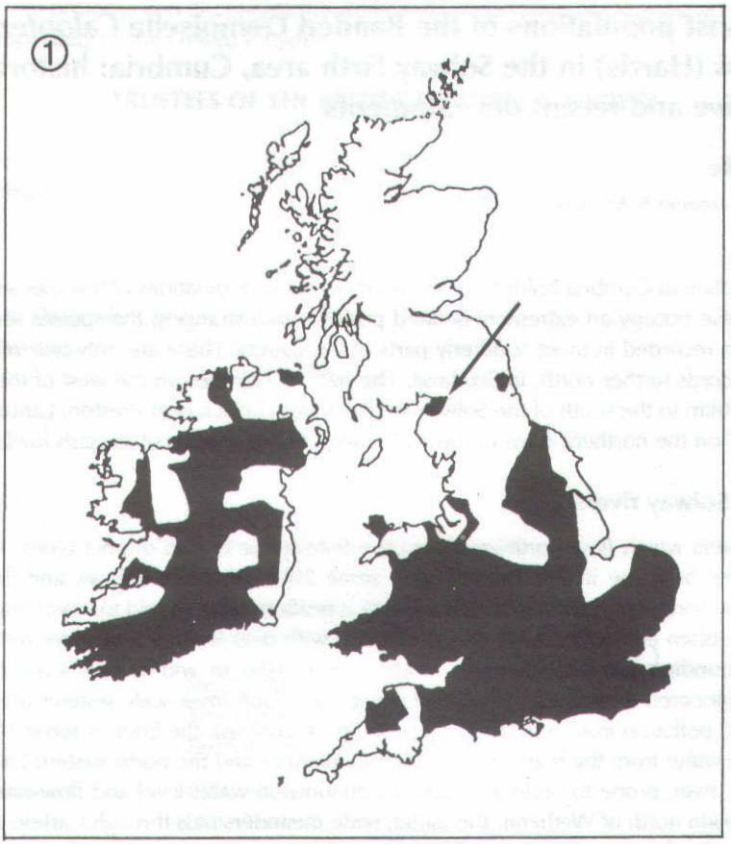
The south Solway rivers

The three rivers which flow northwards into the Solway are of two distinct types. The Waver and Wampool both rise in the low fells only some 20km from the Solway, and flow mainly through a low-lying, open plain in which dairying is predominant. In mid to lower reaches, their channels are often embanked (and thus sheltered), with river level at 3 or more metres below that of surrounding pasture. Channels rarely exceed 10m in width, and some have been variously engineered in the past to improve water flow. Such small-scale systems are especially vulnerable to pollution from industry or agriculture. In contrast, the Eden is some 100km long and receives water from the high fells of both the Pennines and the north-eastern Lake District. It is a 'spate' river, prone to rapid and large fluctuations in water level and flow-rate. It enters the Solway plain north of Wetheral; thereafter, wide meanders pass through Carlisle to the river mouth some 10 kilometres beyond. The Caldew and Petteril are major north-flowing tributaries, entering the Eden at Carlisle. They are probably too fast generally for *Calopteryx splendens* – indeed the Petteril used to hold *C.virgo*.

Overview of records

There appear to be no records of the Banded Demoiselle from the Solway area before 1936. The well-known Carlisle entomologist F. H. Day (1875–1963) gave several accounts of 'Cumberland Odonata'. In his 1943 paper (Day, 1943) he refers to the species as having been reported to him from Wigton, and from the river Eden near Carlisle. Day saw it in good numbers on the Eden 'a couple of miles' downstream of Carlisle in June 1942. His account suggests that it was by no means widespread along this part of the river. He also makes it clear that the species had been unknown to him from the county when he wrote his previous account in 1928.

The lack of earlier records is rather puzzling – and *Calopteryx splendens* is hardly an inconspicuous insect. There are no indications that it was noted by Victorian naturalists – and



Map 1: British and Irish distribution of the Banded Demoiselle. The Cumbrian populations are indicated by a pointer. (Reproduced and adapted from Powell (1999) by kind permission of the publishers.)

Day himself had been an active collector since his early youth in the 1890s. Another entomologist/collector James Murray (1872–1942) actually lived for a few years in the mid 1920s at Kelsick near Abbeytown – close to the heart of the present Solway populations – yet there are no records of this species attributed to him. The possibility thus remains that its colonies had simply never been found by the few naturalists of the area until 1936. Another explanation – for which however there is absolutely no evidence – is that the species was accidentally, or even deliberately, introduced at some time during the early part of this century. The possibility of natural colonization of the Solway area at any time during this century seems remote.

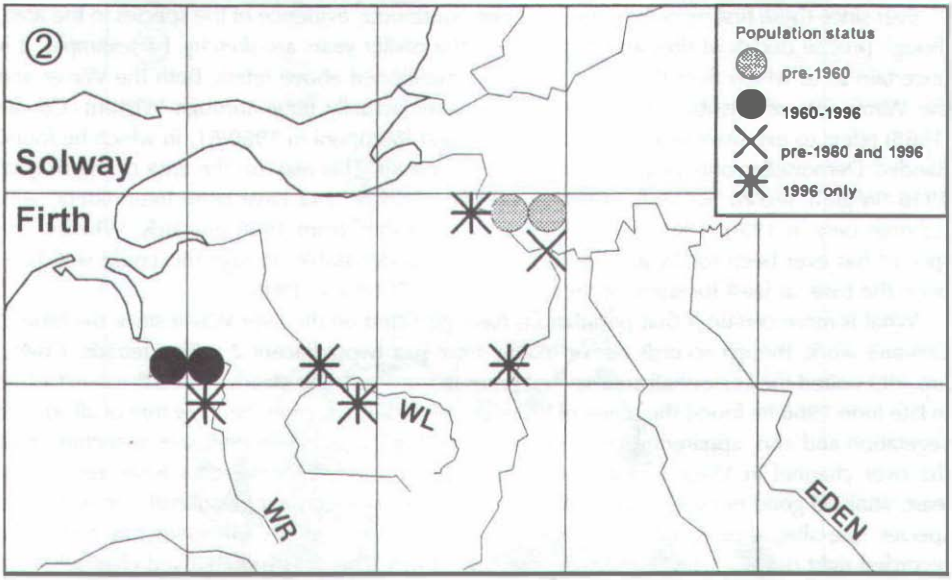
Ever since these first records, there has been continuous evidence of the species in the area, though precise details of sites and numbers for the earlier years are sketchy. For example, it is uncertain as to which river the 'Wigton' record mentioned above refers. Both the Waver and the Wampool are possible (a tributary of the latter actually flows through Wigton). Cowan (1968) refers to extensive searches of the Waver and Wampool in 1960/61, in which he found Banded Demoiselles only near Lessonhall on the Waver. This may be the area of the original 1936 'Wigton' record. Records from the river Eden since 1942 have been intermittent, with sightings only in 1950, 1968 (location assumed) and then from 1996 onwards. Whether the species has ever been totally absent from that river is debatable, though this could well have been the case, at least for some of the time between 1968 and 1995.

What is more certain is that populations have persisted on the river Waver since the time of Cowan's work, though records derive mainly from just two adjacent 2 x 2km tetrads. Cowan (op. cit.) visited the Lessonhall area several times in the 1960s; he clearly feared the worst when in late June 1968 he found the scene of his original 1960 discovery to be 'now free of all aquatic vegetation and also, apparently, of all *Agrion splendens*'. Despite the extensive re-sectioning of the river channel in 1962–3 and Cowan's comment, Banded Demoiselles have, recently at least, attained good numbers. This has especially been the case near Lessonhall – to which the species' site-allegiance is notable, though unexplained. *Calopteryx splendens* has now been recorded right down to the tidal limits near Abbeytown. The deeply embanked channels have overhanging Reed Canary-grass (*Phalaris arundinacea*) and Butterbur (*Petasites hybridus*), which provide the main perching sites for the territorial males. The only other Odonata species in this habitat are *Ischnura elegans* (Vander Linden) and *Pyrrhosoma nymphula* (Sulzer), though visiting adults of *Libellula quadrimaculata* L. and *Aeshna juncea* (L.) often occur.

The 1996 'dispersal' (Map 2)

1996 brought the only known instance (locally at least) of dispersal activity. From mid June onwards (i.e. quite early in the flight period), individuals were noted up to 20km east of the known breeding areas on the river Waver. Only males were definitely seen – but these are always the more conspicuous sex. Their presence was noted at several apparently suitable breeding locations on the rivers Wampool and Eden. There were two sightings of individuals at least 0.5km from typical breeding habitats – one being at a pond in a conifer plantation. Whilst most reports were of single, possibly 'pioneer' individuals, at one location on the Eden several were seen. At the same time, high populations of adults were recorded at the main breeding sites on the Waver. The details are reported in Clarke & Garner (1996).

What had prompted these events is not known. The 1995 summer had been exceptionally hot and dry, with near drought conditions, low water-levels and high water-temperatures. Possibly this had created a stress trigger in 1996 – for example through high breeding success in the 1995 season. However, this is purely speculative. Recent changes to the management of the riverbanks in the breeding areas may also have helped to increase population levels. Through the aegis of the Environment Agency, the flail-mowing regimes of channel banks on the Waver have been improved. This may well have reduced the harmful effects of such activities on breeding populations.

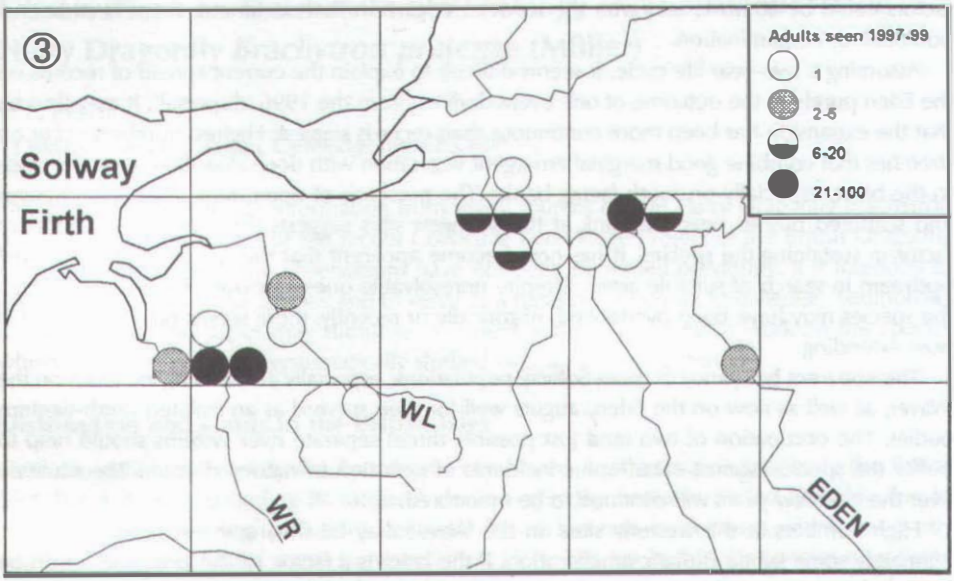


Map 2: The 1966 'dispersal' and earlier records of the Banded Demoiselle in the Solway plain, Cumbria. Non-localized records are omitted.
Symbol: 2 x 2km tetrads; grid interval: 10km (National Grid)
WR = River Waver; **WL** = River Wampool

Post-1996 developments (Map 3)

1997 produced further records from the river Eden, though not the Wampool. Most significantly, the area on the Eden near Cargo, where several individuals had been seen in 1996, now appeared to have numbers that suggested a possible resident population. The situation was similar in 1998 (Naylor, 1997, 1998) and large numbers were again reported at the Waver sites.

More systematic investigations in 1999 confirmed continued presence of Banded Demoiselles in the Cargo/Kirkandrews area from 26 May onwards – a date which itself indicated breeding presence. Significant numbers were also discovered on the Eden in the Park Broom/Low Crosby area, although breeding was not proved. The latter is an entirely new site and the first known east of Carlisle. Much more extreme were sightings 5km upstream of Wetheral (by which point only small pockets of typical habitat occur). The species is thus now recorded from the lowest 30km of the river, though with only one or two places within this range apparently holding any numbers. 1999 records have extended the previously known range upstream by some 20km. Dense stands of *Phalaris* at the water's edge has made observation of oviposition difficult, and there has been only one record – from Cargo. The fact that the adults in the Park Broom area were not to be seen on 12th July or thereafter possibly indicated that they had emerged relatively synchronously and then completed their breeding



Map 3: Status of the Banded Demoiselle in the Solway plain, Cumbria, 1997–99 inclusive. Based on seasonal maxima of adults per 100m of river-bank per visit.
Symbol: 2 x 2km tetrads; grid interval: 10km (National Grid)
WR = River Waver; **WL** = River Wampool

activities in the few weeks which followed. (The numbers present and the early date of first discovery made it unlikely that they had emerged elsewhere).

The Wampool was also checked at several locations in 1999. This resulted in finding very small numbers at the lowest reach, and occasional singletons elsewhere, even in stretches where the banks and marginal vegetation appeared especially suitable for the species. Records now extend from the tidal limit to some 17km upstream.

Reports from sites on the Waver in 1999 indicate that good numbers are still being maintained in the usual stretches of that river, though no comprehensive survey has been possible.

Discussion

The present situation of relatively high breeding numbers of the Banded Demoiselle on the lower Waver is in marked contrast to the adjacent Wampool. The limited presence of the species on the Wampool, despite the similarities of that river to the Waver, is curious. The records (all post-1995) indicate that although it has been reaching the river over the past few years, the species may not yet have attained a firm breeding foothold. Water quality is regularly monitored by the Environment Agency, and they report no obvious problems with fish or the invertebrate fauna from their sampling programmes. However, it is still possible that intermittent

factors could be at work, and with the town of Wigton in the catchment there is additional potential for contamination.

Assuming a two-year life cycle, it seems difficult to explain the current spread of records on the Eden purely as the outcome of one event deriving from the 1996 'dispersal'. It may thus be that the expansion has been more continuous than records suggest. Highest numbers occur on stretches that combine good marginal emergent vegetation with deep slow-flowing water close to the bank, especially on south-facing banks. The presence of open, rank vegetation, hedges and scattered bushes near the bank at the strongest sites suggests this may be an important factor in sustaining the species. It has now become apparent that the species may range well upstream in search of suitable areas. Despite unresolvable questions over the extent to which the species may have been overlooked, historically or recently, there seems no doubt that it is now extending.

The apparent buoyancy of these Solway populations, especially at breeding locations on the Waver, as well as now on the Eden, augurs well for their survival as an isolated north-western outlier. The occupation of two (and just possibly three) separate river systems should help to buffer the species against catastrophic incidents of pollution or natural disaster. The situation over the next few years will continue to be monitored.

High numbers at the westerly sites on the Waver may be driving this expansion, as may ultimately some subtle climatic amelioration. If the latter is a factor, similar processes might be expected at other northern 'edge-of-range' sites. Reports which the writer has received from north Lancashire and Durham this year certainly suggest that population levels are good, and that the species is being found at sites either not hitherto recorded, or in numbers which are greater than previously known.

Acknowledgements

I am grateful to my colleague at Tullie House Museum, Steve Hewitt, for comments and for producing the maps with 'RECORDER' and 'DMAP' software from records in the Museum's Biological Records database; also to Jane Atkins and Steve Garner of the Environment Agency (Cumbria), and to Geoff Naylor, Dorothy Iveson, Barry Marrs, Frank Mawby and Glen Bryson variously for their comments and records.

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Observations on the distribution, ecology and behaviour of the Hairy Dragonfly *Brachytron pratense* (Müller)

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This paper draws together information from many sources on the Hairy Dragonfly *Brachytron pratense*, collected as part of the recent Collective Knowledge Project of the British Dragonfly Society (BDS). Many of the observations have not been published previously. It is intended to act as an overview of the species and to serve as a baseline of current knowledge. Additionally it is hoped that the paper may stimulate comment and further research work on this species which has as yet not been systematically studied over an extended period.

Distribution and status in the British Isles

Until comparatively recently *Brachytron* was considered a rather scarce species in the British Isles, but it is now extending its range. A decline over the post-war period (possibly due to changes in land use and pollution), followed by an increase in numbers which has partly coincided with a series of warm summers since 1991, has resulted in the species now being recorded in many new areas. Evidence for this range expansion comes from a number of sources.

Although the species exhibits a markedly southern distribution in Britain, comparison of the maps in Hammond (1983) and Merritt *et al.* (1996) shows that although *Brachytron* sites in Surrey, Sussex, Kent and Somerset are very similar in the two publications, there are now more sites in Norfolk, Suffolk, Hampshire and South Wales in the later work. In the former county of Avon *Brachytron* has moved in recent years via woodland ponds into cultivated farmland, even reaching the edge of suburban sites. The *Brachytron* map in Merritt *et al.* (1996) also shows that it has been recorded from seven sites in Scotland where it was unknown previously (Smith & Smith, 1984), as well as at many new sites in Ireland (Rippey & Nelson, 1988). *Brachytron* was unrecorded in Worcestershire until 1978 (Kemp, 1981). The first sighting of *Brachytron* in Cheshire for 25 years was at Hatchmere in 1985 (Gabb & Kitching, 1992) and the first Warwickshire record for over 50 years was an immature male at Alvecote Pools NR on 27 May 1992 (Mitchell, 1993).

Habitat

Brachytron is associated with a variety of still water bodies – dykes, canals, ponds, lakes and flooded gravel pits, as well as some slow-flowing rivers. The size of such water bodies can vary considerably; some ponds and dykes may be only a few metres across, but other lakes and old gravel pits can be several hundred metres in extent. A characteristic of most water bodies is that they have a fairly rich associated vegetation both in and around the water. In addition, sufficient adjacent shelter seems to be an important requirement at many sites, in the form of banks and screening trees round at least part of the site. Longfield (1949) mentions that *Brachytron*,

especially the female, is often found in woods well away from water. This has been borne out by modern day observations: some sites are actually ponds in woodland in several counties. However, many more sites are open in nature. *Brachytron* has been recorded from boggy areas in Carmarthen and Co. Antrim, for example, and on the Somerset Levels some of the field drains where the species occurs are heavily grazed, thus representing very open habitat. In Suffolk too, *Brachytron* is a species of the levels and grazing marshes behind the coastal strip, but Mendel (1992) also records that early in the season the dragonfly is often found in woodland backing the marshes where it breeds, hawking along rides and clearings.

Many water bodies are narrow and linear, such as the drainage dykes of the Fens and Somerset Levels. The aspect and orientation of such linear sites varies. On the Somerset Levels, the species favours different rhines on the same Moors in different years, probably in response to routine ditch-clearing operations. Field ditches appear to be preferred to larger drains.

Water depth appears not to be critical – sites range from depths of about 0·5m to several metres. Good water clarity is a feature of the majority of sites and water pH ranges from essentially neutral to mildly alkaline conditions, e.g. pH 7·0–8·7 on ten measured *Brachytron* sites in Cambridgeshire (Perrin, pers. obs.). The pH of the Basingstoke Canal at known *Brachytron* localities ranges from 7·9–8·6 and at Military Lake, another known breeding site in Hampshire, it is 9·0–10·0 (Parkinson, 1993). However, other sites may be slightly on the acid side. At two New Forest breeding ponds the pH of the open water varied between 6·6 in a small pond and 7·01–7·25 in a large pond (1000m diameter) (Goodyear, 1994). *Brachytron* is known to tolerate brackish water and in coastal habitats seems able to survive in quite eutrophic conditions. The presence of fish and waterfowl has been noted at some sites.

The typical floating or submerged vegetation is not common on all *Brachytron* habitats and may include Nymphaeacea (water lilies), *Hippuris* (mare's tail), *Lemna* (duckweed), *Charae* (stonewort), *Myriophyllum* (water-milfoil), *Potamogeton* (pondweed) and *Elodea* (waterweed). However, floating dead plant debris, including *Phragmites* (reed), *Carex* (sedge) and similar broken stems, would appear to be important at confirmed breeding sites. The dense nature of the vegetation round sites retains the abundance of organic material in the water, preventing its removal during periods of high water levels.

Parkinson (1993) surveyed 20 *Brachytron* sites in the Blackwater Valley in Hampshire and showed that all sites supporting breeding or adult populations held aquatic assemblages of 11 or more species of emergent, floating and submerged plants. There did not appear to be any one plant species common to all breeding sites. All sites from which *Brachytron* was absent held communities of eight or fewer plant species. Those sites where *Brachytron* was recorded as breeding were characterized by at least three species of submerged plant. *Equisetum fluviatile* (water horsetail), *Glyceria maxima* (reed sweet-grass), *Ceratophyllum demersum* (rigid hornwort) and *Potamogeton obtusifolius* (blunt-leaved pondweed) were the only species common to seven of the nine breeding sites and were absent at all sites where *Brachytron* was not recorded.

Moore (1991) noted the presence of Brachytron at ponds that were characterized by *Typha* (bulrush), *Alisma* (water-plantain), *Lythrum* (purple loosestrife), *Juncus* (rush), *Sparganium* (bur-reed), *Polygonum, Potamogeton, Lemna*, algae, *Chara* and *Fontinalis*. *Typha*, algae and *Chara* were the only species present at all sites on all occasions. In Cambridgeshire sites surveyed with *Brachytron* present, *Phragmites, Glyceria, Carex* and *Typha* were fringing plants at most sites

(Perrin, pers. obs.). Reedbeds are also common to many sites in Cheshire (Gabb & Kitching, 1992) and in Scotland, *Cladium mariscus* (great fen-sedge) is often found. Thus, although some plant groups appear to characterize the majority of *Brachytron* sites in one area of the country, such plant groups may differ in other areas.

Associated odonate species at *Brachytron* sites

Brachytron is never found as the sole species at a site; its presence indicates a site rich in other odonate species too. The best breeding sites hold 18 or more species. In ten *Brachytron* sites surveyed in Cambridgeshire, numbers of other species ranged from 6–18 (Perrin, pers. obs.). At a number of individual sites in the Blackwater Valley, Hants surveyed by Parkinson (1993) numbers of other odonate species present with *Brachytron* ranged from three to eight.

Adult

Identification

Brachytron appears as a small and dark-looking hawker and is the earliest species of its size to appear on the wing each year. Good morphological descriptions of the adults can be found in most available British dragonfly publications (e.g. Hammond, 1983; McGeeney, 1986; Merritt *et al.*, 1996; Brooks 1997) and thus will not be reiterated here.

Territorial and Feeding Behaviour

The presence of the adults is usually detected by the sighting of patrolling males. They have a typical low-level, zigzagging flight path in and out of clearings in the fringing vegetation (such as *Phragmites*) along a water body. The length of territory patrolled by a male typically covers 25–100m or so, although this may vary depending on the number of males present at a site and the shape of the water body. On the canal at Billingshurst, Sussex, where *Brachytron* is less numerous, males patrol small individual beats, flying fast up and down, interspersed with flight into the reeds within their own beat. The measured density of adults along one Cambridgeshire dyke was 18 over a 2km stretch, with approximately equal numbers of either sex (Perrin, pers. obs.). Other observations indicate a highest steady adult density of about 9 per 100m of water's edge (Merritt *et al.*, 1996).

Clashes between rival males on adjacent territories are frequent. Several males may search clumps of fringing reeds, sometimes remaining in a clump for several minutes. When on territory, patrolling male *Brachytron* also clash with other dragonfly species, such as Four-spotted Chaser *Libellula quadrimaculata* L. (Gabb & Kitching, 1992) and Emperor Dragonfly *Anax imperator* Leach, readily seeing off the latter on occasion. One observer even witnessed a pair of *Brachytron* and a male *Anax* together 'in a brown ball in the air' on the Wey and Arun Canal in Sussex (Price, 1994).

Under suboptimal weather conditions, such as wind or fairly cloudy skies, males seem to abandon their patrolling flights and seek shelter as soon as the sun disappears. At one Fenland site in such weather conditions (air temperature around 17°C), nearly all *Brachytron* will be found on the lee side of sheltering banks, or low down in paths or ruts in long grass on the bank top, where they are more protected from the prevailing wind. If disturbed, flights are short, the insects rapidly seeking shelter again.

Females are more secretive and less often seen near water except in the post-emergence period or when ovipositing. They may be found resting in tall vegetation adjacent to or at some distance from the water. Both sexes are also found away from water during the maturation period, as is common with many other dragonfly species. Resting places, usually in the sun, may include tree trunks and other vertical surfaces such as reed stems and posts.

Occasionally male *Brachytron* will break off patrolling above a water body and revert to apparently short feeding flights, often in sheltered indentations along a mature tree belt. In less than ideal weather prey items appear large (e.g. damselflies, sawflies or mayflies) but are caught infrequently. This is presumably an energy-saving strategy that many other dragonfly species must use under such conditions. It remains to be confirmed whether the opposite of this observed behaviour is true, i.e. that smaller prey items are caught more frequently when conditions are ideal.

Pairing

Mating takes place in nearby trees or other vegetation. Pairs *in copula* are often disturbed from long grass at sites. The length of time over which pairs remain joined varies – one pair was observed resting in the wheel position low down in grass on the back of a dyke bank for over 40 minutes under cloudy skies, with rhythmic movements of the male abdomen being evident. The temperature of the surrounding microclimate among the grass stems was found to be 2–3°C higher than the ambient air temperature (Perrin, pers. obs.).

Oviposition

Female *Brachytron* oviposit alone, unaccompanied by the male, generally inserting eggs into semi-decomposing floating detritus such as rushes, sedges or reeds, dead and living stems of *Schoenoplectus* (= *Scirpus*) *lacustris* (common club-rush), *Nymphaea alba* and *Cladium mariscus* or any other floating or emergent organic material, generally close to the water's edge. In Ireland, the species has been recorded laying eggs into the stems of *Potamogeton*.

Egg laying is carried out near the bank in water depths of about 10–40cm, with the female settling briefly on the rotting vegetation and making frequent, very short jabs into it. Although most ovipositing takes place in late May to mid-June, observations of this behaviour have included the fairly late date of 30 June at Houghton, Sussex (Havers, 1993).

Being a spring species, non-diapause eggs are laid, which hatch after 3–4 weeks (McGeeney, 1986; Merritt *et al.*, 1996).

Larva

Identification and behaviour

For descriptions and illustrations of *Brachytron* larvae see Corbet *et al.* (1960), Hammond (1983) and McGeeney (1986). The sketch in Hammond (1983) is very true to life and a useful reference for this species. Note in particular the small eyes, with prominent lobes immediately behind them sloping inwards. The labium is conspicuously long and waisted. The abdomen has a characteristic dorsal spine on segment nine.

Brachytron larvae fold their legs alongside the body and may lie quiet for some minutes when handled. Although the larva will unfold and swim away after remaining undisturbed, its immediate reaction can make the dark larva very difficult to find when sieving in waters with large amounts of organic detritus.

Aquatic habitat and larval development

Brachytron larvae are found in all types of ditches and on all soils, but numbers of plant species are slightly greater where they are found. The association of *Brachytron* larvae with dead plant material was possibly first recorded by Lucas (1900) who found larvae on dead sticks in the canal near Byfleet, Surrey on 23 March 1894.

More recent records confirm that the larva develops over at least two years among dead reed stems, sedges, twigs and other debris (Corbet *et al.*, 1960; McGeeney, 1986). However, it has been observed that a single larva has completed development in one season in a small pond (Holmes, 1984).

At the *Brachytron* sites on the Somerset Levels and Moors, there is no correlation between the periodicity of ditch-cleaning cycles or the method of cleaning and the frequency of larvae. Scarcely any difference is recorded between observed and expected frequency of larval occurrence in ditches cleaned either one or two years before survey (Drake *et al.* 1984). This finding has also been partly corroborated by observations in Lincolnshire, where *Brachytron* numbers at one site are increasing despite periodic pond clearance.

Emergence

As they usually occur at very low density and may be well hidden, *Brachytron* exuviae are not always easily found. However, on the Basingstoke Canal and at a Cambridgeshire site, *Brachytron* emergence has been confined to short stretches of bank (about 25–100m in length). The numbers of emergent adult *Brachytron* found along a 160m stretch of the Basingstoke Canal during one season was 41 on eight days between 5 May and 9 June (Parkinson, 1993).

The range of recorded emergence sites and heights is very wide. *Juncus* stems or cut stumps of alder only a few centimetres above water may be utilized, whereas on taller plants larval emergence heights may be up to one metre above water. Goodyear (1989) mentions *Brachytron* larvae emerging on floating branches along the edges of Sowley Pond in the New Forest. *Brachytron* exuviae have been found well hidden about 10–15cm above water at a Kentish woodland pond. Other recorded plant substrates used for emergence have included *Glyceria maxima* stems, *Iris pseudacorus* (yellow iris) and *Typha* leaves or even dead stems. In Scotland, observers have found exuviae on any emergent vegetation at varying heights and at distances from five metres beyond the water's edge to a similar distance onshore; they are generally within one metre of the waterline.

Exuviae may sometimes be found clustered near one another. At one Cambridgeshire site, in the New Forest and on the Basingstoke Canal, exuviae have occurred within one metre or less of each other. It would appear that *Brachytron* larvae have no preferred plant or emergence height, but will take advantage of whatever plant substrate is available at the time. Parkinson (1993) confirmed that emerging *Brachytron* on the Basingstoke Canal were not restricted to any one plant species. Over 90 per cent were found on *Glyceria maxima* and *Sparganium erectum*

(branched bur-reed). Other plants used included *Polygonum amphibium* (amphibious bistort) and *Iris pseudacorus*. Widths of some measured plant material with exuviae attached have been 9–12mm, which is about the comfortable span of the larval legs, although clearly such widths are not essential for successful emergence.

The time of emergence is not known for certain, but is believed to be primarily at first light. Some *Brachytron* have been found emerging in the afternoon on the Basingstoke Canal. The adult insect may use long grass in adjacent fields to dry its wings after emergence. At Milton Country Park, Cambridge, one observer has recorded a teneral female *Brachytron* at about midday, in warm sunshine with a light breeze, clinging to a *Typha* leaf about 60cm above water and about 2m from the nearest observed exuvia. It remained thus for at least 30 minutes. Two other teneral specimens were seen on the same occasion fluttering up from *Typha*, with one resting in a tree about 3m above ground for approximately 10 minutes.

Flight period

The flight period of *Brachytron* in the UK is rather short compared with other species, generally extending from early-mid May through to the end of June, or possibly early July. This may vary in different parts of the country, depending on latitude and weather. A possible sighting as early as 21 April was made on one occasion, while at the end of the flight period, a male was seen hawking along a rhine on the North Somerset Levels as late as 27 July (Randolph, 1992).

Conclusion

More information concerning the ecology and behaviour of *Brachytron pratense* has come to light as a result of the Collective Knowledge Project of the BDS. This has included some fascinating insights into aspects of its life cycle not widely known hitherto and it is hoped that these observations, collated together in the present paper, may act as a stimulus for further research and observations on the species. There are numerous unanswered questions that the present account has provoked. For example, which types of habitat are important for breeding *Brachytron* and why do not all similar-looking sites harbour the species? What factors govern the distribution of the species in the British Isles and will the present range expansion continue? In addition, much more still needs to be learned about the breeding densities and population sizes of *Brachytron* that sites will support, as well as information on larval ecology and timing of emergence patterns.

Acknowledgements

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A search for long-distance dispersal in the Southern Damselfly *Coenagrion mercuriale* (Charpentier)

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Introduction

The Southern Damselfly *Coenagrion mercuriale* (Charpentier) breeds in heathland streams and runnels, chalk streams and associated drainage ditches and base-rich mires. It is a globally threatened species and is listed on Annex II of the EC Habitats Directive and Appendix II of the Bern Convention. It has suffered a decline in its UK distribution since 1960, estimated by some to be as steep as 30 per cent. It was recorded in just 25 10km squares in the 1980s (in Devon, Dorset, Hampshire, Mid Glamorgan, the Gower Peninsula, Pembrokeshire and Anglesey) (Merritt, Moore & Eversham, 1996), but this number has now risen to 26. It is described as rare in the British Red List (Shirt, 1987) and in 1998 was afforded full protection under Schedule 5 of the Wildlife and Countryside Act of 1981.

The species' decline in the UK has been brought about by loss of habitat caused by unsympathetic grazing regimes and dredging and canalization of heathland streams. Other potential threats include nutrient enrichment and other run off from agricultural land and pollution of streams. As one of 116 species listed in the 1994 UK Biodiversity Action Plan, it has a National Steering Group, whose first act was to instigate a study of dispersal on a small scale. A preliminary report was published in 1997 (Hopkins & Day, 1997) and a more detailed analysis of the findings is being prepared for publication (B. V. Purse *et al.*, in prep.). One of the findings of the preliminary study was that at least one individual male at the Crockford Stream site moved over 1km. However, due to lack of manpower in 1997, there was little likelihood of finding long distance dispersers and movement on this scale was not expected in any case. Indeed there is evidence from the Crockford Stream itself that movement of mature adults is highly restricted (Jenkins, 1998). The aim of the present study was to investigate the possibility that long distance dispersal by mature adults might be more common than was previously supposed.

Methods

The study was carried out in 1998 in the New Forest in Hampshire, England. The main study site was the Crockford Stream (Grid reference SZ 345993). This is one of the most important sites for *C. mercuriale* in the UK.

The damselflies were marked by inscribing a number on the left hindwing (using an Edding 1800 pen), and by putting a dab of waterproof paint on the dorsum of the thorax. This technique has been used repeatedly and successfully by one of the present authors in the past without causing any apparent harm to damselflies of a comparable size (Banks & Thompson, 1985, 1987; Thompson, 1990, 1998; Gribbin & Thompson, 1991), and was also used in the

Hopkins & Day (1997) study. The left hindwing was measured using a pair of dial callipers. The insects were captured under licence from English Nature.

Adults were captured, marked, measured and released from the Upper Crockford Stream, from its origin at a pipe draining Beaulieu Airfield to a site approximately 400m downstream, at which the stream does not provide suitable habitat for *C. mercuriale*. They were captured from 6 until the 17 July. On 18 July, 27 volunteers were stationed on all the known sites for *C. mercuriale* on or close to Beaulieu Heath from 1100 to 1500h, the times of peak activity. Of these eleven sites, six were part of the Crockford Stream system, four others originated on Beaulieu Heath, but did not drain into the Crockford Stream directly, and the last drained into a separate system. The closest site was 200m away. The furthest sites were 3.3km NW, 1.8km NE, 2.6km E, 1.9km S and 1.3km W. The volunteers were all experienced in identifying *C. mercuriale* or were accompanied by someone who was. They were asked to record the locations of marked individuals on maps that we provided.

Results

The numbers of new adults caught and marked each day are shown in Figure 1. In total 1245 mature adults were marked: 1034 males and 211 females. This indicates the strength of the population on the Crockford Stream.

The weather on 18 July was good (in contrast to that on 12 July, when the delegates of the First European Symposium of the Worldwide Dragonfly Association, who had volunteered for a similar task, were treated to continuous heavy rain!). All volunteers saw many Southern Damselflies, but no marked individuals were seen away from the study site. However, on 25 July one of the marked animals was found *in copula* on the Lower Crockford Stream by a volunteer who had returned to the site. This male had been marked as a mature adult on 14 July and had moved 1.06km in the 11 days since being marked. Its left forewing length of 15.85mm was not significantly different from the mean of the sample (15.83mm).

Discussion

Although the primary aim of this study was to investigate long-distance dispersal in *Coenagrion mercuriale*, it is worth commenting on the number of individuals marked and the sex ratio, in view of the fact that we are dealing with a high profile species on a site at which it has been studied previously (e.g. Jenkins, 1986, 1987, 1991).

A total of 1,245 individuals marked in 11 days in only moderate weather along a 400m section of the Upper Crockford Stream compares with a peak count of 382 recorded by Jenkins (1991) for the period 1984–89 for the whole of the Upper Crockford Stream. It is not suggested that the population has increased at Upper Crockford since 1989. However, this study shows that estimates of population size based on limited counts are never likely to be close to the actual population size. Such counts are useful for making comparisons between years provided that counts are made in similar weather conditions and at comparable times during the flying season (a point clearly made by Jenkins in the first of his Southern Damselfly papers (1986) but often overlooked by others).

The sex ratio of marked animals was strongly male biased (4.9 : 1). No significance should

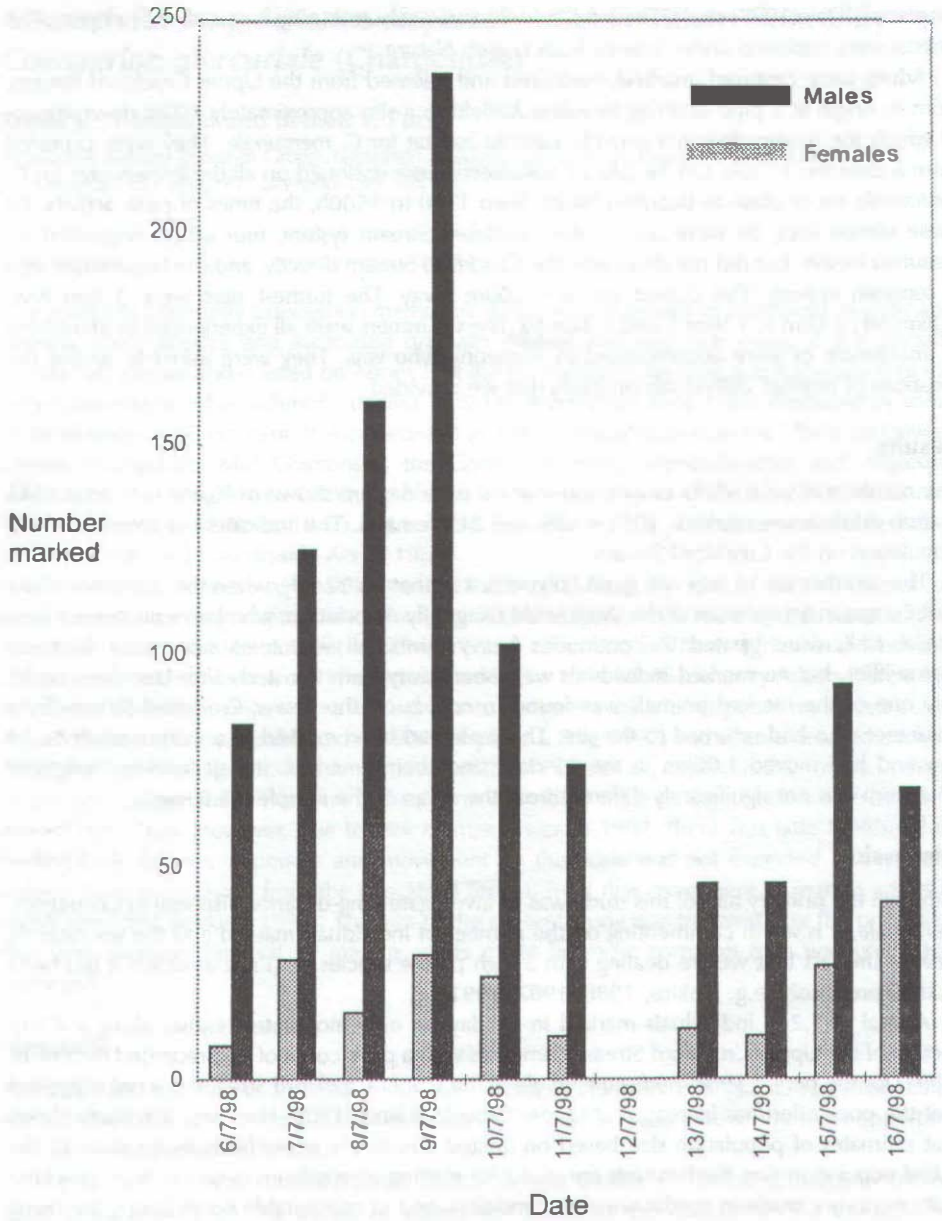

Figure 1. Graph to show the number of males and females marked each day at Upper Crockford 1998.

be attached to this. There are currently no published data on the frequency with which females come to breeding sites to oviposit and no published data on the lengths of time males and females are present at the breeding site on days that are suitable for reproductive activity though males are likely to stay longer than females. Both of these factors are likely to lead to male biased sex ratios in samples such as ours.

One marked animal had clearly moved from a site at which it was searching for mates to another over 1km away at which it found one. The extent of its movement was similar to the one long-distance disperser reported by Hopkins & Day (1997). Indeed, it ended up in the same place. In order to get there it must either have crossed a considerable expanse of dry heath and a road, or followed the stream downstream through unsuitable habitat, including woodland or some combination of the two. Jenkins (1998) reported that C. *mercuriale* was extraordinarily reluctant to move from its home location even across a short open area. The absense of marked individuals at the sites closest to the marking site supports this view. However, C. *mercuriale* clearly has some potential to make relatively long movements after reaching maturity.

All of the individuals marked in this study were marked as mature adults. It may be that the principal time in the life cycle for dispersal is immediately after emergence. However, it is not possible to mark animals immediately on emergence without damaging them. In order to mark them at such a time they need to be retained safely for several hours in order that the cuticle can harden. After this interval their maiden flight may not take on the same characteristics as it would if they had been left unrestrained. This problem needs to be resolved before the true potential for C. *mercuriale* to recolonize restored sites from which it has been lost can be realised.

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The Hornet Robberfly *Asilus crabroniformis* L. (Diptera, Asilidae): Odonata as prey

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David Clements (1999) remarked on the scarcity of records of predation of Odonata by the Hornet Robberfly *Asilus crabroniformis* L. On two occasions at the Seaton Valley, south-east Cornwall, I have observed *Asilus crabroniformis* carrying damselflies as prey items.

On 6 August 1994, near the main pool, *A. crabroniformis* alighted on the ground and was seen to be carrying a damselfly, almost certainly a Common Blue Damselfly *Enallagma cyathigerum* (Charpentier). Then on 15 August 1995, at the same location, *A. crabroniformis* perched on a small willow tree *Salix* sp. with another almost-certain *E. cyathigerum* in its grasp (along with a flesh-fly *Sarcophaga*). On each occasion they remained long enough for me to obtain photographs.

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Migrant and dispersive dragonflies in Britain and Ireland during 1998

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Introduction

This article summarizes events reported to the BDS Migrant Dragonfly Project during 1998. It should be noted that this year saw the establishment of an Odonata Records Committee (ORC) to consider reports of national rarities formally. This was a timely development, given the number of dramatic events which occurred during 1998 – most notably the first European records of the North American dragonfly, the Green Darner *Anax junius* (Drury). All of these records have now been fully verified and documented. For a report of events in 1997, see Parr (1998a).

Aeshna cyanea (Müller) – Southern Hawker

1998 – Singles were caught at UV light at Bradwell-on-Sea, Essex, on 27 July and 5 August (SD). Although several *Aeshna* species normally fly until dusk given suitable weather, resident individuals are apparently rarely caught in moth traps.

Aeshna mixta (Latreille) – Migrant Hawker

1998 – The species had another relatively good year in Britain. Reports from the Isle of Man on 24 July (Tunmore, 1999) and 22 August (via PHi) were the first records for this region, and must refer to migrant or dispersive individuals, though they were most likely to have been of British rather than Continental origin. Records of groups of males from the Scilly Isles in September and October (JH, PHe) probably also refer to migrants, though it is possible that the species may in addition be becoming established on the islands. On the east coast of Britain large numbers suddenly appeared at Bradwell-on-Sea, Essex, on 9 and 10 August (SD). A total of 200 were seen on 1 September at Great Yarmouth Cemetery, Norfolk, with 80 still there on 4 September (via PHi).

Anax imperator Leach – Emperor

1998 – Several unusually late records of *A. imperator* were received during 1998. Records of adults came from near Landguard, Isle of Wight, on 20 September (AB), and from both the Lizard, Cornwall (MTu), and Delamere, Cheshire (PHi), on 11 October. Fresh exuviae had been found in small numbers on the Lizard, Cornwall, during much of September (SJ). These autumn records, and in particular the fresh exuviae found in September, clearly do not fit with the accepted flight period of *A. imperator* in Britain as being from early June to late August (Merritt *et al.*, 1996). It is possible that some late adults may be primary immigrants from further south. Locally-emerged individuals could perhaps be the progeny of spring immigrants from

Mediterranean Europe or North Africa, where the species may be adapted to conditions which favour more rapid larval development than the 12- or 24-month period recognized for British individuals (Corbet, 1957). *Anax junius* (Drury), which is the commonest *Anax* species in North America, is well known to have both a resident form with a 1-year generation time and a migrant form which produces an autumn generation of adults from eggs laid in early summer (Trottier, 1971), and perhaps immigrant *A. imperator* can also follow this strategy. The exuviae found in Cornwall during September were at a site where *Sympetrum fonscolombei* (Sélys) was also breeding (SJ), as were exuviae interestingly found at Portland, Dorset, during September 1996 (KD). This gives some support to the migrant hypothesis.

Anax parthenope (Sélys) – Lesser Emperor

The following unprecedented series of records have been accepted by the ORC. The species was recorded in Britain for the first time only in 1996 (Philips, 1997).

1997 – One late submission:

23 & 27 July	Male at Rye Harbour NR, East Sussex (PT)

1998 –

17–18 May	Male at Drift Reservoir, Cornwall (SJ, GS)
23 May	Female near Bonython, Cornwall (SJ)
20 June	Male at Holme Pierrepont, Nottinghamshire (ACr, JS)
30 June–7 July	Up to two males at Marazion Marsh RSPB reserve, Cornwall (DF, PF, MTu)
1–2 July	One at Kenfig NNR, Glamorgan (GJ)
18–25 July	Male near Trerulefoot, Cornwall (LT et al.)
4 August	Male at Dungeness, Kent (DW)
8 August	Male at Rye Harbour, East Sussex (PT)
8–17 August	Male near Dungeness RSPB reserve (many observers), not necessarily different from the individual of 4 August
14 September	Female at St Buryan, Cornwall (PC, SJ)

1998 was by far the best year ever for this species, though whether this represents increased observer awareness, increased immigration or a combination of these and/or other factors is not yet fully clear. With records in all months from May to September, the presence of more than a single individual at one site, and the occurrence of both males and females, it is possible that Lesser Emperor may now be breeding in Britain. Larvae/exuviae are similar to those of *A. imperator*, but males can be separated on the basis of the shorter projection at the base of the epiprocts (Askew, 1988).

Anax junius (Drury) – Green Darner

1998 – The amazing events from Cornwall and the Scilly Isles during September 1998, which saw the first European records of the North American species *Anax junius*, are discussed in some detail by Pellow (1999a). Who would have believed that south-west England would see records of no fewer than three different *Anax* species during 1998, when prior to this year only two had

ever been recorded from western Europe, and only one of these is so far known to breed in Britain?

The following records have all been accepted by the ORC. A small number of additional records of unusual *Anax* seen too briefly for specific identification make it possible that further individuals may well have been present, but proof is unfortunately lacking.

9–17 September	Male at Penlee NR, near Rame, Cornwall (KP, MF *et al.*)
10 September	Male on St Agnes, Isles of Scilly (KP)
10 September	Female at Covean, St Agnes, Isles of Scilly (TB, PHe)
10 September	Female at Gugh, Isles of Scilly (JD, PHe)
16 September	Female at Penlee NR, near Rame, Cornwall (EG)
20–23 September	Male at Nanquidno, Cornwall (BM, SR, RW, MTu)
30 September–1 October	Female on Tresco, Isles of Scilly (ACo, RH, RP)

Analysis of weather conditions (Davey, 1999) has indicated that in early September the wind systems of Hurricane Earl affected much of the east coast of the USA, and obviously led to the displacement of migrating *A. junius* across the Atlantic to SW England. In addition to *A. junius*, birds such as the Common Nighthawk *Chordeiles minor* (Davey, 1999), and butterflies such as the Monarch *Danaus plexippus* and American Painted Lady *Cynthia virginiensis* (Davey, 1999; Hill, 1999) were also displaced.

Hemianax ephippiger (Burmeister) – Vagrant Emperor

1998 – The following records have been accepted by the ORC:

1 March	Female seen near Osmington Mills, Dorset (EB)
21 June	Male photographed on the Lizard peninsula, Cornwall (SJ).

A significant influx of dragonflies took place in southern England from mid January through to mid March (Parr, 1998b), with over 20 records in total. This correlated with an unusual period of prevailing warm winds blowing up from North Africa. Unfortunately very few dragonflies were seen well, and only one was positively identified – the female *H. ephippiger* listed above. Many records referred to brownish 'hawker-type' individuals, with occasional reports of insects showing some blue, and it is likely that several others were in fact also female *H. ephippiger*, with a few males present. This suggestion is strengthened by sightings of migrant *H. ephippiger* on the island of Madeira on 14 January (one), and 28 February (many hundreds, mostly female) (J. Smit, in litt.). These are the first records of the species from Madeira, and confirm that numbers of *H. ephippiger* were on the move during the early part of 1998.

Libellula quadrimaculata L. – Four-spotted Chaser

1998 – Although no large scale immigrations of this well-known migrant were reported, there was evidence of more activity than in recent years. An obvious movement was noticed at Great Yarmouth, Norfolk, on 16 May (via PHi). Also possibly part of the same event were the first *L. quadrimaculata* for several years at Barn Elms Reservoir, London, on 18 May (GMa), and small numbers of individuals seen at North Warren, Suffolk, during a ten day period in mid May, with

a maximum of 5 on 18 May (RM). In Scotland, *L. quadrimaculata* was recorded during June from two areas where the species is only a very rare vagrant – namely from Noss on the Shetland Isles on 14 June (PM) and at Craigton Quarry, West Lothian, on 21 June (GF). Also on 21 June, a group of 11 appeared at Spurn Point, Yorkshire (BS). These latter sightings coincided with a period of lepidopteran immigration on the south and east coasts (Tunmore, 1999), and also with arrivals of *Sympetrum fonscolombei* (Sélys) in southern Britain.

Crocothemis erythraea (Brullé) – Scarlet Darter

1998 – a single record:

5–15 August Male at Nanquidno, Cornwall (PS, SJ).

This is the third British record in four years, and it seems probable that the species is currently a regular visitor to our shores. There is still no sign of breeding, though it has occurred on the near Continent in recent years.

Sympetrum striolatum (Charpentier) – Common Darter

1998 – Continued evidence for regular arrivals on the east coast was obtained, though events were nowhere near as dramatic as those of 1997 (Parr, 1998a). Many were observed coming in off the sea at Waxham, Norfolk, on 27 July (via PHi). Numbers suddenly appeared at Bradwell-on-Sea, Essex, on 9 and 10 August, coinciding with numbers of *A. mixta* (SD). At that Essex site a total of 10 were then caught in UV moth traps during the period 10 August to 30 September (SD). Elsewhere in England, an interesting event was observed at Woorgreens Lake, Forest of Dean, on 23 September (JP). Here at 1200 hours *S. striolatum* were observed flying east into a force 4 wind in a steady movement. Many were flying in tandem, often ovipositing as they went. During the course of half an hour perhaps 1000 individuals were seen; however when the site was re-visited at 1400 hours the movement had totally ceased.

Sympetrum fonscolombei (Sélys) – Red-veined Darter

1997 – There was a late report of a male at Beddington Sewage Farm, Surrey, on 8 July 1997 (GMe).

1998 – Despite the excitement with the various *Anax* species, in many ways *S. fonscolombei* provided the highlights of 1998. During the year records were received from some 46 sites in 37 10km squares. Records covered the period 10 May to 18 November, and were predominantly from coastal regions (Fig. 1). As is now typical for the species, many of the records were from Cornwall, though the southwest of Britain in general did well. Particularly interesting reports included the third- and fourth-ever from Ireland – at Kilkeel, County Down, on 18 and 19 August (IR), and Lake Tacumshin, County Wexford, on 26 August (JE).

Adults were seen during May at 14 sites, 10 of which were in Cornwall. Many individuals were probably fresh immigrants, but a few were noted outside normal periods of migration and might have emerged locally, the progeny of adults present in 1997. Certainly at Spurn, Yorkshire (BS), and Bake Farm, south-east Cornwall (KP), small spring emergences were fully

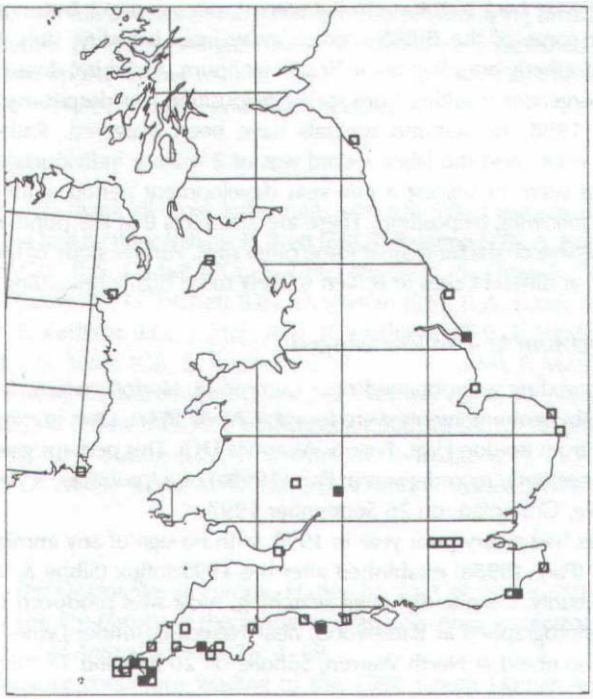

Figure 1. Distribution map of *Sympetrum fonscolombei* in Britain and Ireland during 1998, showing the 10km squares in which adults were recorded. Filled symbols indicate confirmed breeding sites.

This figure was prepared using DMAP software written by Dr. A. Morton.

documented. A second wave of records then occurred in late June, with adults still being seen throughout July. August saw yet another widespread series of records, and then finally during mid August/September emergences of locally-bred adults resulting from spring ovipositing were noted at several sites in the South-west. At the most prolific of these, emergences continued even into November (Pellow, 1999b).

If sites are counted at which either spring or autumn emergences were noticed, successful breeding took place at a minimum of 8 sites in England during 1998. This is the third year in succession that breeding has been confirmed, and several sites feature in more than one year. In this relatively short time a number of interesting observations on the breeding biology of *S. fonscolombei* have been made. Most sites show major emergences during late summer/autumn resulting from eggs laid in spring, with productivity often being high. At Bake Farm, Cornwall, some 2,000 individuals emerged during 1998 (Pellow, 1999b). From the paucity of fully-mature adults seen during the autumn, it is clear that these emerging adults rapidly disperse away from their natal sites. Quite where they go is at present unclear; it has been suggested that at least a

proportion may migrate back to the south (J. Lempert, pers. comm.), but more local wandering could account for some of the British records away from breeding sites. In contrast to this picture, the most northerly breeding site in Britain (at Spurn, Yorkshire) does not appear to show these autumn emergences resulting from spring oviposition, for despite records at the site in 1996, 1997 and 1998, no autumn tenerals have been observed. Rather, in 1998 early emergences were noted and the latest record was of 2 mature individuals on 25 August (BS). These observations seem to suggest a one-year development period, with emergence in the spring or summer following oviposition. There are also hints that the population at Spurn may have less of a dispersive character than at some other sites. Further study of the breeding biology of *S. fonscolombei* at different sites in Britain is likely to be highly rewarding and productive.

Sympetrum flaveolum L. – Yellow-winged Darter

1997 – Proof of breeding was obtained near Carbrooke, Norfolk, where for the second year running small numbers of emergents were found (GN via PHe). One immigrant was recorded during late August from Boldon Flats, Tyne & Wear (via DC). This perhaps gives added credence to the even more northerly record given in Parr (1998a) of a 'probable' *S. flaveolum* from Spey Bay Nature Reserve, Grampian, on 26 September 1997.
1998 – The species had a very poor year in 1998, with no sign of any immigration. The British breeding colonies (Parr, 1998a) established after the 1995 influx (Silsby & Ward-Smith, 1997) also suffered very badly. Despite thorough searching, most sites produced negative returns. A single male was photographed at Bateswood, near Newcastle-under-Lyme, on 8 August (RG), and males were also noted at North Warren, Suffolk, on 20 July and 14 August (DN).

Sympetrum sanguineum (Müller) – Ruddy Darter

1998 – There were few signs of any significant migration by this species. Singles were caught at UV light at Bradwell-on-Sea, Essex, on the nights of 11 and 17 August (SD).

Sympetrum danae (Sulzer) – Black Darter

1998 – A few individuals were noted from unusual sites on the east coast of England during the autumn. One was seen at Landguard Point, Suffolk, during early September (NO) and one was at Gibraltar Point, Lincolnshire, on 12 October (KW). A single male on the coast at Whinnyfold, Aberdeen, on 12 September (MI) may also have been a migrant, though the species breeds some 4km away.

Discussion

Although the generally westerly airflows which lasted for much of the summer meant that the volume of immigration from the Continent was lower than in many other recent years, a number of notable events took place throughout the year. The most dramatic was clearly the first British and European occurrence of Green Darner *Anax junius*. In addition Red-veined Darter *Sympetrum fonscolombei* had an outstanding season, with breeding proved at a number of sites, and there was also a remarkable series of records of Lesser Emperor *Anax parthenope*

which may indicate that this species is also in the process of colonizing Britain. On the negative side, breeding colonies of Yellow-winged Darter *S. flaveolum* established following the big invasion of 1995 now appear all but extinct. It will be of considerable interest to see what the next few years have in store for these, and other, species.

Acknowledgements

I would like to sincerely thank all those individuals who submitted records. The following have been identified in the text by their initials: E. Brett (EB), T. Broome (TB), A. Butler (AB), D. Clarke (DC), A. Colston (ACo), P. S. Corbet (PC), A. Critchley (ACr), S. Dewick (SD), J. Dixon, (JD), K. Dolbear (KD), J. Eaton (JE), G. Fitchett (GF), D. Flumm (DF), P. A. Fraser (PF), M. Frost (MF), R. Gillibrand (RG), E. Griffiths (EG), J. Hale (JH), R. Hathway (RH), P. Heath (PHe), P. M. Hill (PHi), M. Innes (MI), G. Jones (GJ), S. P. Jones (SJ), R. Macklin (RM), P. Marsh (PM), G. Martin (GMa), B. Mellows (BM), G. Messenbird (GMe), D. Newton (DN), G. Nobes (GN), N. Odin (NO), R. Parslow (RP), K. Pellow (KP), N. J. Phillips (JP), I. Rippey (IR), S. Rogers (SR), P. Semmens (PS), B. Spence (BS), G. P. Sutton (GS), J. Szozur (JS), P. Troake (PT), L. A. C. Truscott (LT), M. Tunmore (MTu), D. Walker (DW), R. Williams (RW) and K. Wilson (KW).

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Roosting behaviour of some British Odonata with notes on the Scarce Chaser *Libellula fulva* Müller

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The roosting behaviour of British Odonata has received relatively little attention. This paper brings together observations made over a twenty-year period with some notes on the differences in the roosting behaviour exhibited by *Libellula fulva*.

The study of roosting behaviour needs to be undertaken at the end of a day when dragonflies select a roost site, and shortly after sunrise the following day as they resume activity. These criteria probably limit the 'attractiveness' to observers of this type of study, which may explain the lack of reported observations. A number of British species have been observed by the author. *L. fulva* is of particular interest, not only because of its relative scarcity, but because it appears to show differences in its roosting behaviour.

Observations

In general, roosting Zygoptera are relatively easy to observe. Large numbers of most species can be found roosting in areas of suitable vegetation in close proximity to breeding sites. Resting and roost site selection in coenagrionids has been described elsewhere (Askew, 1982). Anisoptera on the other hand prove difficult to find and pose more of a challenge. The males and females of most species tend to wander over larger distances and become more dispersed away from water. Sites with high numbers of Anisoptera provide more opportunities for study of roosting behaviour. Visits to Thursley NNR, Surrey, have been made on numerous occasions during the flight season (May–September) either late in the day or at sunrise (0500–0600h). In addition, early morning visits have been made to Meadow Lane gravel pits, St Ives (VC 31), to study *Libellula fulva*. This site comprises a series of old, well-vegetated gravel workings adjacent to the River Great Ouse. *L. fulva* is abundant here and has been proven to breed both in the river and the lakes.

Thursley NNR is a well-known site and supports more species and higher numbers than most other sites in the British Isles. During suitable years many roosting Odonata can be found. Four-spotted Chaser *Libellula quadrimaculata* L., Black-tailed Skimmer *Orthetrum cancellatum* (L.), Keeled Skimmer *O. coerulescens* (Fabricius) and Black Darter *Sympetrum danae* (Sulzer) can be found in clumps of vegetation surrounding the bog areas. As temperatures fall late in the day individuals seek shelter and become inactive as they cling to stems or leaves (see also Moore, 1960). Clumps of heather are often utilized at Thursley with individuals exposed as they sit out the night. Overnight the bodies and wings are cooled and by morning, after clear nights, they are covered with droplets of dew. As the sun rises and warms the body the first signs of movement occur. In most species the first signs of activity involve cleaning of the eyes and antennae with the fore.legs. This is often followed by wing 'flicking' to remove the burden of dew. Some species, especially aeshnids and corduliids utilize wing-whirring during the warm up

phase to increase body temperature. The observer will be assisted in early morning searches by walking towards the sun. The low angle of the sun backlights the vegetation and highlights the glistening wings of dragonflies. Despite being totally motionless during the roosting period some species appear able to sense potential threats. If disturbed many libellulids will release their grip and fall further into the vegetation as they are approached. The exposed nature of some roosting sites makes them vulnerable and this tactic gives them a chance to avoid predation.

Observations at Meadow Lane showed that *Libellula fulva* was extremely difficult to observe roosting both late in the day and at sunrise. They were easily observed once actively flying. Zygoptera species Blue-tailed Damselfly *Ischnura elegans* (Vander Linden), Azure Damselfly *Coenagrion puella* (L.) and Variable Damselfly C. *pulchellum* (Vander Linden) were especially abundant and easily found roosting in areas of tall grasses. Banded Demoiselle *Calopteryx splendens* (Harris) could be found roosting in large groups in vegetation by the river. The dragonflies of these gravel pits were studied during the early 1980s (Milne, 1984). During periods of dull, cool weather *Libellula fulva* was occasionally found resting deep down in clumps of rank grass (B. S. Milne, pers. comm.).

During late afternoon/evening, individuals of *Libellula fulva* could be observed flying around sheltered parts of the Meadow Lane site. They would make several attempts before finally resting. Early morning searches in these areas failed to find roosting individuals. If likely areas, such as patches of Stinging Nettle (*Urtica dioica*), were carefully studied for the first few hours after sunrise the rustling of dragonfly wings could be heard. This revealed the presence of *L. fulva* before any observation was possible. Within minutes individuals could be seen climbing up the nettle stems to catch the warmth of the rising sun. Once high up the stem they would rest for approximately 30 minutes before taken the first flight. These first flights were sluggish with frequent settling, usually allowing a very close approach (5cm away with a 20mm lens!). As the day progressed, feeding flights became more active and individuals were less approachable. Similar observations have been made in patches of tall grass and umbellifers where *L. fulva* would suddenly 'appear' despite earlier searches revealing nothing.

Conclusions

It would appear that *Libellula fulva* has a very effective method of concealing itself whilst roosting, by comparison with that of other species. By roosting low down in relatively dense vegetation it not only avoids potential predation and disturbance but is also sheltered from adverse weather conditions.

It is hoped that these brief notes may stimulate others to enjoy the fascination of early morning dragonfly watching and contribute to a better understanding of the roosting habits of other species.

Acknowledgement

I would like to thank Brian Milne for sharing some of his findings on the dragonflies of Meadow Lane.

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Prolonged partial immersion of abdomen by male *Anax imperator* Leach

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At about 1300h GMT on 17 July 1999, at the Waldegrave Pool, near Priddy, Somerset, in bright, warm and sunny weather conditions, I saw a well-coloured, mature male Emperor Dragonfly *Anax imperator* fly to perch on a raft of submerged, dead vegetation. The dragonfly then arched its abdomen and inserted the posterior third into the water at the edge of the vegetation mat; this posture was maintained for at least two minutes when, thinking that the immobile dragonfly might be injured, or ill, I started to wade towards it to investigate. I was able to note that there was no evidence that the dragonfly had clasped any submerged plant material, in a mistaken sexual attempt. However, when I had approached to within 1.5 metres, the individual flew off speedily and strongly.

Moore (1960), writing about the habits of a Four-spotted Chaser *Libellula quadrimaculata* L., described how males of this species will fly over water and dip the tip of the abdomen on the surface in the course of the morning. Moore considered that this might be a method of confirming the presence of water, using a sense organ other than the eye. In the case of the *A. imperator,* however, the insect was at rest rather than in flight and I think that it is most unlikely that its partial abdominal immersion was aimed at testing the water. Had the dragonfly been a female, I would have suspected suspended egg-laying; assuming that the *A. imperator* was healthy and uninjured, as it appeared, I find it difficult to account for its behaviour. At the time of the incident, other male dragonflies of the same species were flying over the pond and attacking rivals; might the immersion strategy of the individual have been directed at the avoidance of conflict, without withdrawal from the area?

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Mixed pairing of *Libellula* species

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On 29 May 1999 on the River Ouse at Brampton, near Huntingdon, Scarce Chaser *Libellula fulva* Müller were fairly numerous. Although perched males would chase off other passing male *L. fulva*, sometimes two or more males would share the same stem for basking, seemingly unaware of each other's presence when at rest. Pairs *in cop.* would circle round each other in a decreasing spiral while descending into a sunlit hollow in bankside vegetation, sometimes taking up resting positions near one another. One such pair proved to be a mixed pairing of male *L. fulva* and female *L. quadrimaculata* L.

Book reviews

Dragonflies: Behaviour and Ecology of Odonata.
Harley Books, Colchester CO6 4AH, England (1999). 252 x 175mm, 862pp. incl. 96 col. illustrations. £62.50 hardback (Special price to BDS members £56.50 + p.&p.).
ISBN 0 946589 64 X
Philip S. Corbet

If Philip Corbet's 1960 book *A Biology of Dragonflies* was a car it would be a VW Beetle: a classic in design and utility with a large and faithful following but now, sadly, showing its age. The year 1999 heralded the arrival of eagerly awaited successors to both. Unlike the beetle, Philip's *Dragonflies: Behaviour and Ecology of Odonata* is not a repackaged product of niche marketing. When I got my review copy I could barely bring myself to open it: behind that cover lay almost 20 years of anticipation. It was a feeling I haven't had since I was a child when the birthday package in front of me may have contained the binoculars I had asked for, or disappointment.

'Dragonflies' does not disappoint. It is a large book by anyone's standards containing over 4,000 references! Somehow (I guess that's why it took 20 years) Philip has managed to distil his incredible knowledge, insight and ability into this book. 'Dragonflies' is an unashamed natural history of dragonflies and deals, as the title suggests, with the important traits and phenomena that surround the behaviour and ecology of the order. The book chapters are organized in the temporal sequence that begins with the egg, moves through the larval stage, emergence, adulthood and then reproduction, with a final chapter covering conservation. Since most readers are acquainted with dragonfly biology and the temporal sequence in which life-history events occur, it seems pointless for me to go through each chapter outlining what it contains.

Suffice it to say, despite the fact I consider myself to be a fairly well-informed entomologist, the book had an odonatological surprise around every corner.

As a test (forgive me, Philip) I examined, in careful detail, a part of the book that would not attract the attention of many readers. I am interested in the role of parasites in some aspects of dragonfly biology and felt certain that after four years of research and reading around this matter I could find something that Philip had left out, or misinterpreted. To my surprise he had uncovered everything I had, as well as references I had not, and had synthesized the material into a clear exposition of the facts. It is a tribute to the book that I felt unable to uncover every stone: it was hard enough to get a full impression of what lay under the larger ones and I spent almost four full days reading! I suspect every bit of specialist information in the book is as well researched, synthesised and explained as the sections I teased apart with a fine-tooth comb. This book will provide invaluable support for anyone with an interest in dragonflies and it will do so for many years to come.

At the beginning of the book Philip quotes John Ray:

'Good and quickly seldom meet'.

This quote encircles much of this book. Quite apart from the quote's aptness for the Herculean task of researching and synthesizing the book, it has relevance for the reader as well. One simply cannot pick it up and have a quick dip into a subject – it draws you in and provides plenty of opportunity to dig around.

All dragonfly enthusiasts should be grateful that they now have access to what is probably the best natural history monograph available for any taxon. Read it before the next flying season and you will watch dragonflies through new eyes.

M. Siva-Jothy

Die Exuvien Europäischer Libellen (Insecta, Odonata).

[The Exuviae of European Dragonflies]

Huxaria Verlag, Höxter (1999). 29.5 x 21.0 cm, 354 pp. incl. approx. 400 b/w figs. DM38.50 Euro 19.68 (approx. £12.00) (softback). ISBN 3-9805700-4-5.

Bernd Gerken & Klaus Sternberg

(Order from Prof. Dr. B. Gerken, University G.H. Paderborn, Dept. Tierökologie, An der Wilhemshöhe 44, D-37671 Höxter, Germany (fax. 0049 5271.687.235))

This is the first book devoted exclusively to exuviae and follows the recent *Die Libellenlarven* Heidemann & Seidenbusch (1993) and the series *Die Libellen Europas* Martens & Wildermuth (Eds), works which have provided both breadth and depth to our knowledge of the larvae of European and related species.

It is a generously proportioned paperback, being in A4 format, and contains a species list, a detailed key of some 109 described species, and 296 figures of line drawings. These latter are

the best feature of the book, the line drawings being large, mainly clear and mostly original, though none are to scale, whilst several are repeated, being used first as generic and then as specific aids. Some illustrations are not of key features and do not seem to serve any purpose, whilst other highlighted features are not shown.

The book is organized into four main sections: *Exuviae* – their definition and collection; *Systematics* – glossary of terms, list of species and identification key; *Acknowledgements* – of help and material received and *Literature* – further reading and references.

There is an introductory section on the collection, preparation and study of exuviae and their importance in odonatological research. It also contains information on where to find different species. Most pages are divided horizontally into German text above and English text below. The translation unfortunately contains many errors, some of which could lead to misinterpretation. One highly useful feature is an Anglo-German glossary of anatomy, which is repeated as a semi-translated backleaf appendage.

The species list includes 137 species of which, as stated above, 109 are keyed and described. There is no definition of the area covered by 'Europe' but, as the species list includes *Gomphus davidi* (Syria), *Cordulegaster* myzymtae (Georgia and NE Turkey) and *Platycnemis subdilatata* (Morocco), this indicates inclusion of the Caucasus, Levant and North Africa. Sadly none of the 'outlying' and therefore more critical species are keyed out. The key itself includes some novel keying out of groups such as aeshnids and it will be interesting to see how these stand the test of time. Some of the couplets however contain unclear phrases, and there is no back referencing. It is disappointing that such an up-to-date work does not include keys to such species as *Orthetrum anceps*, *Diplacodes lefebvrei*, *Trithemis annulata*, *Somatochlora (metallica) meridionalis* and *Gomphus schneiderei*, which have been described in recent publications.

One of the major problems in writing a book where original work has been done over a period of years is that of when to stop, and therefore how up-to-date the reference list will be. Whilst most of the major works in this field have been included, there are several important omissions e.g. C. Conci & C. Nielsen's *Fauna d'Italia* (1956), Odonata in G. Sahlén's *Sveriges Trollsländor (Odonata)* (1985) and Erich Schmidt's 'Two notes on corduliine nymphs. Odonata: Libellulidae' (1951) whose paper on sternite distribution has clearly been used.

For those who find the German language fiendishly difficult to translate this will be a welcome addition to the important larval work done by such authorities as Schmidt, Heidemann, Seidenbusch and Jödicke. It is also good to have a Continental perspective on keying out genera such as *Ischnura* and *Sympetrum* where there are several close species to separate. Despite the above criticisms I shall certainly enjoy spending time using the key to sort material collected from previous trips, and hope that it will encourage future workers on trips both home and abroad.

Stephen Butler

Die Libellen Baden-Württembergs.
Verlag Eugen Ulmer, Stuttgart, Germany (1999). 24 x 17cm, 468pp. 241 colour photos. DM 98.00 (approx. £35) (hardback). ISBN 8001-3508-6
K. Sternberg & R. Buchwald (Eds)

This, the first part of a two-volume work (in German), presents a general but detailed account of the Odonata, followed by a species by species treatment of the 26 species of Zygoptera recorded from Baden-Württembergs. There is an index, but the bibliography will appear in the second volume, which will cover 49 species of Anisoptera.

Baden-Württembergs is situated in south-west Germany and has an exceedingly rich fauna, including amonst its damselflies such local species (in a central European context) as *Coenagrion ornatum, C. scitulum* and *Nehalennia speciosa*. For each zygopteran, there is a very detailed account encompassing global range of the species, distribution within Baden-Württembergs (including a multi-symbol map), annual and diurnal phenology, larval habitat (including vegetation and physical and chemical properties of the water), the biotypes occupied by the adult at various stages of its life (feeding, breeding, roosting), a comprehensive section on the biology of the larva and adult and, finally, a record of parasitism. From this it may be correctly inferred that this is very much more than a standard regional study of dragonflies. It is a scholarly and beautifully produced book, illustrated by some marvellous photography. The photographs are mostly of dragonflies 'doing things' such as, to mention but a few, a prolarva emerging from its egg, a male *Pyrrhosoma nymphula* clasping a male *Erythromma najas*, *Aeshna caerulea* eating a peacock butterfly and two male *A. caerulea* showing different temperature-controlled colour phases. The photographs alone make the book (at less than £30) very good value, even for those who have difficulty in reading German. Volume 2 is eagerly anticipated.

R. R. Askew

Also received

A Guide to the Dragonflies of Great Britain illustrated by Dan Powell, with text by the artist and Colin Twist. Published by Arlequin Press, Chelmsford, Essex. £15.95 incl. post and packing (softback). ISBN 1 900159 01 5.

A full review of this attractive book will be published in the next issue.

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 or word-processed, double-spaced, on one side of the page only and with margins at least 25mm 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
Ceriagrion tenellum	Small Red 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
Erythromma najas	Red-eyed Damselfly
ANISOPTERA	DRAGONFLIES
Aeshna caerulea	Azure Hawker
Aeshna juncea	Common Hawker
Aeshna mixta	Migrant Hawker
Aeshna cyanea	Southern Hawker
Aeshna grandis	Brown Hawker
Anaciaeschna isosceles	Norfolk Hawker
Anax imperator	Emperor Dragonfly
Anax parthenope	Lesser Emperor Dragonfly
Anax junius	Green Darner
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
Sympetrum vulgatum	Vagrant Darter
Crocothemis erythraea	Scarlet Darter
Pantala flavescens	Globe Skimmer
Leucorrhinia dubia	White-faced Darter

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