Journal of the British Dragonfly Society

Volume 15
Number 1

April
1999

Editor: B. H. Harley

The Journal of the British Dragonfly Society, published twice a year, contains articles on Odonata that have been recorded from the United Kingdom. The aims of the British Dragonfly Society (B.D.S.) are to promote and encourage the study and conservation of Odonata and their natural habitats, especially in the United Kingdom.

ADDRESSES

Editor:	B. H. Harley, Martins, Great Horkesley, Colchester, Essex CO6 4AH
Secretary:	W. H. Wain, The Haywain, Hollywater Road, Bordon, Hants GU35 0AD
Librarian/Archivist:	P. M. Allen, Little Thatch, North Gorley, Fordingbridge, Hants SP6 2PE

Articles for publication (two copies please) should be sent to the Editor. Instructions for authors appear inside back cover.

Back numbers of the Journal can be purchased from the Librarian/Archivist at 1–4 copies £2.75 per copy, 5 copies or over £2.60 per copy (members) or £5.50 (non-members).
Ordinary membership annual subscription £10.00.
Overseas subscription £12.50.
All subscriptions are due on 1st April each year. Late payers will be charged £1 extra.
Life membership subscription £160.
Other subscription rates (library, corporate) on application to the Secretary, who will also deal with membership enquiries.

Front cover illustration of male *Cordulegaster boltonii* (Donovan) at rest on bell-heather by Roderick Dunn

The Status of *Coenagrion hastulatum* (Charpentier) in Scotland, with notes on larval sampling

E. M. Smith and R. W. J. Smith

33 Hunter Terrace, Loanhead, Midlothian EH20 9SJ

Introduction

Marren & Merritt (1983) reviewed the status of the Northern Damselfly C. *hastulatum* (Charpentier) in Britain giving the historical background and a summary of the total number of sites in their various vice-counties. In Merritt *et al.* (1996) the current status is brought up to date. C. *hastulatum* occurs in three compact, widely separated areas in Speyside, Deeside and Perthshire. Marren & Merritt (1983) gave a total of 14 sites from which the species was recorded in 1978-83. As a result of further survey work the number of known sites has increased to 26 although at one of these, where good numbers bred 20 years ago, the species has probably died out very recently.

Since 1991 the authors have visited all of the known C. *hastulatum* sites, including those recorded through the Odonata Recording Scheme, and those reported by Stewart Taylor (Royal Society for the Protection of Birds) and by Dr R. A. H. Smith, J. Parkin and A. Edgar (all Scottish Natural Heritage). Many lochans and small ponds, adjacent to occupied sites, have been visited to establish presence or absence of the species.

Distribution

Speyside

The 17 known sites stretch in a belt up to 4km wide from the Grantown area to a few kilometres south of Loch an Eilean. There is one outlying pool to the south-east. These sites are closely associated with the large areas of Scots Pine (*Pinus sylvestris*) and Birch (*Betula*) woods which occur in the basin of the River Spey to the north-west of the Cairngorm Massif. The sites are at altitudes varying from 180--290m asl, with one at 370m asl. Larvae have been found at 13 sites whilst another is an inaccessible peat-bog pool. Of the three other sites where no larvae have been found, one regularly has good numbers of adults in summer and the other two are small ponds in Scots Pine woodland with typical micro-habitat but records of only a very few imagines at each.

Deeside

Six sites have proven breeding records. Four of these form a compact group in the region of the Dinnet National Nature Reserve. The other two sites are within 6km to the south-east and the south-west of the Reserve. The sites lie between 170--230m asl and are all associated, at least peripherally, with Birch or Scots Pine woodland.

Perthshire

Three sites with proved breeding lie between 150–350m asl in an extensive area of planted conifer on a rocky ridge.

Habitat

There are 26 known sites for C. *hastulatum* in Scotland where breeding has been proved or suspected. Some 'sites' comprise 2 or 3 adjacent ponds. A site as herein specified is a body of water where:

a) the C. *hastulatum* population is large enough to be self-sustaining even if close to another such good site;
b) even if the population is small, there is no other known site for some distance. It may be that some of these are not self-sustaining but, at times, rely on wandering incomers.

An attempt to define the habitat was complicated by the apparent variety of the water-bodies involved ranging from an acid-basin mire, through tiny pools and well-vegetated ponds to a large loch and including both acidic and neutral waters. It seemed paradoxical that there are so few known breeding sites when there are so many other waters that, superficially, would appear to be suitable. This anomaly was first addressed by examining the larval micro-habitat at a site (S1) where there are very good numbers of easily obtainable C. *hastulatum* larvae.

S1 is an overgrown pond with a border of open water. This open water is 2–3m wide, perhaps 80m long and 30-60cm deep with relatively sparse emergent sedges and a good growth of Broad-leaved Pondweed (*Potamogeton natans*). Further out there are thicker stands of Bottle Sedge (*Carex rostrata*) and there is a narrow dense border of this sedge at the water's edge. The pond is surrounded by heather and regenerating Scots Pine and Birch and fed by a flush running from the bare heather moor above through an area of shallow bog-pools. The site supports a very good population of C. *hastulatum*. Other odonate species present are Large Red Damselfly *Pyrrhosoma nymphula* (Sulzer), Emerald Damselfly *Lestes sponsa* (Hansemann), Common Hawker *Aeshna juncea* (L.) and Black Darter *Sympetrum danae* (Sulzer) with Four-spotted Chaser *Libellula quadrimaculata* L. and Golden-ringed Dragonfly *Cordulegaster boltonii* (Donovan) on the shallower bogs. The Common Blue Damselfly *Enallagma cyathigerum* (Charpentier) does not breed. There is a rich fauna of other invertebrates but no fish.

The open water is easily accessible with a pond-net from the shore. Drawing the net under water and through the sparse emergent sedges and sometimes thick *P. natans* will secure good numbers of C. *hastulatum* larvae – perhaps 10–40 with one triple sweep depending on time of year. Larval sizes range from that of newly hatched at 1.25*mm* in July to final instar in spring. *P. nymphula* and *A. juncea* larvae apparently have a preference for the area of denser C. *rostrata* along the shore and presumably that beyond the open water. A few *L. sponsa* larvae are encountered mainly in June and July but two at just over 2mm on 9 May 1997 presented no difficulty with identification. Apparently this area of relatively open water is ideal breeding habitat for C. *hastulatum*, providing egg-laying sites and supporting the larvae through their entire aquatic life. Armed with this basic knowledge, all of the reachable C. *hastulatum* sites have since been surveyed with a pond-net for larvae. In all cases the micro-habitat occupied by the larvae has particular similarities regardless of the general type of water body. The characteristics common to all breeding sites are:

1. The optimum water depth is perhaps 30-60cm. At one extreme it is up to 1m deep in several dug-out ponds with a few larvae found among emergent vegetation around the

edges. The other extreme of about 10cm or less was found mainly in pools suffering from falling water-levels or, in one case, drying out.

2. The emergent vegetation is rather sparse, often Water Horsetail (*Equisetum fluviatile*) or *Carex* species, and there is usually a *Potamogeton* species present. Larvae are not found among thickly growing emergent vegetation and *C. hastulatum* does not breed in waters where this is the only type of vegetation structure.
3. The breeding sites are protected from the wind, usually in small ponds but one is in the sheltered arm of a large loch.

Norling (1984) sampled *C. hastulatum* from two sites in southern Sweden and three sites in northern Sweden. He states '*Coenagrion hastulatum* is one of the most successful damselflies in the northern part of the boreal spruce forest area, and it is often the dominant coenagrionid species in small bodies of water throughout Sweden.' His brief descriptions of his sampling areas suggest that the water depths and perhaps the vegetation utilized by the larvae were consistent with the above description.

Breeding behaviour

At its breeding sites *C. hastulatum* flies slowly in a weak flight amongst the not-too-dense stands of thin-stemmed emergent sedges. One male was seen to fly back and forth many times within a rather enclosed stretch of about 3 x 2m and appeared to 'see off' two other males. This is the only suggestion of territorial behaviour we have noted. They avoid the dense stands of vegetation often typical of Slender Sedge (*Carex lasiocarpa*) or *Carex rostrata* preferring areas where the emergent vegetation, often these same two or similar species, is more widely spaced. This allows them to fly freely well below the top of the sedges. Many of the sites are peaty with a low pH but some are in neutral waters. Sites are never far from trees, usually Scots Pine or Birch, and often there is a surrounding cover of heather or Bog-myrtle (*Myrica gale*) and grasses on any of which the insects may perch. Sphagnum species are often present but apparently have no particular significance for *C. hastulatum*.

Oviposition

On the several occasions when we have observed egg-laying, it occurred while in tandem. Sometimes only the abdomen of the female is under water. With one pair the female and the tip of the male abdomen were already immersed when discovered. They slowly backed down the *Potamogeton* petiole with the female egg-laying as she went down. Eventually both were at least 5cm below the surface. After some 25 minutes they emerged rapidly, climbed 5cm up a stalk then rested for a few minutes before the male quickly disengaged and flew off. We have noted similar behaviour on *Equisetum fluviatile*. Marren & Merritt (1983) quote several sources suggesting that a wide range of vegetation may be used on the Continent for ovipositing.

Flying period

The same authors say '... at one Deeside locality in 1982, *C. hastulatum* males were abundant on May 28th, whilst in 1983 both sexes were still flying in the second week of August.' By

21 May 1995 there had obviously been a good emergence at site S1. In our pond-net samples there were only nine larvae of 14mm or over compared to 79 on 2 May. Similar evidence for 27 May 1997 suggests that emergence by the last week of May is normal. There appears to be no published description of emergence in this species in Scotland.

On 8 June 1994 we collected seven *C. hastulatum* exuviae from one sheltered area in Pond S1. They were all on thin-stemmed sedges, or dead stalks, at the outer edge of the thicker vegetation lining the bank with one of them 80cm further out. They were 4–8cm above water level. Two exuviae found in denser sedge proved to be *P. nymphula*, one of them 20cm above water.

Larval identification

Identification of the larvae in Pond S1 is simplified by the paucity of damselfly species breeding there. *P. nymphula* is stubby and tapers from the head to the tail end of the abdomen. *L. sponsa* is long and very slim with a hammerhead appearance and a characteristic labium. Even at only 2.5mm in length both species are unmistakable and our catches generally included only a few of either species. Final-instar *C. hastulatum* larvae, through a 8x lens, are noticeably spotted, as though sprinkled with pepper, on the dorsal side of the head behind the eyes. Each lamella has a black-edged notch or node at approximately the centre of both edges providing an obvious 'hinge' across the middle. The spots behind the eyes start to appear at around 9–10mm long. No nodus is visible around 4mm but starts to show at 5–6mm. The numerous smaller larvae are assigned to this species as there is no logical reason to question the identification.

Methodology

The larvae were collected by sweeping through suitable vegetation with a very fine pond-net then transferred into colanders above separate basin-like containers. All materials were meticulously sifted through so it is thought few larvae escaped detection. Usually treble sweeps of the net were made in 3–4 separate areas which normally resulted in a catch of at least 100 larvae – sometimes very many more when large numbers of very small ones were involved. The larvae were measured on site. Only body length was measured (not including lamellae) as we did not have suitable equipment nor expertise to measure head-width on site.

The smallest larvae, which have numbered up to 380 individuals on one occasion, were either separated by eye into groups of c. 2–2.5mm, 3–3.5mm etc., or, as at 4 September 1995 and 30 August 1997, separately measured to the nearest mm. Those of 6mm and over were all measured to the nearest mm (except on 28 September 1997) with 0.5mm included in the lower figure. After examination all specimens were returned to the pond.

Results

Table 1 shows larval counts made during 1994–97. A very few 1.5mm yearlings appeared in mid-July with the earliest three of 1.25mm size on 13 July 1997. A month later yearlings were the most numerous components of the catch with the tiny mid-August larvae ranging around 2–3mm. At this time some of the eggs laid later would still be unhatched. By the first week in September most of the yearling larvae were in the 3–4mm range with peaks of c. 4mm in 1995

Table 1 Counts of *C. hastulatum* larvae from 1994 to 1997

	1994						1995						1996					1997					
	24.4	7.6	16.7	12.8	7.9	15.10	2.5	21.5	23.6	20.7	4.9	6.10	6.5	8.7	11.8	6.9	9.10	9.5	27.5	16.6	13.7	30.8	28.9
19							2																
18		3					17	3	2				1					2	6				
17	23	4			3		14	5				4	4				1	18	5				1
16	27			2	10	4	14					4	8			1	10	33	4			2	4
15	13		2	5	8		18				12	3	12		1	5	5	11				12	11
14	18		3	5	6	4	16	1			7	7	9		1	15	12	2				4	4
13	16		13	4	5	4	4			5	7	7	3		3	10	15					14	14
12	3	2	7	4	12	1	3		1	6	18	1	5	2	3	12	2	1		2		6	15
11	1	4	4	8	9	1			3	5	8	4		3	11	13		2		5		11	9
10		23	4	8	2	1		1	6	10	6	1	1	5	8	2		3	6	2	1	9	10
9	4	22	1	11	3	4	6	3	3	25	3	1		17	2	2		2	3	5	1	1	4
8	12	12	6	3	4	6	8	5	7	33	3			12	3			1	1	7	16	3	7
7	9	2	21	9	9	4	3	3	28	31	5	1	4	13	1			2	2	19	19	8	
6		2	55	11	5	4	3	6	52	29	10	28	11	13				3	13	34	17	21	
5			52	7	50		4	50	24	16	3	21	4	5				16	43	57	6	89	200
4		32	18			50	6	22	7		238	4	1	1		150		5	29	24		112	
3			2	143	140	3	2	4	1		135	1			60			2	6	4		62	
2																						10	
1.5			3																		3	1	

All measurements taken to nearest mm with 0.5mm included in lower figure. Those larvae from 1.25–1.75mm included with 1.5mm group. The groups of small larvae (up to c. 5/6mm) which are bracketed were not measured separately. Numbers highlighted in black show distinct groups of larvae of related lengths indicating probable splitting into different cohorts.

and 1997 when all of the small larvae were measured. At this period there is a bewildering range of larvae of every size from around 2mm to those in F-1 instar at 15–16mm. On the Table those numbers which appear to form distinct groupings of 1st or 2nd year larvae are highlighted. In 1994 the second calendar-year larvae showed good evidence of having divided into two cohorts. This is less evident in the second-year larvae of other years sampling although they all show a wide range of body-size. Larvae attain a maximum length of around 17–18mm and growth takes two years.

Table 2 gives measurements of larvae adjudged to be final instar, F-1, a few F-2 and some probable F-3. These are based on wing-bud length (see Gardner, 1954). There is no problem with final instar (on to segment 4) nor with most F-1. When considering F-2 there is a possibility of confusion with smaller F-1 due to human error, natural variation or overlap and similarly with F-3. At the beginning of August there are no final instar and only a few F-1 larvae. By the beginning of September many have attained F-1 but not final instar. A month later, at the beginning of October, there are a number of final instar and probably most of the previous months F-2 have reached F-1 stage. Most of these early October final instar have only attained a length of 15–16mm and presumably have still to expand or stretch before they reach the stage of emergence. A very few of the larvae caught were not sexed or assigned to a particular instar. conclusions reached are tentative ones and further measurements would clarify the situation.

Table 2. Larval measurements of last four instars of *C. hastulatum* larvae

Length in mm		**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**
11.8.96	**F-1**				1	1					
	F-2						3	1	2	3	
	?F-3								6	5	2
6.9.96	**F-1**			1	5	15	7				
	F-2						5	12	13		
	?F-3									2	1
9.10.96	**F**		1	10	5						
	F-1					12	15	2			
9.5.97	**F**	2	17	32	11						
	F-1					2					
27.5.97	**F**	6	5	4							
30.8.97	**F-1**			2	11	3	11	5	1		
	F-2						2	3	9	9	1
28.9.97	**F**		1	4	11	2					
	F-1					2	14	15	8	1	

Table 3 gives sex ratios of larvae on two dates in autumn 1997. The larvae of 30 August were c. 33 F-1 and the remainder F-2. On 28 September 18 larvae were final instar and the remaining 40 were all or nearly all F-1. The 59 larvae measured in August gave a figure of 54.2 per cent males, while the 58 in September had 55.2 per cent males.

Table 3. Sex ratios of *C. hastulatum* larvae

	Length	Total numbers	Nos males	Nos females	% males
30.8.97	10–16mm	59	32	27	54.2
28.9.97	11–17mm	58	32	26	55.2

Table 4 shows the proportion of males/females in relation to length. On both 30 August and 28 September 1997 females comprised a substantially greater proportion of the largest group of larvae although their overall numbers were smaller.

Table 4. Proportion of males/females of *C. hastulatum* larvae in relation to length

30.8.97	**Length**	**10–12mm**	**13mm**	**14–16mm**
	Total numbers	27	14	18 (F-1/F-2)
	Number females	9	5	13
	% females	33.3	35.7	72.2
28.9.97	**Length**	**11–14mm**	**14–17mm**	
	Total numbers	40	18 (all Final instar)	
	Number females	15	11	
	% females	37.5	61.0	

Status and conservation

The number of known *C. hastulatum* sites has risen from 14 in 1983 to 26 in 1997 and it seems probable that no substantial increase on this figure will be made. The numbers of larvae in Pond S1 and the ease with which they can be netted may give a false impression of the overall status of this species in Scotland. Pond S1 is optimum habitat and the narrow corridor of suitable open water is easily accessible from dry land. Few other sites will have comparable numbers of accessible *C. hastulatum* larvae. A subjective assessment of the annual productivity (i.e. the number of imagines produced) suggests that six of these 26 sites would have very low numbers (certainly under 50 and at most sites perhaps under 20 imagines) based on the small total volume of water in these ponds, the very small area of suitable vegetation and the apparent shortage of larvae found during pond-netting. Reports of 'about 100 or 100+' flying insects come from only four ponds and it seems likely that a maximum of ten sites will produce many hundreds of imagines in any one year. The remaining ten sites do not appear to be so productive but population assessment is not straightforward and the species can be difficult to find away from the water as the insect merges into the surrounding heather. The impression remains that it is nowhere a very common damselfly and one never sees it in hundreds as one regularly does *E. cyathigerum* which sometimes shares the same sites.

The preferred habitat of shallow well-vegetated pools is one which, in the medium to long-term, tends to dry out with natural vegetational succession. One lochan in a Deeside estate is gradually infilling with vegetation and the Estate is considering clearing out much of the thick mat of sedges and the large area of shallow mud. They are aware of the presence of *C. hastulatum* and any clearance will have to be sensitively done to retain a suitable habitat for the

species. Another endangered Scottish site is an acid basin mire with very shallow peaty pools and surrounding afforestation. The first numerical records made in 1976 at this site were of more than 100 *C. hastulatum* with several pairs in copula. None have been reported during the last three years, and it is possible that the drought year of 1995 finished them off. Some conservation measures are under way at this site.

On the positive side, new habitats have been created which favour the species. Among some of the best sites in Scotland are four in Abernethy Reserve formed when the Royal Society for the Protection of Birds dammed and flooded ditches in the Scots Pine woods. Forest Enterprise has recently flooded a shallow area in one of their forests as a measure designed purely to help increase the area of habitat suitable for *C. hastulatum*.

Discussion

C. hastulatum is a boreo-alpine species and probably a relict one in Scotland. Broader parameters of the general habitat can be defined as follows:

1. 'The known localities of *C. hastulatum* all lie within the 0.6°C February minimum isotherm and the 2.5°C January mean, which is the coldest part of Britain ... They are also within the relatively warm 14–14.5°C July mean, and we are thus within the continental rather than the oceanic parts of northern Scotland.' (Marren & Merritt (1983).
2. There is a strong relationship with long-established forests of Scots Pine and Birch. Breeding waters tend to be mesotrophic. Ponds which have heavy usage by cattle are grazed and become trampled and muddy round the edge, so the micro-habitat necessary for this species is missing. This rules out most small waters outwith permanent woodland and may be one reason for the limited distribution of *C. hastulatum* in Scotland even in suitable climatic conditions.
3. The larger lochs have fluctuating water-levels and are exposed to strong winds which results in stony edges. Others are bordered by thickly growing sedges making them unsuitable for the species. It is interesting that there is only one large loch with a known breeding *C. hastulatum* site, in a sheltered arm of the loch. This loch has a tiny water catchment area and a small inflow and equally small outflow burn. The outflow burn dries up quickly in most summers and the local farmer reports that the water level in the loch never drops more than c. 30cm even in drought years.
4. It is possible that the presence or absence of *E. cyathigerum* at any site may have a bearing on *C. hastulatum* numbers. Both species make extensive use of *Potamogeton natans* for resting and egg-laying. Some of the best *C. hastulatum* sites have no breeding *E. cyathigerum* and, where the latter occurs, it may outnumber the former species. On two small ponds where both species occur we have been unable to find *C. hastulatum* larvae when pond-netting in typical *C. hastulatum* micro-habitat, although many *E. cyathigerum* were taken. More work is needed on this aspect. *E. cyathigerum* has been noted at ten (and perhaps occurs on c. 12) of the total of 26 *C. hastulatum* sites. Fortunately, as those pools become more overgrown, this will tend to favour the latter species.

In conclusion, although widespread in northern Europe *C. hastulatum* is a scarce species in Britain. Superficially the 'range of habitats in which *C. hastulatum* is found in Britain is best

exemplified by briefly describing three typical sites' (Marren & Merritt, 1983) – the authors then describe three apparently different habitats. In reality the micro-habitat to which breeding is restricted, although found in a variety of very different waterbodies, is not widespread. This is an outpost population at the extreme edge of its range which occupies a very restricted niche. Many of the sites are already very overgrown with only a small proportion of the total wetland area suitable for the species. Monitoring and occasional active management of these sites is essential for their long-term viability.

Acknowledgements

We are indebted to the Biological Records Centre, Monks Wood, for permission to use BRC records, and to the field-workers who submitted them. We thank Stewart Taylor, Dr Ros Smith, A. Edgar and J. Parkin for site information, Mo Richards, Louise Mitchell and Emma Clarke for assistance with field work and Bob Merritt for most helpful discussions. Various landowners, the RSPB and Forest Enterprise have been most co-operative in allowing access.

References

Gardner, A. E. 1954. The life-history of *Coenagrion hastulatum* (Charp.). *Entomologist's Gazette* **5**: 17–39.

Marren, P. R. & Merritt, R. 1983. A review of *Coenagrion hastulatum* (Charpentier) in Britain. *Journal of the British Dragonfly Society* **1**(2): 16–19.

Merritt, R., Moore, N. W. & Eversham, B. C. 1996. *Atlas of the dragonflies of Britain and Ireland*. HMSO, London. 149 pp.

Norling, U. 1984. The life cycle and larval photoperiodic responses of *Coenagrion hastulatum* (Charpentier) in two climatically different areas. *Odonatologica* **13**(3): 429–449.

A sighting of *Coenagrion pulchellum* (Vander Linden) in Gloucestershire

John and Viv Phillips

Yorkleigh Cottage, Pope's Hill, Newnham-on-Severn, Gloucestershire GL14 1LD

During the afternoon of 1 August 1998 we were dragonfly watching at a group of well-established shallow ponds on an area of long revegetated former industrial workings near Cinderford in the Forest of Dean (SO 645150). This is close to the only recent breeding site in Gloucestershire for *Orthetrum coerulescens* (Fabricius) (Holland, 1991), and about 2km NW of where *Anax parthenope* (Sélys) occurred in 1996 (Phillips, 1997). The sky was mostly overcast with occasional sunny spells, and temperatures were near average (c. 19°C).

Since about 1990 we have routinely checked blue damselflies, with *Coenagrion pulchellum* (Vander Linden) in mind, and a male *Coenagrion* which settled in front of J.P. received the usual scrutiny. It flew almost immediately, but not before giving an impression of very narrow, possibly discontinuous an

Fortunately the sun was obscured and the damselfly did not fly far, and by careful 'stalking' we were able to approach very closely, down to a few centimetres, as it perched on vegetation one to two metres above the shallow water of the pond edge. Over a period of some 10 minutes we compared it carefully with a nearby male *C. puella* (L.). At one stage J.P. managed to catch it by hand but in the absence of a hand lens little additional detail could be seen.

With considerable surprise and delight we were able to confirm the identity as *C. pulchellum*. The right antehumeral stripe was broken into the characteristic form of an 'exclamation mark', while the left became very narrow without actually breaking. The black mark on the second abdominal segment was in the form of a U, thicker at the base than in *puella*, with a thin line ('stem') between the U and the distal black ring. At very close range the stem proved to be separated from the U by a fraction of a millimetre. The black on the 9th abdominal segment was more extensive than on *puella* and the anterior boundary was in the form of a very shallow w, with no extension of black anteriorly along each side of the segment as in *puella*. This was a very noticeable difference. We were aware that the shape of the posterior edge of the pronotum was an important feature, but were not sure of the details. To the naked eye the edge of the pronotum appeared as a thin pale line. The line was decidedly undulating on this *pulchellum* and noticeably straighter-looking on several *puella*. This individual looked darker overall, slightly smaller and more dainty than nearby *puella*. All the field characters were confirmed by reference to Brooks (1997).

This appears to be the first record of *C. pulchellum* for Gloucestershire, although it seems probable that it would formerly have occurred on the low-lying margins of the Severn estuary in South Gloucestershire. There have been some past reports within the county, but all have proved to be *C. puella* (Holland, 1991).

As with the 1991 record of *C. mercuriale* (Charpentier) at Cothill, Oxfordshire (Paul, 1998), possible reasons for this individual's appearance include the presence of a small population on the site, the existence of undiscovered population(s) nearby, and vagrancy from a more distant

colony. An origin somewhere in the fairly immediate vicinity seems likely. The site itself appears to be potentially suitable for breeding, with several small to medium-sized, mostly shallow ponds with abundant aquatic vegetation including much Common Spike-rush *Eleocharis palustris*, with Bulrush *Typha latifolia*, Pondweed *Potamogeton* sp. and other species. There are also a number of apparently even more suitable ponds in the Forest of Dean within a few kilometres of this site. The Dean has been relatively well watched for dragonflies, but it is possible that a population of *C. pulchellum* at low density could have been overlooked among more abundant *puella*. There is also the possibility of an undiscovered site near the Severn.

It seems less likely that this could have been a longer-distance vagrant but it is not out of the question. The nearest 10km squares mapped for *pulchellum* in Merritt *et al.* (1996) are SO12, c.50km to the WNW of Cinderford, and ST47, c.45km to the SSW. Waring (1996, 1998) lists no closer sites.

References

Brooks, S. 1997. *Field guide to the dragonflies and damselflies of Great Britain and Ireland.* British Wildlife Publishing, Hook. 160 pp.

Holland, S. 1991. *Distribution of dragonflies in Gloucestershire.* Toddington Press, Cheltenham. [2] + 74 pp.

Merritt, R., Moore, N. W. & Eversham, B. C. 1996. *Atlas of the dragonflies of Britain and Ireland.* HMSO, London. 149 pp.

Paul, J. 1998. On the mysterious occurrence of *Coenagrion mercuriale* (Charpentier) at Cothill. *Journal of the British Dragonfly Society* **14**(1): 28–30.

Phillips, J. 1997. Lesser Emperor Dragonfly *Anax parthenope* (Sélys) in Gloucestershire; the first British record. *Journal of the British Dragonfly Society* **13**(1): 22–24.

Waring, E. 1996. *Coenagrion pulchellum* (Vander Linden) in England since 1990. *Journal of the British Dragonfly Society* **12**(1): 26–29.

Waring, E. 1998. Further sites for *Coenagrion pulchellum* (Vander Linden). *Journal of the British Dragonfly Society* **14**(1): 4–5.

Observations on the use of Yellow Flag (*Iris pseudacorus*) as a support for emerging zygopteran larvae

Stuart J. Andrews
39 Guildford Street, Staines, Middlesex TW18 2EQ

It is generally accepted that mortality of dragonflies during emergence may be caused directly or indirectly, in three ways: (1) by physical factors; (2) by overcrowding; and (3) by predation (Corbet, 1962). Studies designed to investigate the mortality at emergence in the Large Red Damselfly *Pyrrhosoma nymphula* (Sulzer) have found that mortality can occur as a result of aquatic and terrestrial predation, competition for emergence sites, and damage from the wind, rain and other physical factors (Gribbin & Thompson, 1990). More recently, Bennett & Mill (1993) found that mortality at emergence over a three-year study of *P. nymphula* ranged from 3 to 5.2 per cent and that the main causes were incomplete ecdysis, failure to expand the wings and predation by spiders.

Treacher (1996a,b) has recently reported high levels of mortality (83 per cent) of emerging *P. nymphula* between 5 and 8 May 1995 at a garden pond in Weymouth, Dorset. Over the four days of observation, 23 larvae of *P. nymphula* were seen to crawl up the central ribs of Yellow Flag (*Iris pseudacorus*) leaves to heights of between 50 and 150mm above the water. During various stages of emergence, 19 of these fell off and subsequently died. It was postulated that the *Iris* leaves were too wide for the legs of the centrally-positioned larvae to clasp at both edges, so that larvae and emerging damselflies were totally reliant on their tarsal claws for gripping the shiny surfaces of the leaves. It was noted that although a few were blown off, most simply fell whilst extricating bodies and wings from the exuviae, and some completed ecdysis. Two of the four larvae which successfully developed into adults were located in the centre of the *Iris* leaves (precise position of the legs not given) and the other two were on small *Iris* leaves that were narrow enough for the larvae to obtain a grasp around the edges. A number of possible explanations for the surprisingly high rate of mortality have been put forward, including that:

1. a cold April, followed by a heatwave at the beginning of May, triggered the larvae into an early emergence;
2. the pond being sheltered and shallow would warm up quickly thus triggering emergence;
3. the goldfish present in the pond were not being fed, and were successfully competing with larvae for pond food. This resulted in larvae becoming weak and undernourished prior to emergence (they appeared smaller than larvae successfully emerging the following year); and
4. *Iris*, with wide, shiny, tough leaves were not suitable for the weak larvae to grasp for emergence (Treacher, 1996a).

More recently, Treacher (1996b) concluded that the principal reason for the emergence failure was likely to be that the selection of *I. pseudacorus* provided too wide an emergence site. Remedial action was taken, including the planting of narrow-leaved marginal plants, feeding the fish with supplementary food, and pushing garden sticks, of about 5mm diameter,

into the roots of all the pond plants at various angles. This action appears to have been successful (Treacher, 1996b; Anon, 1996).

In the BDS handbook *Dig a Pond for Dragonflies*, *I. pseudacorus* is recommended as a marginal plant. It has been suggested, however, that it should not be the only marginal plant in small garden ponds if high levels of mortality of damselfly larvae are to be avoided (Treacher, 1996b).

From my own limited observations in the field, I would like to suggest that (a) the overall width of *Iris* leaves may be of little importance to the successful emergence of *P. nymphula*, or indeed any other species of Zygoptera of similar size, and therefore that (b) the high levels of mortality reported by Treacher may not be solely due to the fact that *I. pseudacorus* was the only marginal plant grown. Evidence to substantiate this suggestion is presented here using the Common Blue Damselfly *Enallagma cyathigerum* (Charpentier) as a model. As members of the family Coenagrionidae, both *E. cyathigerum* and *P. nymphula* share many features, including aspects of the size of the final-instar larvae (see Table 1). As such, it seems reasonable to assume that the basic mechanics associated with the attachment to leaves of *I. pseudacorus* for emergence are likely to be similar for both species.

Table 1. Morphological similarity between final-instar larvae of *E. cyathigerum* and *P. nymphula* (measurements taken from Lucas (1930)).

Characteristic	*E. cyathigerum*	*P. nymphula*
Length (including lamellae)	19mm	20mm
Maximum width	2.5mm	2.5mm
Length of legs – fore	7mm	7mm
– mid	8mm	8mm
– hind	11mm	11mm

Observations of the emergence of *Enallagma cyathigerum* on *I. pseudacorus*

As part of an ongoing study on the emergence of *E. cyathigerum* at a local flooded gravel-pit, particular attention was given to certain aspects of vertical stratification on *I. pseudacorus*. It had been noted since the study was started in the summer of 1994 that the precise position of larvae on leaves chosen for emergence, in particular their position relative to the mid-rib vein, varied. A number of visits to the study site, approximately weekly, were made between 6 and 16 August 1994 (3 visits) and between 12 and 29 June 1996 (3 visits) to investigate this observation further.

Study site

The study site was a flooded gravel-pit at Wraysbury, nr Staines (National Grid Reference TQ 014737). The pit was one of a series which had been worked for gravel during the 1960s and to a lesser extent in certain parts up to the early 1990s. The pit had steep banks, was filled with water with an average depth of between 3–5m, and had marshy fringes. The trophic status of the aquatic habitat was generally mesotrophic tending towards eutrophic in certain parts during the summer. Samples of surface water taken in May and August 1994 had pH values of 7.0 and 6.5, respectively. An area of shingle beach, south facing, at the north end of the pit was

chosen for this particular study. The beach was backed by a near-vertical mud/shingle bank approximately 3m from the water's edge, and 30 to 60cm in height behind which was a mixed plant community including an extensive bed of Common Nettle (*Urtica dioica*). Clumps of *I. pseudocorus* grew at the water's edge.

Design of the investigation

On each visit to the study site, between 1000–1700h BST, the irises were searched, as randomly as practically possible, for exuviae of *E. cyathigerum*. This species was the dominant species of Odonata (approx. 95 per cent of exuviae collected and identified) which used the irises as emergence supports, the Red-eyed Damselfly *Erythromma najas* (Hansemann) and the Banded Demoiselle *Calopteryx splendens* (Harris) each forming a minor part of the sample examined. On each visit a number of observations were made in the field, including the following:

1. the height climbed by each larva (vertical height from either the base of the leaf or, if in the water, the lowest part in contact with the water to the leaf tip);
2. the width of the leaf at the attachment site;
3. the position of exuviae relative to the mid-rib vein; and
4. whether the exuviae were situated on the upper or lower surface of the leaf (observation 2, 3 and 4 were made during visits in 1996 only)

Results

A total of 60 exuviae of *E. cyathigerum* was examined, 34 during 1996. It is noteworthy that a small but significant number of larvae appeared to bypass the irises and emerge on other vegetation including the nettles behind the mud/shingle bank. These alternative supports for emergence appeared to be used more often during the early part of the emergence period (data not shown).

Height climbed for emergence

The average height climbed by larvae in this study for emergence was 42cm (range 10–100cm). Together with additional data collected during the emergence periods for 1994 and 1996, it can be seen that most larvae climb at least two-thirds of the total height of the iris for emergence but not necessarily right up to the very top (Fig. 1).

Width of leaf at emergence site

As a general observation, the average width of any single iris leaf does not vary considerably throughout most of its length, the overall width tending to increase with increasing length (age) of the leaf. The average leaf width at the position of emergence was 14mm (range 5 to 25mm).

Position of exuviae relative to the mid-rib vein on either side of leaf

An equal number of exuviae were recovered from both sides of the iris leaves. 41 per cent of larvae chose a position whereby both sets of legs could clasp both edges of the leaf whilst 53 per cent chose an alternative position utilizing the mid-rib vein as an alternative to one of the leaf edges (Table 2).

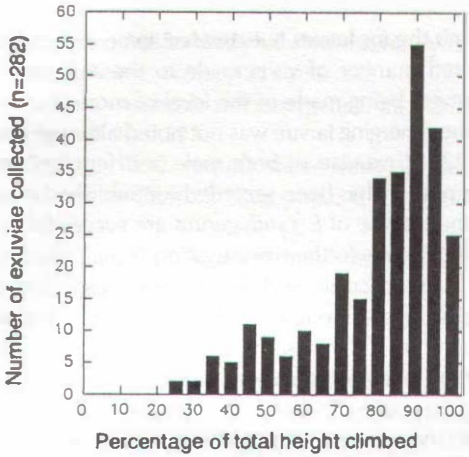

Figure 1. Height climbed by *E. cyathigerum* larvae for emergence on *I. pseudacorus* (including additional data from 1994 and 1996).

Table 2. Number (percentage) of exuviae of *E. cyathigerum* and their location on leaves of *I. pseudacorus* relative to the mid-rib vein of the leaf.

Surface of leaf chosen for emergence	Legs clasping both edges of leaf (position A)	Legs clasping mid-rib vein and edge of leaf (position B)[a]	Legs clasping mid-rib vein and edge of leaf leaf (position C)[b]	Legs arranged in other positions
Upper Surface	8 (23.5%)	6 (17.6%)	2 (5.9%)	1 (2.9%)
Lower Surface[c]	6 (17.6%)	4 (11.8%)	6 (17.6%)	1 (2.9%)

[a] legs on right-hand side of larva clasping edge of leaf, with other set of legs clasping mid-rib vein of leaf.

[b] legs on left-hand side of larva clasping edge of leaf, with other set of legs clasping mid-rib vein of leaf.

[c] Lower-surface = underside of leaf.

Discussion

This study provides data which suggests that high levels of mortality of damselfly larvae during emergence may not be directly associated with the sole use of *I. pseudacorus* as a marginal plant. Although the level of mortality in *E. cyathigerum* at the study site was not quantified, the large number of exuviae and teneral forms observed on the clumps of *Iris* at the study site over a three-year period (1994–1996) are suggestive of a low level of mortality. However, the fact that (a) the final instar larvae of *E. cyathigerum* (and also *P. nymphula*) are small and cryptic and easily overlooked, especially low down in the middle of a clump of irises; (b) the observation

that many larvae did not climb the *Iris* leaves but crawled some distance from the water's edge to emerge; and (c) the limited number of visits made to the study site over the emergence period prevent a true assessment being made of the level of mortality.

The nutritional status of the emerging larvae was not noted although a variation in the length (range 18.5–23.5mm, n=222) of exuviae of both male and female *E. cyathigerum* collected from this site over a number of years has been recorded (unpublished observations). Therefore, whether or not undernourished larvae of *E. cyathigerum* are successful in using *I. pseudacorus* as an emergence support still requires further investigation.

The shape of clumps of *I. pseudacorus*, with leaves being very close together at the base, dictates the need for larvae to climb a certain height for emergence in order to have at least sufficient room for wing expansion. If the clasping of both edges of the leaf were a prerequisite for successful attachment, then one would expect most exuviae to be located on either the narrower leaves or at the top of wider leaves. Such a distribution of exuviae was not apparent. Indeed, it would appear that larvae can attach successfully to either side of the leaf and that the mid-rib vein often acts as an alternative to a leaf edge and is thus a suitable structure to which either one set of legs or tarsal claws can attach.

Having originated some three-hundred million years ago and with very little change in their basic structure (Askew, 1988), it would be surprising if high levels of mortality in any species of dragonfly were to be associated with the choice of an unsuitable support for emergence in any established habitat, although a newly constructed garden pond may offer fewer suitable emergence supports. The damselfly *P. nymphula* is widely distributed in the UK and can be found in a range of different habitats including ponds (Merritt, Moore & Eversham, 1996). Furthermore, it has been observed by other workers that emerging larvae of *P. nymphula* can often be seen to be testing upright plant stems for stability/suitability by climbing several inches only to flick themselves off into the water in order to try again elsewhere (Corbet, 1952), or to wriggle their abdomens from side to side, an action which possibly serves to test the grip of the tarsal claws on the support (Corbet, 1962).

In conclusion, it would appear unlikely that the primary cause for the apparent high mortality of *P. nymphula* described by Treacher (1996a,b) was due to the selection of *I. pseudacorus* as an emergence support *per se*, but is perhaps more likely to be associated with either climatic factors or the nutritional status of the larvae.

Acknowledgements

I would like to thank Mr Stephen Brooks of the Natural History Museum, London, for his useful comments on the manuscript.

References

Anon, 1996. Questions and answers. *Newsletter of the British Dragonfly Society* **30**: 15.

Askew, R. R. 1988. *The dragonflies of Europe*, Harley Books, Colchester. 291 pp.

Bennet, S. & Mill, P. J. 1993. Larval development and emergence in *Pyrrhosoma nymphula* (Sulzer): (Zygoptera: Coenagrionidae). *Odonatologica* **22**: 133–145.

Corbet, P. S. 1952. An adult population study of *Pyrrhosoma nymphula* (Sulzer): (Odonata: Coenagrionidae). *Journal of Animal Ecology* **21**: 206–222.

Corbet, P. S. 1962. Growth, metamorphosis and emergence. In: *A biology of dragonflies*. H. F. & G. Witherby Ltd, London, pp. 90–119.

Gribbin, S. D. & Thompson, D. J. 1990. A quantitative study of mortality at emergence in the damselfly *Pyrrhosoma nymphula* (Sulzer): (Zygoptera: Coenagrionidae). *Freshwater Biology* **24**: 295–302.

Lucas, W. J. 1930. *The aquatic (naiad) stage of the British dragonflies (Paraneuroptera)*, The Ray Society, London. 132 pp., 35 pls.

Merritt, R., Moore, N. W. & Eversham, B. C. 1996. *Atlas of the dragonflies of Britain and Ireland*, HMSO, London, 149 pp.

Treacher, P. 1996a. Questions and Answers. *Newsletter of the British Dragonfly Society* **29**: 16.

Treacher, P. 1996b. Mortality of emerging *Pyrrhosoma nymphula* (Sulzer) at a garden pond. *Journal of the British Dragonfly Society* **12**: 61–62.

An unusual mismatch

T. G. Beynon

34 Church Lane, Checkley, Stoke-on-Trent ST10 4NJ

On 5 July 1997, at Shooters Pool, Chartley Moss NNR, I noticed a female Emperor Dragonfly *Anax imperator* Leach ovipositing. After a hot, bright, breezy morning the sun had clouded over by 1230h and general activity was much reduced.

The female was perched on a horizontal leaf of Hare's-tail Cottongrass (*Eriophorum vaginatum*) lying along the surface in the marginals on the northern edge, and ovipositing into it.

A male Common Blue Damselfly *Enallagma cyathigerum* (Charpentier) approached and settled on the *Anax* at the wing bases on the thorax. It curled its abdomen round and under and attempted to grasp the *Anax*. It lifted off briefly, settled again, and tried once more to grasp the *Anax*. The *Anax* paid no attention to the *Enallagma*, but then flew off a little way, dislodging the *Enallagma*, and began ovipositing near the original site.

I believe that the green and black pattern of her abdomen, accentuated by the fact that it was nearly horizontal as she oviposited into the horizontal leaf, may have resembled that of a huge *Enallagma*, and acted as a super-stimulus to the male.

The Hornet Robberfly *Asilus crabroniformis* L. (Diptera, Asilidae): interactions with Odonata

David K. Clements
7 Vista Rise, Llandaff, Cardiff CF5 2SD

The hornet robberfly *Asilus crabroniformis* L. is a large, Nationally Notable predatory fly of the family Asilidae. It has declined markedly throughout its British range in the period since 1970 and as a result is included on the UK Biodiversity Action Plan 'Short List'. During 1997 it was the subject of several research studies undertaken by the statutory agencies into its behaviour, ecology and distribution. Clements & Skidmore (1998) set out the results of recent behavioural and ecological studies in Wales, whilst a parallel study undertaken in England is reported by Pinchen *et al.* (1998).

Adult *Asilus* fly in mid to late summer, peaking in August. They actively hunt for a wide range of prey, including grasshoppers, Lepidoptera and various beetles, flies, wasps and bees. They are seemingly adapted for the taking of larger insect prey items, and have a bite which delivers a powerful and fast-acting paralyzing venom.

During recent studies at Crymlyn Bog, near Swansea, a male *Asilus* was seen with an Emerald Damselfly *Lestes sponsa* (Hansemann) as prey (9 August 1997). This appears to be the first record of Odonata as prey of *Asilus crabroniformis*. Odonata are very rarely recorded as prey of Asilidae generally. The monumental work by Melin (1923) makes reference to the scarcity of such records, whilst referring to the taking of a Variable Damselfly (*Coenagrion pulchellum* (Vander Linden)), by the robberfly *Neoitamus cyanurus* (Loew) in Sweden. Melin summarized a further seven published records of Odonata as asilid prey, all referring to non-European countries but including the taking of a *Libellula* dragonfly by a large *Asilus* sp. (*sens. lat.*) in America (Todd, 1881). Poulton (1906) mentions only four records of Odonata as prey out of some 256 recorded observations from amongst the world asilid fauna. In Europe, Parmenter (1952) records Common Blue Damselfly *Enallagma cyathigerum* (Charpentier) as prey of the smaller robberfly *Lasiopogon cinctus* (F.) in Britain, whilst Hobby (1932) records the Orange-spotted Emerald *Oxygastra curtisii* (Dale) as prey of *Dysmachus trigonus* (Meigen) in France.

Adult *Asilus* also feature amongst the prey of Odonata. In 1994, Dr Jonty Denton observed a Downy Emerald *Cordulia aenea* (L.) dragonfly capture and eat an *Asilus* on Thursley Common in Surrey (Pinchen *et al.*, 1998). Parmenter (1952) refers to dragonflies as being 'known enemies of robberflies' (along with birds) but gives no further details. I am not aware of any other published records of predation by Odonata.

Adult *Asilus* spend a great deal of time perched motionless on reflective surfaces such as dried cow-pats, especially in warm, sunny conditions. This 'sunning' or 'basking' behaviour is probably thermoregulatory, as adults are usually inactive at air-temperatures less than 16°C, and the surfaces chosen are an average of 3°C warmer than the ambient temperature. Perches are often shared with a range of other 'sunning' species, including dragonflies, butterflies, grasshoppers and various other flies.

In the great majority of cases the co-habitees of a perch (many of which are potential prey) ignore, and are ignored by, the occupying *Asilus*. During the recent studies, however, adult *Asilus* were seen occasionally to displace basking Common Darters *Sympetrum striolatum* (Charpentier) and Keeled Skimmers *Orthetrum coerulescens* (F.) dragonflies from perches. Conversely, adult *Asilus* were also observed being displaced from perches by *S. striolatum*.

In many cases displacement appears to arise incidentally, the surprise arrival of one species causing the abrupt and probably instinctive, precautionary departure of the other. In some cases, however, adult *Asilus* have been observed deliberately displacing Odonata by means of aggressive, close-darting flights and hovering (Painter, 1997).

Adult *Asilus* show some (probably temporary) territoriality associated with perches, which are also used as 'hunting platforms' from which predatory capture flights are made, and to which the *Asilus* habitually returns to consume its prey. Whether there is any distinction between 'sunning' perches and 'hunting platforms', and the degree to which this might affect tolerance of other predatory species, is presently unknown. Observations of the interactions between *Asilus* and Odonata are still accumulating, and relationships are at present poorly understood. The author would greatly welcome any novel observations from BDS members.

Thanks are due to the Countryside Council for Wales and English Nature for permission to quote from cited reports.

References

Clements, D. K. & Skidmore, P. 1998. The autecology of the hornet robberfly *Asilus crabroniformis* (L.) in Wales, 1997. Countryside Council for Wales Contract Science Report No. 263.

Hobby, B. M. 1932. Supplementary list of the prey of Asilidae (Dipt.). *Journal of the Entomological Society of the South of England* **1**: 69–78.

Melin, D. 1923. Contributions to the knowledge of the biology, metamorphosis and distribution of the Swedish Asilids. *Zoologiska Bidrag Från Uppsala* **8**: 1–317.

Painter, D. 1997. Monitoring the hornet robberfly *Asilus crabroniformis* at Crymlyn Bog NNR, 1997. Countryside Council for Wales, internal report.

Parmenter, L. 1952. Diptera: Notes on the Asilidae (Robber Flies). *Entomologist's Record & Journal of Variation* **64**: 295–299.

Pinchen, B. J., Denton, J. S. & Bird, D. R. 1998. The hornet robberfly (*Asilus crabroniformis* Linnaeus): adult behaviour at selected sites in Dorset, Hampshire and Surrey in 1997. English Nature Research Report No. 274.

Poulton, E. B. 1906. Predacious insects and their prey. *Transactions of the Entomological Society of London*: 323–409.

Todd, J. E. 1881. *Asilus* sp. attacking dragonfly. *American Naturalist* **15**: 1005.

Cannibalism in dragonflies exemplified by the species *Anax imperator* Leach and *A. parthenope* (Sélys)

Henning Pedersen

Mellemvej 15, DK – 8800 Viborg, Denmark. E-mail: henning.pedersen@post12.tele.dk

On 23 July 1991, I was visiting a large clay pit, just 1km NE of the small village of Üllies. The nearest town is Kiskunmajsa. Both are situated in the southern part of Hungary. The purpose of the visit was to carry out behavioural research on dragonflies.

The weather conditions on that day were:

Wind NE 2 (Beaufort), Cloud 0/8, Temperature >+30°C, Precipitation: none.

Time of day: 1130–1400h.

Species of Anisoptera recorded during that period were:

Anax imperator Leach, *A. parthenope* (Sélys), *Orthetrum cancellatum* (L.), *O. albistylum* (Sélys), *Crocothemis erythraea* (Brullé) and *Sympetrum pedemontanum* (Allioni). All these species were abundant.

Observations on cannibalism:

On several occasions, I observed *Anax imperator* and *A. parthenope* chasing and catching other dragonflies. More than 35 of the attempts observed were successful. I noted that *A. imperator* and *A. parthenope* were the only species successfully attacking two different species: *Crocothemis erythraea* and *Sympetrum pedemontanum*. Without any doubt it was clear to me that *C. erythraea* was the preferred prey – and that made me wonder. One would have expected that the much slower (so it seemed to me) *S. pedemontanum* would be the most frequent prey. But surprisingly it was *C. erythraea* that suffered greater predation. I estimated that for every 5 *C. erythraea* caught, *A. imperator* and *A. parthenope* succeeded in catching only 1 *S. pedemontanum*!

I occasionally observed *A. imperator* and *A. parthenope* attempt to catch *Orthetrum cancellatum* and *O. albistylum* but these two species seemed to be too fast for the attackers – at least, I never saw them succeed in catching even one.

I also noticed that *A. imperator* was a much more aggressive species than *A. parthenope*. However, both species were always chasing other dragonflies, just like a Peregrine Falcon *Falco peregrinus*. Very often I saw what I would describe as 'deliberate feints', and like birds the victims were trying to avoid the attacks by diving and turning in the air. Often the victims ended up as prey. I would estimate the success rate at fifty per cent.

In some cases, I observed, especially with *A. imperator*, *Crocothemis erythraea* being chased over a very long distance. A distance of up to 150m was recorded on several occasions. For *A. imperator* it seems to be of no importance at all whether it has to chase a prey vertically or horizontally.

I never observed the two species under observation, *A. imperator* and *A. parthenope*, consume their prey on the ground or perched on a twig – this always happened in the air.

Common Green Darner *Anax junius* (Drury) in Cornwall and Isles of Scilly – The first British and European records

Keith Pellow

Mount Pleasant Bungalow, Botus Fleming, Saltash, Cornwall PL12 6NQ

On 9 September 1998 a routine visit to Penlee N.R. near Rame Head, Cornwall, led to a quite extraordinary series of events.

At about 1330h BST whilst walking through a sheltered section of the Reserve I saw a large hawker-type dragonfly which initially resembled a male Emperor *Anax imperator* Leach. However its overall colouring appeared too dark and lacked that species' obvious contrast between the green thorax and blue abdomen. It also showed a quite distinct blue area, towards the top of its abdomen, and I initially considered that it might be a Lesser Emperor *A. parthenope* (Sélys).

Fortunately, after a while, the insect settled low down in grass and within a short time of viewing it through binoculars I began to think of another possibility, Common Green Darner *Anax junius* (Drury), an American species which I had seen earlier in the year in large numbers during a visit to Florida, and which had been suggested as a potential migrant from the Nearctic (Parr, 1998).

Being mindful that the differences between *A. junius* and *A. imperator* are only slight and subtle, I made careful reference to its markings, noting its green/olive eyes, its completely green thorax and the black central abdomen markings gradually widening along its length.

However the most noticeable feature, quite easily seen when settled, was the entirely blue second segment which was pale-centred with only two short black lines either side of this central line rather than with the black central line diagnostic of *A. imperator*. An oval black mark, surrounded by yellow and bordered dorsally by a blue semicircle on the forehead, was also a noticeable feature.

Leaving the insect still settled I returned later with a camera only to discover it had gone, and I was unable to re-locate it. However after consulting a number of reference books that evening I became convinced that I had indeed seen Britain and Europe's first Nearctic dragonfly.

The following day, 10 September, I travelled to St Agnes, Isles of Scilly, and through a quite amazing coincidence I discovered another dragonfly which, when I obtained settled views of it, displayed exactly the same features as the Penlee individual, with the pale-centred second segment and the black 'bulls-eye' mark again being quite noticeable.

The insect was however quickly blown away in a rather strong westerly wind but, after alerting others to this potential second record of *A. junius*, I received reports of at least one other or possibly the same male, as well as of sightings of at least one female which was photographed on Gugh.

The next day, 11 September, I returned to Penlee N.R. where at 1530h, together with Leon Truscott and following a rather nerve-racking wait, I managed to capture the male Green Darner, obtaining photographs of it, as well as to make a detailed description, noting in particular the diagnostic black hooks or pins situated at the end of the anal appendages.

It remained on the Reserve until 17 September being seen by a large number of enthusiasts who made the journey to see it.

Astonishingly, a female *A. junius* was seen and photographed in the Reserve on 15 September by Ted Griffiths and others.

The reporting of these sightings led to several additional records of *A. junius* in Cornwall and on the Isles of Scilly being documented.

There would seem to have been a minimum of six individuals, but perhaps as many as ten or more, involved in this influx of a species which is the most common and widespread large dragonfly in the USA where it is known to be highly migratory (Dunkle, 1989).

What makes the records so extraordinary is that not only do the sightings at Penlee and the Isles of Scilly represent the first European records of an American dragonfly but that they were also the first multiple sightings, which must lead to speculation that perhaps colonization here could be a possibility.

The records coincided with a deep, fast-moving Atlantic depression, the remnants of Hurricane Danielle which brought strong gale/storm force westerly winds to South-West Britain and which were also responsible for the arrival of two Common Nighthawks *Choreiles minor* on the Isles of Scilly.

List of confirmed *A. junius* in Britain during 1998*.

1. Penlee N.R., Cornwall	– one male	– Sept 9th	– photographed
2. St Agnes, Isles of Scilly	– one male	– Sept 10th	– field record
3. Gugh, Isles of Scilly	– one female	– Sept 10th	– photographed
4. Penlee N.R., Cornwall	– one female	– Sept 16th	– photographed
5. Nanquidno, Cornwall	– one male	– Sept 20th–23rd	– videoed
6. Tresco, Isles of Scilly	– one female	– Sept 30th–Oct 1st	– photographed

*As of 1 January 1999.

Acknowledgements

Thanks are due to John Chappel, Mike Frost, Ted Griffiths, Ren Hathway, Chris McClure, Steve Rogers and Leon Truscott who have permitted the use of their records or provided photographs allowing this astonishing occurrence to be documented.

References

Parr, A. J., 1998. Potential New Dragonflies for the British List. *Atropos* 4: 18–21.

Dunkle, S. W., 1989. *Dragonflies of the Florida Peninsula, Bermuda and the Bahamas.* Scientific Publishers Nature Guide.

Some observations of a breeding population of Red-veined Darter *Sympetrum fonscolombei* (Sélys) in Cornwall during 1998

K. Pellow

Mount Pleasant Bungalow, Botus Fleming, Saltash, Cornwall PL12 6NQ

Bake Farm Fishing Lakes near Trerulefoot, South-East Cornwall consist of a series of seven shallow pools of varying sizes which cover approximately 37ha (15 acres) in area. They were created during 1996 with the intention of being used as a commercial fishery and the first pool was allowed to fill with water naturally from November of that year.

The whole site is rather open with the only vegetation sparsely distributed around the total circumference of each pool. The most frequent of this consists of small clumps of Soft Rush (*Juncus effusus*), clumps of Jointed Rush (*J. articulatus*) which was often semi-submerged in the water margins and Floating Sweet-grass *Glyceria fluitans* which was found at the dry water's edge or wetter margins.

My visits to the site did not commence until 15 August 1997 when I discovered a total of 19 male Red-veined Darter *Sympetrum fonscolombei* (Sélys). The site was visited regularly thereafter with insects being found until 28 September when 4 males were still present. The maximum numbers noted at the site were 45 on 19 August with numbers remaining high through to mid September (33 on 16 September) before gradually reducing until the last sightings were made.

Whilst only males were ever noted, the fact that the majority held obvious territories led to some speculation, and hope, that perhaps at least some females might have arrived with the initial immigration. The subsequent events of 1998 proved that this was in fact the case.

The following account arises from a total of 38 visits made to this site between 5 June and 18 November 1998, a period which, whilst this is not intended to be a full account, does allow for some observations to be made and conclusions drawn in respect of what turned out to be a wholly unexpected and highly successful breeding season for *S. fonscolombei*. Poor weather, work and other commitments unfortunately prevented additional visits earlier in the season.

Throughout the season, whilst *S. fonscolombei* were noted over the whole of the site, and ovipositing was noted at five of the seven pools, successful emergence and exuviae were noted only from the two main pools named Mirage and Dunes, and it is from these two sites that the majority of the following observations were made. The results do suggest that adults emerging from the first generation show only a limited tendency to disperse, primarily breeding at the natal site and producing a rapidly developing second generation of adults which disperse widely and to a considerable distance. They also suggest that a relatively small number of breeding adults are capable of producing a surprisingly large second generation. The following references to the stages of emergence are as defined by Beynon (1995).

Emergence

The first adult emergence was noted on 5 June when several tenerals were seen. Further visits

were not possible until 19 July and no other tenerals were noted until the following month. Tenerals were then noted from 15 August (9+) and, as none had been seen on the previous visit on 6 August, this second generation emergence presumably commenced during this period. Only 3 exuviae from 19 collected on 15 August were *S. fonscolombei*, which tended to confirm this, the remainder being of Common Darter *S. striolatum* (Charpentier), which was the next most abundant dragonfly present.

Emergence of this second generation continued through to 18 November when a failed emergent at stage 1 was found, which gives a period covering 96 days (up to a possible maximum of 105 days). The last teneral/immature was noted on 12 November.

Numbers of emerging individuals reached a peak during the last two weeks of September when numbers averaged 50+ per day, with smaller peaks occurring in mid August, averaging 35 per day, and in mid October (Fig. 1). Collection of exuviae during this period tended to confirm these peaks (Fig. 2).

Emergence generally occurred early in the morning, certainly during August and September, with most making maiden flights before midday.

Later in the season emergence tended to take longer, probably owing to cooler temperatures and more inclement weather conditions.

On 4 October one was still emerging (stage 3) at 1445h when the temperature was 14°C, whilst on 9 October there were several at stage 3 at 1600h, and on 25 October one was at stage 2 at 1530h, indicating a prolonged diurnal emergence period during optimum conditions.

On 8 November with a temperature of 15°C one at stage 1 at 1200h had moved to stage 3 by 1300h. However, emergence was also noted on a number of days when the temperature failed to rise higher than 12°C or sometimes lower, such as the failed emergence of one individual on 18 November when the temperature was only 9°C. Significantly, even when these emergents were noted and the weather was apparently unsuitable with high winds and overcast or rainy skies, the days had always started with bright sunshine until about 0900h, indicating that sunshine may well be an influencing factor for emergence.

Water temperature may well also influence emergence. On 26 October the water temperature was 12°C and emergence was still continuing with 9 individuals. However, by 3 November the water temperature had dropped to 8°C and no new emergents were noted until 7 November when the water temperature had risen to 13°C and emergence started again.

Crippled individuals were noted throughout the emergence period, their numbers seemingly increasing later in the season when temperatures dropped and weather deteriorated. Many failed to expand their wings completely and a smaller number had deformed abdomens.

From actual and estimated total figures, between 1.6–3.8 per cent of emergents were deformed to some extent, although this figure is considered by the author to be probably an underestimate.

Rain was a major factor in failure to maiden successfully. On 21 October after heavy overnight rain 7 out of 17 tenerals were found dead below their emergent sites.

Newly emerged adults generally made only short maiden flights of up to a distance of 10 metres into nearby stands of *Juncus*. Some remained in this area for a day or two but the majority tended to make longer second flights taking them into nearby crop fields where they remained for the same length of time. Up to 400 individuals were disturbed from a nearby field

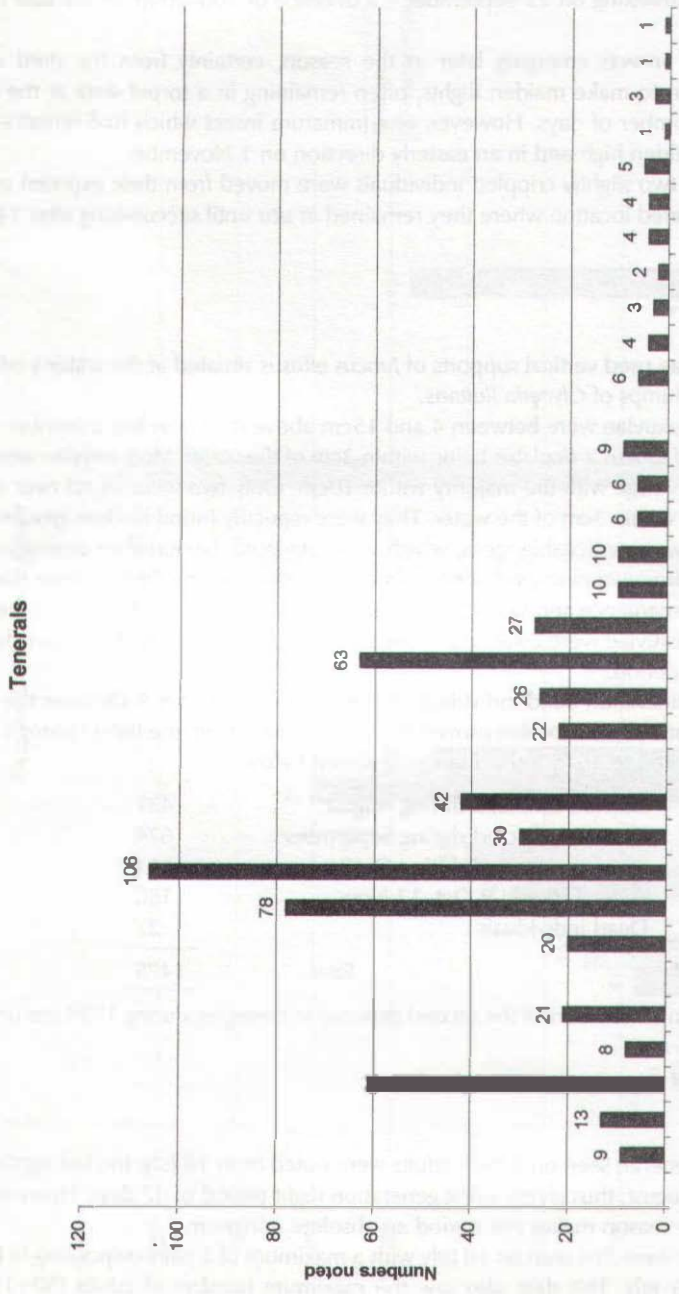

Figure 1. Totals of teneral *Sympetrum fonscolombei* emerging between August–November 1998.

of rape during its harvesting on 22 September – a distance of 100–200m to the east from the nursery pool.

The majority of insects emerging later in the season, certainly from the third week of October, failed even to make maiden flights, often remaining in a torpid state at the point of emergence for a number of days. However, one immature insect which had remained so for several days did maiden high and in an easterly direction on 1 November.

On 25 October two slightly crippled individuals were moved from their exposed emergent site to a more sheltered location where they remained *in situ* until succumbing after 14 and 16 days respectively.

Exuviae

Most emerging larvae used vertical supports of *Juncus effusus* situated at the water's edge, or in partly submerged clumps of *Glyceria fluitans*.

The majority of exuviae were between 4 and 15cm above the water but a number were on floating platforms of *Juncus articulatus* being within 3cm of the water. Most exuviae were within 80cm of the water's edge with the majority within 10cm. Only two were found over dry land, but they were both within 3cm of the water. They were regularly found in close groups of three or fours and there were noticeable areas, which were obviously favoured for emergence.

The partially submerged clumps of *Juncus articulatus* and *Glyceria fluitans* were particularly popular for group emergence and individual clumps were used regularly throughout the season.

A total of 1298 exuviae were collected between 15 August through to 9 October during the second-generation period.

Taking into consideration dead individuals and tenerals noted after 9 October the number of second generation *S. fonscolombei* proved to have emerged from the Bake Fishing Lakes site during 1998 amounted to 1475 individuals as analysed below.

Exuviae collected during August	431
Exuviae collected during September	674
Exuviae collected during Oct/Nov	193
Tenerals noted 9 Oct–12 Nov	150
Dead individuals	27
Total	1475

For an estimation of numbers of the second generation emerging during 1998 see under Size of population.

Adults

Following several tenerals seen on 5 June adults were noted from 18 July, the last sighting being of 5 males on 30 August, thus giving a first generation flight period of 87 days. However, a lack of visits early in the season makes this period an absolute minimum.

Copulating pairs were first seen on 18 July with a maximum of 3 pairs ovipositing in the main nursery pool on 25 July. This date also saw the maximum number of adults (50+) present.

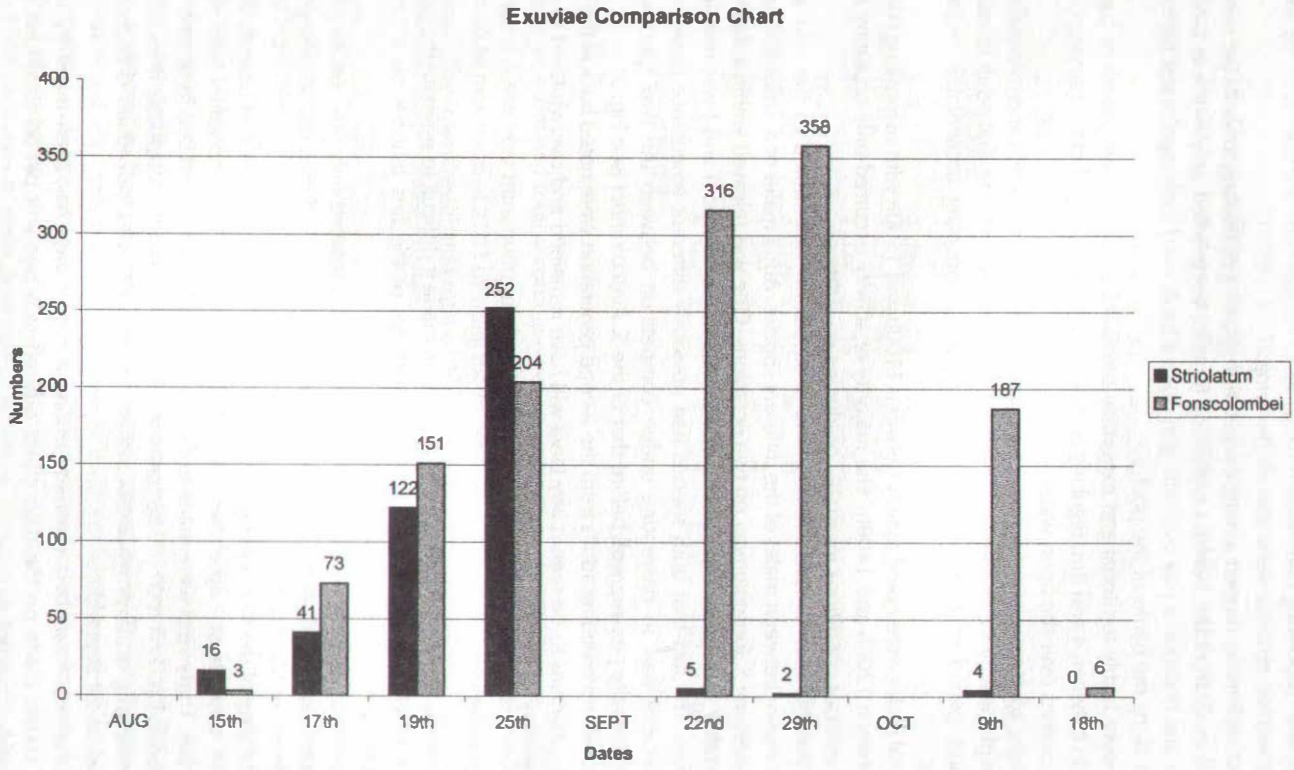

Figure 2. Totals of exuviae collected during August–November 1998, with comparison of both *S. striolatum* and *S. fonscolombei*.

Copulating and ovipositing continued through to 15 August with one pair seen, by which time second-generation tenerals were also on the wing.

Ovipositing females dipped amongst vegetation growing or floating towards the centre of the pools, well away from the banks. Ovipositing females were noted only when in tandem with males. On one occasion a pair ovipositing in quite a fresh wind took regular rest periods in low vegetation along the banks of the pool.

Males were highly territorial and extremely site faithful to their own stretch of bank which extended to between 4 and 8m, regularly patrolling the water's edge before carrying out regular longer excursions over the open water.

Amazingly, adult females were noted only when they were in tandem and ovipositing, which perhaps explains why none were seen in 1997. It may also indicate that adult females spend only a short period of time at the breeding pools, dispersing immediately ovipositing is completed.

Territorial males were noted mainly between 1100h and 1500h with ovipositing taking place usually between 1200h and 1400h. The majority of activity occurred only on sunny days with cloudy or overcast conditions invariably producing no sightings.

Interaction between *S. fonscolombei* and *S. striolatum* was limited to the odd aggressive behaviour shown between males of the different species. Adult males of *S. striolatum* were seen to grab maidening *S. fonscolombei* on two occasions. One was released within a short distance whilst the other was taken some distance to the far side of the pool and I was unable to note the outcome. The fact that both species had obviously different emergence peaks may have played a crucial part in preventing undue competition between the two species, with *S. striolatum* generally peaking well before that of the *S. fonscolombei* (see Fig. 2).

Significantly no breeding adults from the second generation were noted back at the breeding pools and it remains to be seen if any larva will have remained and overwintered to continue this success story in 1999!

Size of population

Lack of coverage during the early part of the season made it difficult to estimate the population of the first generation emergence. Following sightings of the first tenerals on 5 June adults continued to be noted through July until 30 August.

The maximum number of adults seen on any one day totalled only 50+ on 25 July, which is insignificant compared to the numbers which were recorded during the second-generation emergence.

From the date of the first sighting of the second generation on 15 August tenerals continued to be seen throughout September and October until the last individual was noted on 12 November. Thirty visits were made to the site during this period and counts of tenerals made as presented in Fig. 1. A total of 586 tenerals was counted, but this obviously does not include numbers emerging on days when not visited nor the 300-400 individuals disturbed from a nearby crop on 22 September.

An estimation of numbers emerging during non-visit days has been made by using the 'mean' of counts made on the days either side of each non-visit period as follows (showing actual monthly totals in brackets).

AUGUST						
16	1 day	x	10.5	= 10.5		
18–23	6 days	x	25.5	= 153		
26–29	4 days	x	14.5	= 58	total	121 (107)
SEPTEMBER						
1–10	10 days	x	20	= 200		
12–18	7 days	x	49	= 343		
20	1 day	x	71	= 71		
23–28	6 days	x	60	= 360		
30	1 day	x	32	= 32	total	906 (276)
OCTOBER						
1–3	3 days	x	32	= 96		
5–8	4 days	x	24	= 96		
10–12	3 days	x	44	= 132		
14	1 day	x	45	= 45		
16–17	2 days	x	18	= 36		
19–20	2 days	x	10	= 20		
22	1 day	x	8	= 8		
24	1 day	x	6	= 6		
27–31	4 days	x	7	= 28	total	467 (179)
NOVEMBER						(24)
					TOTAL	1494 (586)

This gives an estimated total second-generation population of 2080 (586 + 1494), which I would suggest is the very minimum number. It compares with an absolute minimum of 1660 and an absolute maximum of 2783 by using the minima and maxima of contiguous days instead of the 'mean'. The 'mean' estimated total of 2080 compares quite favourably with the figure of 1475 mentioned earlier under Exuviae.

Predation

Both adult and emerging insects were subject to predation from a number of sources.

During September 1997 an immature Hobby *Falco subbuteo* was present over the pools for several hours during which time it was seen to take a large number of *Sympetrum* sp., the majority being *S. striolatum* but its prey undoubtedly also included *S. fonscolombei* which were still present in good numbers at the time.

The detrimental effect fish may have had on the larvae in this commercial fly/coarse fishing enterprise is debatable. Even though ovipositing was noted from five of the seven pools, breeding was noted from only two of them. Both of these contained trout, which had a fairly quick removal/turnover rate, whereas the remainder contained coarse species which had a far longer period of residency.

During 1998 predation of tenerals as well as emerging insects was noted. On 18 October a

pre-maiden was attacked by a wasp *Vespula* sp. which was decapitating it at its emergence site. Tenerals or maidening individuals were also removed on two occasions from spiders' webs that were situated in water-edge vegetation.

Dispersal

With so many second-generation individuals emerging from the site it is somewhat surprising that very few were located elsewhere. Up to five adult males were seen at Seaton Valley, 5km to the SW, during early August but these were probably dispersing adults from the first generation at Bake Lakes rather than newly arrived immigrants.

Maturing immatures were seen to make an apparently dispersive flight on only two occasions: on 25 October one was seen to leave high to the SE and on 1 November another was seen to leave high to the E.

Of considerable interest is the record of an immature insect from Dawlish Warren, Devon, 32km to the NE during the night of 12 October, which coincided with good numbers of tenerals emerging from Bake Lakes, i.e. 63 on 13 October.

Access to the site

Although operating as a commercial enterprise public access is permitted on a daily basis. Anyone intending visiting this site in 1999 is requested to report to the reception hut and is asked to make a small contribution to assist in maintaining the site for the benefit of breeding Odonata.

Acknowledgements

Thanks are due to Steve Madge for assistance in identifying relevant plants and to Leon Truscott for some additional casual records.

Special thanks are due to the management of W. H. Bond & Son for creating the pools in the first place, and especially to Chris Bond and Tony Lister for their support, patience and extreme forbearance without which the site would not have reached its current potential, making it one of the best for Odonata in Cornwall.

Reference

Beynon, T. G., 1995. *Leucorrhinia dubia* (Vander Linden) at Shooters Pool, Chartley Moss, Staffordshire, in 1994. *Journal of the British Dragonfly Society* **11**(1): 1–9.

Book review

De dansk guldsmede (The Dragonflies of Denmark)
Apollo Books, Stenstrup, Denmark. 24 x 17cm, 279 pages.
300 Danish kroner (approx. £35.00 incl. p. & p.) hardback. ISBN 87-88757-21-8.
Ole Føgh Nielsen.

I really do count myself very lucky to be able to read the text of this beautiful book, because it cannot be often that Denmark produces a natural history book that betters most of the equivalent texts available in Britain. In fact, this is the first attempt to review the Odonata fauna of Denmark since 1910, so the work is long overdue. Ole Fogh Nielsen, schoolmaster and invertebrate photographer, is *the* acknowledged dragonfly expert of Denmark, and in this book, he really has set the standard for future national overviews.

The book opens with general accounts which cover evolution and systematics, the life cycles of the Odonata, habitats and ecology, threats to the Danish fauna and a nice section on how to study and photograph these fascinating insects. There is also a key to identification of adults and larvae/exuviae that is extremely well presented (although I have not tested their efficacy myself!). All 54 species recorded from Denmark are featured in pictures and text, even including *Hemianax ephippiger* (known only from larvae found at one site after the 1995 invasion of northern Europe), *Nehalennia speciosa* (known from one location) and *Sympetrum fonscolombei* which scrapes in as a 'stop press' based on the first Danish records reported in September 1998! Each species account includes descriptions of adults and larvae, habitat, behaviour, life cycle (which includes a great deal of detail relating to egg-laying and other features of reproduction), flight period, and finally the distribution in Denmark, surrounding countries and the world. The associated photographs are stunning and are mostly by the author himself. Virtually all species are illustrated by plates of both adult male and female insects, supplemented with larvae and/or emerging adults in many cases. All species accounts are illustrated with a typical habitat scene and a simple distribution map is provided for each, covering Denmark, southern Sweden/Norway and northern Germany. Alas, many of the most interesting species feature in the newly published Red Data Book for Denmark, and all too often the analysis of population decline and range contractions reflect the problems of changing water quality and habitat loss with which British readers will be so familiar.

This work is volume 8 in the series The Fauna of Denmark, and it is hard to see how the publishers could have squeezed more than the 233 colour photographs and 258 line drawings into this magnificent book. That is not to suggest in any way the tome is overcrowded, merely that the space has been used to great advantage! Although there is an undoubted bias towards Jutland sites in the illustrations of habitat types, this is hardly a criticism of an excellent attempt to give an immediate impression of the habitats used by the different species. It would have been interesting to present an additional selection of well-recorded dragonfly sites that are accessible to public, listing typical species present. Also, I would have liked some explanation of how the distribution maps were produced, since there is no current mapping scheme with

adequate coverage to support the maps. But these are very trivial criticisms of a beautifully produced volume.

Sadly, but inevitably, the book may have limited appeal outside Scandinavia because of the language. Nevertheless, for real dragonfly enthusiasts, the financial support of the Aage V. Jensens Fund has made the price of this book extremely reasonable given the quality of the photographs and presentation. Even if you don't understand a word of Danish, it is worth the cost just to possess the book and pick amongst its many illustrations! You may even decide it is worth learning the language! Most important, however, is that this beautiful book will undoubtedly stimulate enormous interest within Denmark in these magnificent insects which, to date, have not enjoyed the level of interest created in Britain in the last 20 years. Indulge yourself!

Tony Fox
Nimtofte, Denmark

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

Registered Charity No. 800196

CONTENTS

Printed by Gem Publishing Company, Brightwell, Wallingford, OX10 0QD