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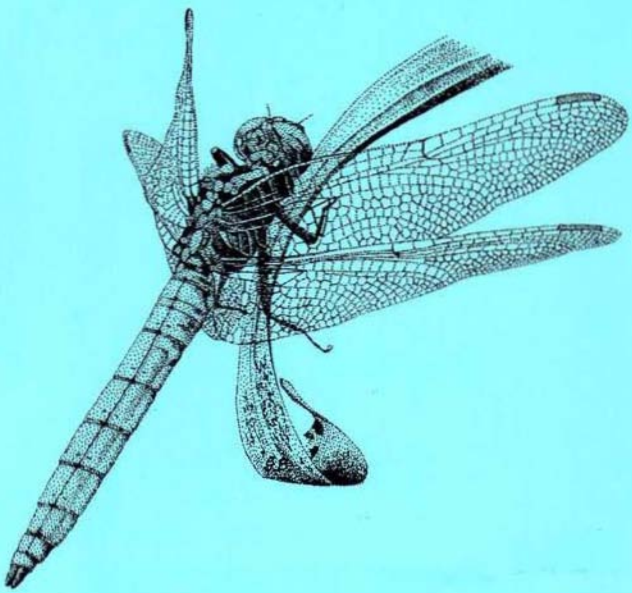

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Front cover illustration: Keeled Skimmer *Orthetrum coerulescens* at Hothfield Common, Kent, 16 August 2000, by Gill Brook

The Keeled Skimmer *Orthetrum coerulescens* (Fabricius) at Holt Lowes, Norfolk: History and habitat use

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Introduction

The Keeled Skimmer *Orthetrum coerulescens* (Fabricius) is widespread in western and central Europe (Askew, 1988), breeding in flushes, streams and seepages in valley mires in areas of heath and moorland (Brooks, 1997). The larvae live in peaty detritus or muddy silt and probably take two years to reach maturity (Merritt *et al.*, 1996). In the British Isles the species has a distinctly westerly distribution. It is very scarce in eastern England where it is confined to two colonies in Yorkshire and single colonies in both Kent and Norfolk (Merritt *et al.*, 1996). These isolated colonies are small but persistent (Moore, 1986).

The history of *Orthetrum coerulescens* at Holt Lowes

At the start of the study the only known breeding locality of *O. coerulescens* in East Anglia was Holt Lowes in Norfolk (Taylor, 2003) from where it has been recorded for at least 80 years (White, 2000). The persistence of this colony is impressive considering its high degree of isolation, being some 185km from the nearest population (Moore, 1986). During this time the size of the Holt Lowes population has not been constant. Scrub encroachment in the mires from 1950 onwards resulted in numbers reaching very low levels. In 1980 it was estimated there was only room for 10 territories (all on the Mixed Mire) and the extinction of the population was predicted (Moore, 1986). In July 1985 only three to four males were seen (Moore, pers. comm.).

Some small-scale scrub clearance in the Mixed Mire starting in July 1984, allowed the population to expand. About this time some ponds were dug in the Mixed Mire, possibly an attempt to benefit the species. In late August 1984, 16 males were holding territory (Moore, pers. comm.). This increase in population has continued with the more extensive scrub clearance since 1998.

Males were observed holding territory in the Ponds Area in 1999 following clearance the previous winter and exuviae were found in the streamlets south of Soldiers' Pond in the following year. A clearing was created in the Northern Mire in March 1999 and a mature male was observed there later that summer. Breeding was confirmed in June 2000 when several exuviae were located.

Holt Lowes – Site Description

Site status: Holt Lowes (British National Grid reference TG082377) is a 'Poors' Allotment' of 49.3ha set aside by the Holt and Letheringsett Enclosure Act in 1807 and located about one mile south of the town of Holt. The site is owned by the Holt Lowes Trustees and was registered as a Common as of 4 March 1968. It was declared a Site of Special Scientific Interest (SSSI) in 1954 and re-notified in 1986 (with some boundary revisions). It is also a candidate Special Area of Conservation (SAC) under the European Union Habitats Directive.

Geology and Hydrology: Holt Lowes is a relict of the once extensive tract of heathland in north Norfolk that extended between the towns of Cromer and Holt and south to Norwich. The heath has been maintained by grazing, burning and periodic cultivation. It is situated on deposits of sand and gravel left by retreating glaciers, which overlie deposits of boulder clay (Lowerstoft Till) and Norwich Crag. Beneath these, at about 30–40m below ground level is Upper Chalk. The surface water catchment of Holt Lowes lies mainly to the north-west, is about 1.76km^2 and feeds into the River Glaven, which marks the eastern boundary of the site. Although the hydrology of the site is poorly understood, the modern interpretation suggests that water enters the system from four main routes: direct rainfall, surface run-off from around the fringe of the heathland plateau, from an aquifer in the sand and gravel deposits (of limited extent) and perhaps from some very localized springs originating from an aquifer in the chalk (Harrap, 2001).

Biodiversity conservation and management: The site has long been recognized as a special place for plants and animals with the first records of notable species dating from the end of the 18th Century (Harrap, 2000). In common with many similar lowland heaths, Holt Lowes had been steadily reverting to woodland as traditional common land uses dwindled. However, since 1998, the Norfolk Wildlife Trust, in association with the Lowes Trustees and English Nature, has undertaken work to conserve the biological interest of the site, including extensive scrub clearance. Lottery funding was received through the 'Tomorrows Heathland Heritage' Project. Low density grazing by cattle was commenced in 1999, although no animals were present in 2003, the time of this study. Further areas of woodland have since been cleared, notably to the west of the Mixed Mire.

Habitats: Holt Lowes is a mosaic of extensive areas of dry heath (predominantly National Vegetation Classification (NVC) H8a), with stands of Bracken (*Pteridium aquilinum*), Gorse (*Ulex* spp.) and scrub (mainly Downy Birch (*Betula pubescens*)) together with a variety of wetland habitats. The wetland vegetation of fen and mire is remarkably diverse, presumably reflecting the complicated hydrological conditions. Two parallel tributary valleys drain the site and both contain large areas of wet heath and mire communities (NVC: M13c, M13/14, M16a, M16b) in addition to wet woodland (W2a, W2b and W7). The southern mire is referred to as the 'Mixed Mire' and contains a small, permanently flowing stream with smaller 'streamlets' and flushes. The second mire is known as the 'Northern Mire' and possesses a less contiguous tributary stream. The location of the mires is shown in Figure 1.

The valley of the River Glaven links the two mires and contains a range of fen communities (NVC: M24a, M24b, M24c, M25a, M25c and M27) with wet woodland (W2 and W5a). The fen areas appear to be fed by water from an aquifer and, as this is limited in extent and dependent on recharge from rainfall, these are vulnerable to periods of drought. A number of ponds of varying sizes, probably all artificial in origin, are located in these three wetland areas. The confluence of the mixed mire and the Glaven Valley is referred to as the 'Ponds Area' (Figure 1) and contains a number of flooded shell craters and slit trenches (relicts of use by the army during the Second World War) as well as the deliberately embanked 'Soldiers' Pond'. Some of the ponds appear to be fed by seepage of groundwater or run-off from the heath and retain water all year round, others are less permanent. A few former ponds can be identified which are now covered by 'hovers' of vegetation. In some places stump-holes resulting from recent scrub clearance retain water for varying periods.

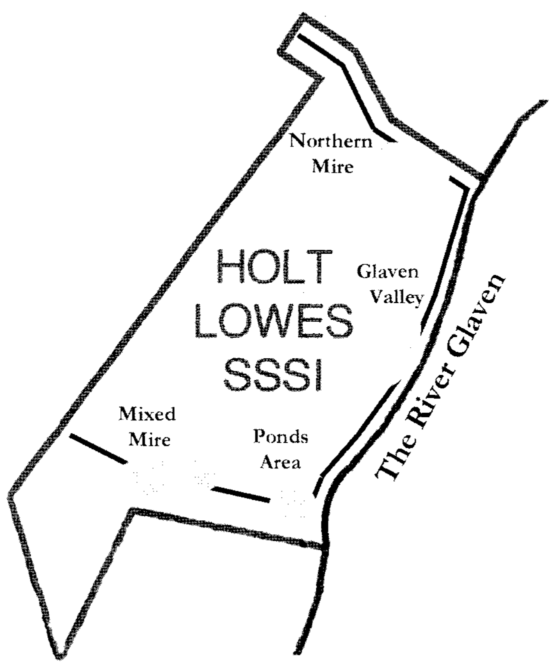

Figure 1. The Holt Lowes Site of Special Scientific Interest showing the location of the four habitat zones in which territories of *Orthetrum coerulescens* were studied.

The odonate fauna: Fifteen species of Odonata are considered resident or breeding at the site, whilst over 20 species have been recorded since 1990 (White, 2000) making it an important SSSI for this reason alone. Of the damselflies, Large Red Damselfly *Pyrrhosoma nymphula* (Sulzer) and Azure Damselfly *Coenagrion puella* L. are common with smaller numbers of Emerald Damselfly *Lestes sponsa* (Hansemann), Scarce Emerald Damselfly *L. dryas* Kirby and Common Blue Damselfly *Enallagma cyathigerum* (Charpentier) present. Anisoptera that breed at the site include Four-spotted Chaser *Libellula quadrimaculata* L., Broad-bodied Chaser *L. depressa* L. and Emperor Dragonfly *Anax imperator* Leach. However, Holt Lowes is particularly noted for its population of *O. coerulescens*.

Methodology

Period of study: To discover how the species was using the site, the presence and distribution of *O. coerulescens* during the summer of 2003 was observed between 26 May and 22 September. The wetland habitats were systematically searched for males holding territory, whilst the dry heathland was sporadically visited to look for non-breeding individuals. The population was studied by direct observation, aided by the use of close-focusing binoculars (Minox 8 × 42).

Marking males: Males were marked with permanent marker pens using a system of unique coloured dots on the wings enabling individuals to be identified in the field without recapturing. A total of 68 males were marked on six dates (16 June, 17 June, 24 June, 25 June, 29 June and 7 July).

The four 'wetland zones' and their territories: For descriptive and comparative purposes the wetlands of Holt Lowes were divided into four zones: the Northern Mire, the Southern or 'Mixed Mire', the Glaven Valley and the 'Ponds Area' – an area with a number of artificial ponds where the last two zones meet (Figure 1). The habitats where territories were present in each of the four zones are shown in Table 1. Fifteen territories of marked males were surveyed in the Mixed Mire, 13 in the Northern Mire, six in the Ponds Area and four in the Glaven Valley.

Results

1. Distribution of *O. coerulescens* at the site

The flight season: The earliest emerged adult *O. coerulescens* was observed on 24 May and the last sighting of an adult was on 22 September, implying a minimum flight period for the population of 122 days (Table 2).

The fate of the marked males: Of the 68 males marked, 44 (65 per cent) were seen again on at least one occasion. Of these, all but one stayed within the zone in which they were caught for marking. The exception was a single male caught and marked as a mature adult in the Mixed Mire on 11 July and seen two days later west of Pond 12 in the Glaven Valley (*c*.750m from point of capture). On no occasion was this individual seen holding territory.

Table 1. The wetland habitats present in the four zones at Holt Lowes, Norfolk; explanations of the four habitat zones are given

ZONE	NVC categories	Standing-water habitats: Ponds	Seasonal pools	Mire Pools	Flowing-water: Stream	'Streamlets'
Northern Mire	Unassigned (recently cleared)	1 ('pond 14'); irregularly shaped; *c*.12m^2	0	Extensive throughout cleared area	Not present	Not present
Mixed Mire	M13c; M13/14; M16 a & b	4; all less than 3m^2	2	F[illegible] particularly adjacent to stream	Down full-length of eastern side of mire (*c*.150m long)	A few; indistinct, draining into stream
Glav Valley	M24a,b & c; M25a & c; M27	1 significant pond ('pond 12'); *c*.30m^2	Several, including one *c*.20m^2	Present behind 'Old Wood'; 'insignificant elsew	Not present; (no territories were held on the River Glaven	A few, draining off plateaux behind 'Old Wood'
Ponds Area	Unassigned (recently cleared)	4; Including 'Soldiers' Pond' *c*.30m^2	5–6; all less than 10m^2	Present below Soldiers' Pond and seasonally-wet mire north of stream	Stream drains Soldiers' pond and continues to R. Glaven	3; (each *c*.20m long) South of Soldiers' Pond

Table 2. Significant dates relating to the flight period and reproductive at Holt Lowes, Norfolk in 2003

Observation	Date	Location
Earliest observed	24 May	Northern Mire
Earliest observed territorial behaviour	9 June	Northern Mire, Pond 14
Earliest observed copulation and oviposition	12 June	Northern Mire, Pond 14
Latest observed teneral (latest emergence?)	13 August	Glaven
Latest copulation and oviposition	4 September	Glaven Valley, Old Wood
Latest observed territorial behaviour	9 September	Glaven V
Latest adult observed	22 September	Glaven Valley,

Teneral adults and exuviae: The first teneral adults of the year were observed in the Northern Mire on 24 May with the first individuals in the Mixed Mire four days later. Teneral individuals were observed in all wetland areas of the site. The last teneral adult was present in the Glaven Valley on 13 August, implying a minimum emergence period of 80 days. Exuviae proved difficult to locate, but six were found in the Mixed Mire during June in seepages next to the stream and a single one was located at an ephemeral pool in the same area.

Non-reproductive adults: Individuals were observed throughout the site. From mid May to early August pre-reproductive adults and adult females were seen sunning themselves and feeding in most areas of dry heathland. A small number of these individuals were also seen in set-aside fields to the west and in woodland clearings up to 800m from breeding areas. These wanderers included an apparently adult male and two females which must have crossed a 600m belt of mature conifers to reach a small clearing in a Scots Pine plantation to the north of the site.

Territorial males: Males were observed holding territories in 'colonies' wherever open-water was present. The minimum period that that territories were held by individuals in the population was 62 days and the longest period that a marked male was observed to be holding the same territory was 21 days. Territories were held at both standing water and flowing water. Areas of standing water included relatively large areas ($> 0.5m^2$) of open-water that retained water throughout the season ('ponds'), ephemeral pools that dried out during the summer ('seasonal pools') and smaller areas ($< 0.5m^2$) of flooded mire vegetation ('mire-pools'). Territories on flowing water occurred along the stream in the Mixed Mire (with associated wet 'flushes') and at less distinct 'streamlets' draining the mires.

2. Territory Attributes:

Territory description: Invariably the territory contained a patch of open-water, which was defended by the male. There were usually one or two favoured perches to which he would return after feeding or territorial-defence flights. The perches used were either emergent vegetation or, occasionally, a tree-stump or fallen log and generally they were less than 0.5m from the ground. Whilst not always in the centre of his defended territory, the perch was always in a position which provided a vantage point to watch for intruding males and receptive females.

The mean territory size of the forty marked *O. coerulescens* was $5.75 \pm 10.16m^2$. The mean area of open-water contained in a territory was $2.78 \pm 3.26m^2$ ($n = 40$) or 33 per cent of the total territorial area.

Differences in territory size: Territory size varied between the different wetland zones (ANOVA test: $f = 2.968$; df 3,36; $p = 0.045$). Post hoc tests (Tukey HSD) showed that territories were significantly smaller in the Northern Mire than the Glaven Valley (Mean territory sizes: Northern Mire: $2.02 \pm 0.83m^2$; $n = 13$; Glaven valley: $8.85 \pm$

4.69m²; n = 5). There were also differences between habitats within the Northern Mire. The mean territory size was larger for territories at Pond 14 than in the 'mire pool' territories in the rest of the Northern Mire ($t = 2.56$, df 11, $p = 0.027$). The mean territory size at Pond 14 was $2.55 \pm 0.27m^2$ ($n = 6$) and in the rest of the Mire it was $1.57 \pm 0.69m^2$ ($n = 7$).

Differences in territory shape and territory density: In the region of the Northern Mire containing 'mire pools', territories were more-or-less circular and evenly spaced throughout. When the sun disappeared behind a cloud, it was possible to see a male perched every 1.5–2m in a remarkably regular pattern. This contrasted with the territories held at the stream in the Mixed Mire which were more linear and less regular both in size and shape and with some apparent overlap.

Vegetation in the territories: A total of 31 plant species was recorded in the territories of the marked males of which 13 were considered to be the dominant or co-dominant species in at least one of the territories (Table 3). The most frequently dominant or co-dominant species was Jointed Rush (*Juncus articulatus*) (70 per cent of territories), followed by Marsh Horsetail (*Equisetum palustre*) (22.5 per cent) and Pondweed (*Potamogeton* sp.) (17.5 per cent).

The maximum height of vegetation within territories was 1300mm and the mean predominant vegetation height was 355 ± 148mm ($n = 40$). The predominant height of vegetation differed in the different locations (ANOVA test: $f = 18.56$; df 3,36; $p < 0.05$). Post hoc test (Tukey HSD) showed there were differences between the Northern Mire and both the Glaven Valley and the Ponds Area and also between the Glaven Valley and both the Mixed Mire and the Ponds Area. (Mean predominant height: Northern Mire: 360 ± 105mm, $n = 13$; Mixed Mire: 380 ± 108mm, $n = 15$;

Table 3. The plant species considered dominant or co-dominant in the 40 territories held by marked male *Orthetrum coerulescens* at Holt Lowes, Norfolk; data collected between 16 June and 18 September 2003.

Rank	Dominant or Co-dominant spp.	No of Territories	per cent of territories
1	*Juncus articulatus*	28	70
2	*Equisetum palustre*	9	22.5
3	*Potamogeton* sp.	7	17.5
4=	*Equisetum sylvaticum*	4	10
4=	*Typha latifolia*	4	10
4=	*Juncus effusus*	4	10
7=	*Schoenus nigricans*	3	7.5
7=	*Mentha aquatica*	3	7.5
9	*Sphagnum* spp.	2	5
10=	*Ranunculus* sp.	1	2.5
10=	*Eupatorium cannabinum*	1	2.5
10=	*Chrysosplenium oppositifolium*	1	2.5

Glaven Valley 80 + 12mm, n = 5; Ponds Area 492 ± 29mm, n = 7). There were no significant differences in water depth, sediment depth, and vegetation density between the territories in the different locations.

Comparisons of pH in the four different locations: In the wetland zones, pH differed significantly (ANOVA test: $f = 17.35$; df 3,36; $p < 0.05$). Post hoc test (Tukey HSD) showed there were differences between the Ponds Area and each of the other three study locations. (Mean pH values: Northern Mire: 6.69 ± 0.17, n = 13; Mixed Mire: 6.65 ± 0.21, n = 15; Glaven Valley 6.60 ± 0.14, n = 5; Ponds Area 6.07 ± 0.24, n = 7).

Comparisons between territories at still and flowing water: Differences sought between territories associated with still and flowing water using independent t-tests. Sediment depth and vegetation heights were different in the two situations (Table 4), but no significant diff

pH. There was noticeably greater variation in territory size at flowing water than at still water but no significant difference.

Table 4. Comparison of territory attributes in standing water and flowing water situations for *Orthetrum coerulescens* at Holt Lowes, Norfolk; data collected between 16 June and 18 September 2003.

Territory attributes	Standing Water (n = 21)	Flowing Water (n = 19)	t value	df	p
Depth of sediment	143 ± 98mm	77 ± 63mm	–2.50	38	0.017
Predominant height of vegetation	303 ± 156mm	413 ± 119mm	–2.48	38	0.018
Territory size	7.36 ± 13.81m^2	3.67 ± 1.14m^2	1.30	20	0.207

Discussion

At Holt Lowes, *O. coerulescens* breeds in a number of relatively discrete 'colonies' of territories in all the wetland areas. Territories were maintained at both still and flowing water bodies, at permanent and temporary pools and in flooded mire vegetation. Males exhibited all-day occupation of territories in suitable weather conditions whilst the females only visited the territory areas to mate and for oviposition.

Territory size: the effects of population density and the 'plantscape'

The mean territory size at Holt Lowes of 5.75 ± 10.16m^2 appears smaller than that quoted for the species by others and the territories seem more densely packed. In a previous study by Parr (1983) conducted along 150m of the Ober stream in the New Forest, there were 14 territories that ranged from 7–16m (mean 10m) in length. Merritt *et al.* (1996) refers to a density of 9 males per 100m of water-course. Is this apparent difference in territory size at Holt Lowes real? The figures reported by other authors relate to territories along linear features and may not be strictly comparable with those at

Holt Lowes as a whole, where the territories occur in clusters in mires. When defending an area along a stream, a territory is essentially one-dimensional, with patrolling merely up and downstream. At Holt perhaps the situation most similar to such reports occurred along the stream in the Mixed Mire where there were 15 linear territories with a mean size of 2.9 ± 0.91m² in a 35m stretch. This still implies a significantly smaller territory size at Holt.

It is suggested that the factors determining these differences may be related to population density of the males and the composition, height and density of vegetation – the 'plantscape' – of the area. Weak evidence for the former is provided by the observation of fewer, larger territories at the Mixed Mire stream following a spell of bad weather when a fall in the population was suspected. Additionally, as the season progressed and the site became drier, males were forced to defend tightly packed territories around small puddles. Territory size was also seen to decrease with the 'in-filling' of space by males during the day. Thus the division of available suitable habitat may result in smaller territories when the population of males is higher.

It is suggested that this was the case in the Northern Mire where territories in the mire-pools were a mere 1.57 ± 0.69m² (n = 7) and very densely packed together. Anecdotally, it appeared that density of males was greatest here and, as the area of mire vegetation is very limited, the effect of 'in-filling' squeezed the territories. Furthermore, the isolation of this 'colony' of territories from the other wetland zones (being separated from them by carr woodland) might have discouraged dispersal and helped maintain a high population.

The 'plantscape' of the territory colony area is probably significant. In his study, Parr (1983) noted that males rarely chased intruders away from the stream and suggested that this was because vegetation limited visibility on the stream banks. In the Mixed Mire, the vegetation along the section of stream studied was short (< 450mm) and, as *O. coerulescens* regularly flew up to a height of about 1m when patrolling, this would not have restricted their vision and territories invariably included flushes adjacent to the stream. It can be argued that the use of the flushes would increase the area of suitable habitat for oviposition compared with the linear bank-side in the stream studied by Parr and would reduce the need to defend such a long section.

Territory size was more comparable with the published data in the Glaven Valley (8.85 ± 4.69m²) where it was significantly larger than in the other wetland zones ($f = 2.9$; df 3,36; $p = 0.045$). Territories here were located around ponds and in mire-pools. The only suitable oviposition sites at the ponds were immediately adjacent to the bank, in effect meaning the territories were linear and thus perhaps more similar to the areas in the previous studies. Aside from territory size, the only other territory attribute in the Glaven Valley that was significantly different from the other wetland zones was the predominant vegetation height, which was shorter (*c.*80mm). It is considered unlikely that this could help to explain the larger territory size. As has been noted *O. coerulescens* regularly patrols up to a height of 1m and, as the mean predominant height of vegetation in all territories was 600mm, this variable is perhaps not relevant here.

Where the 'plantscape' does appear to be significant is in limiting the area occupied by the territory colonies. It is clear from mapping the distribution of males that there were areas of the mires that contained water but where there were no territories. The pH in these locations was within the range measured throughout the site and therefore unlikely to be a contributing factor. The reason for the absence of territories appears to be that the vegetation in these locations was too tall or too dense. This is most apparent in the Northern Mire, which was flooded throughout (except for an area in the south east section), but where territories were only located where the predominant height of the vegetation was less than 600mm. This is presumably related to the tendency of *O. coerulescens* to fly low over the ground. No differences were found in pH or sediment depth throughout the clearing. A similar situation was observed in the Mixed Mire where the lower section of the stream held no territories as it flowed into Soldiers' Pond. This section was similar to the rest of stream except that the vegetation was considerably taller (mainly Soft-rush *Juncus effusus* but with taller Common Reed *Phragmites australis*). It is worth noting that in previous years there had been a number of territories in this area (pers. obs.), but the amount of *Phragmites* has increased considerably since then.

It is highly likely that the density of vegetation is also important. In the Northern Mire, territory-holding males largely ignored an area of *Juncus* that was flattened by wind or rain, presumably because it limited access to the open water. Various authors have noted that the 'plantscape' can influence territory size and shape (e.g. Corbet, 1999; Parr, 1980), with screens of vegetation acting as barriers or 'landmarks'. This was observed on the Mixed Mire where screens of *Juncus* were taller than the favoured flying height of *O. coerulescens* and acted as natural boundaries between territories over which the territory-holding males rarely crossed.

There were minor differences in pH throughout the site. It has often been stated that *O. coerulescens* is one of a number of 'acidophilous' dragonflies (also including Small Red Damselfly *Ceriagrion tenellum* (Villers) and Black Darter *Sympetrum danae* (Sulzer)) inhabiting the acidic waters of bogs and mires (e.g. Corbet *et al*., 1960; Askew, 1988). Water acidity (pH) is one environmental variable that is consistently reported as of prime importance in determining aquatic invertebrate communities (e.g. Moss, 2001). Miller (1987) identified pH as a major factor affecting the distribution of dragonflies in the UK. However, some authors have questioned how much acidity affects the distribution of the 'acidophilic' dragonflies (Brooks, 1994; Foster, 1994). The association of these species with acid water may be related to some other factor, or combination of factors. For *O. coerulescens* the presence of a peat substrate or nutrient poor conditions may be crucial determinants. The depth of the water could also be important. The shallow pools and streams of valley mires and bogs warm more quickly than deeper ponds and this may speed-up larval development (Corbet, 1999). Importantly, shallow mire streams and seepages may also retain water throughout the year, where similarly shallow water bodies in other habitats may be prone to drying out.

Conservation implications

Although the species is not nationally threatened, the Holt Lowes population of *O. coerulescens* remains the only extant population in East Anglia. Its persistence over many years, despite severe deterioration in its habitat, has been remarkable. The recent restoration work at Holt Lowes has undeniably benefited this species and the current population level is probably higher than it has been for many decades. The removal of scrub from the mires has been the most significant aspect of the restoration work, and the open nature of the new clearings together with the pools created by the stump holes has provided ideal conditions for *O. coerulescens* to establish territories.

Maintaining open heath for females and pre-reproductive males is also important. The continuing scrub clearance programme being undertaken by the Norfolk Wildlife Trust will benefit *O. coerulescens*, and is supported. There may be scope for extending the clearing in the Northern Mire to increase the area of mire vegetation. This would probably benefit dragonflies, but any action must obviously be balanced against the needs of other groups of organisms and habitats.

The current study has highlighted the importance of vegetation height and density in determining the presence of territories of *O. coerulescens*. Where *Juncus* or *Phragmites* becomes too tall or too dense, as appears to happen in the years after clearance, the 'plantscape' becomes unsuitable. Thus, the removal of scrub may not be sufficient in itself to maintain suitable conditions. It may be necessary to manage the mire vegetation through more intensive grazing, perhaps by increasing stocking density, or by mowing or cutting with a brush-cutter (with the raking off of cut material). It is suggested that it would be favourable to maintain a vegetation height of around 600–1000mm around open-water and along the stream in the Mixed Mire.

The need to maintain water levels is also crucial. Careful consideration should be given before any action is undertaken that might affect this. In the light of the uncertainty concerning the hydrological conditions, any further increase in water abstraction in the general vicinity of Holt Lowes may compromise the future biodiversity and conservation value of the site.

As the current direction of the habitat management work at Holt Lowes appears highly beneficial to *O. coerulescens*, this population seems secure in the immediate future. Similar restoration work is being undertaken at other heathland and mire sites in North Norfolk and the species appears to be spreading. The presence in recent years of wandering males at suitable habitat elsewhere in Norfolk has been observed particularly at Buxton Heath, near Aylsham (pers. obs.) where copulation and egg laying have also been recorded.

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References

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

Brooks, S. J. 1994. How much does acidity affect the distribution of 'acidophilic' dragonflies? *Journal of the British Dragonfly Society* **10**: 16–18

Brooks, S. (ed.) 1997. *Field Guide to the dragonflies and damselflies of Great Britain and Ireland.* Second edition. British Wildlife Publishing, Hook, Hampshire. 160pp.

Corbet, P. S., Longfield, C. & Moore, N.W. 1960. *Dragonflies*. Collins, London. 260pp.

Corbet, P. S. 1999. *Dragonflies. Behaviour and ecology of Odonata*. Harley Books, Colchester. 829pp.

Foster, G. N. 1994. Evidence *Dragonfly Society* **10**: 40–44

Harrap, S. 2000. In: Barnes, O., Clifton, J., Dawson, B., Eradus, K., Harrap, S., Leech, A., Starling, A. & White, D. *Holt Lowes Wildlife Group Report* **1**: 1–3

Harrap, S. 2001. In: Barnes, O., Clifton, J., Dawson, B., Harrap, S., Leech, A., Starling, A. & White, D. *Holt Lowes Wildlife Group Report* **2**: 37–47

Merritt, R., Moore, N. W. & Eversham, B. C. 1996. *Atlas of the dragonflies of Britain and Ireland*. ITE research publication no. 9. HMSO, London. 149pp.

Miller, P. L. 1987. Oviposition behaviour particular reference to *Brachythemis lacustris* and *Orthetrum coerulescens*. *Odonatologica* **16**: 361–374

Moore, N. W. 1986. Acid water dragonflies in eastern England – their decline, isolation and conservation. *Odonatologica* **15**: 377–385

Moss, B. 2001. *Ecology of freshwaters. Man and medium, past to future*. 3rd Ed. Blackwell, Oxford. 557pp.

Parr, M. J. 1980. Territorial behaviour of the African libellulid *Orthetrum julia* Kirby (Anisoptera). *Odonatologica* **9**: 75–99

Parr, M. J. 1983. Some aspects of territoriality in *Orthetrum coerulescens* (Fabricius). *Odonatologica* 12: 239–257

Taylor, P. 2003. *Dragonflies of Norfolk*, Norfolk and Norwich no. 9, Norfolk and Norwich Naturalists' Society, Norwich. 32pp.

White, D. 2000. The Odonata of Holt Lowes. In Barnes, O., Clifton, J., Dawson, B., Eradus, Harrap, S., Leech, A., Starling, A. & White, D. *Holt Lowes Wildlife Group Report* **1**: 12–20

Migrant and dispersive dragonflies in Britain during 2005

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Summary

The 2005 season was a rather mixed one for migrant and dispersive dragonflies, with the autumn in particular being relatively uneventful. There were, however, several highlights during the main part of the year. Most notably, Lesser Emperor *Anax parthenope* appeared in record numbers and, with ovipositing reported from at least three sites in England (as well as one in Ireland), the species is perhaps now starting to reliably colonize our area. Following a quiet season in 2004, Red-veined Darter *Sympetrum fonscolombii* was once again recorded quite widely and a limited amount of oviposition was observed, although no observations of the autumn emergence of locally-bred individuals following rapid larval development took place. In addition to sightings of unusual species, there was also evidence of the continuing range expansion of a number of our resident species such as Migrant Hawker *Aeshna mixta*, Broad-bodied Chaser *Libellula depressa*, Scarce Chaser *L. fulva* and Black-tailed Skimmer *Orthetrum cancellatum*.

On the negative side, following sightings during 2002–2004, there were no reports of the Southern Emerald Damselfly *Lestes barbarus* during the season, suggesting that the possible colonization of Britain by this species has been temporarily halted.

Account of Species

Important records received by the Migrant Dragonfly Project during 2005 are summarized below. For a summary of events in Britain during 2004 see Parr (2005).

[*Lestes barbarus* (Fabricius) – Southern Emerald Damselfly]
The fate of this species, first discovered in Britain during 2002, is currently unclear. It is likely that it has been (temporarily?) lost from the UK. Despite searches at its two previously-known sites (Parr, 2005) and elsewhere, no records were received during 2005. The site at Sandwich Bay in Kent, where individuals had been seen ovipositing during 2004, was flooded with seawater during the 2004–2005 winter and salinity remained high for some while afterwards (P. Forrest, pers. comm.). At Winterton Dunes in Norfolk, sightings have always been a little erratic and perhaps the species may have always been no more than a primary immigrant there.

***Pyrrhosoma nymphula* (Sulzer) – Large Red Damselfly**
One seen at the Longstone Heritage Centre, St Mary's on 9 June (MWTS) was

apparently a new record for the Isles of Scilly. It may be no coincidence that the first record for Shetland came the previous year (Parr, 2005).

Erythromma viridulum **(Charpentier) – Small Red-eyed Damselfly**
There were some signs of fresh immigration during the year, with 80 counted on 29 August at Eccles-on-Sea, Norfolk following a poor showing by the resident population there (NBo). The coastal Sea-blite (*Suaeda* sp.) bushes on Blakeney Point, Norfolk contained a total of 22 individuals on 1 September (RP) and further individuals were also seen in atypical habitat at Scolt Head, Norfolk during the year.

As far as the resident population was concerned, further range expansion was noted, although on a relatively small scale compared with previous years. Additional sites were discovered in Warwickshire (PR), at the current north-westerly limit of the range for this species, and the first records for Berkshire were made in the Bracknell area during August (JWS). Many of the more established populations, notably Wight, Hampshire and Bedfordshire, appeared to do well, although some sites in East Anglia where the species had been seen in recent years produced either nil or very low counts during 2005. Some of these sites may be sub-optimal and therefore only occupied during periods of migration or dispersal.

Aeshna mixta **Latreille – Migrant Hawker**
A small influx was noted at Kingsgate, Kent on 2 August (FS) and singles were caught in UV moth-traps at Bradwell-on-Sea, Essex on 15 August (SD); at Coventry, Warwickshire on 29 August (PCa) and on the Lizard, Cornwall on 10 September (MTu). Records of dragonflies at light may refer to individuals undertaking night migration/dispersal (Dumont, 2004).

The species is at present rapidly expanding its range within Britain, isolated individuals having reached Scotland over the last few years (Parr, 2005). A record from St Abbs, Borders (TR) on 11 September is of interest in this context.

Anax imperator **Leach – Emperor**
One was caught at UV light at Dumpton, Kent on 25 July in a suburban area with little water but only 1km from the coast. Another was observed at sea on 12 August, heading shoreward some 800m off Luccombe, Isle of Wight. That same day, one was also reported from Tresco, Isles of Scilly – an area where the species does not regularly occur.

Anax parthenope **Sélys – Lesser Emperor**
A total of some 30 sightings, several involving more than one individual, represents a record year for the species. There were two clear periods of immigration around 21–23 June and 9–11 July, but there was also a suggestion that, although no exuviae were found, a proportion of records might refer to locally-bred individuals. During the year several records came from sites where individuals had also been seen during 2003 or 2004, and numbers seen in Britain were noticeably greater than those on the near

Continent and Ireland. During 2005, oviposition was noted from at least three sites in England (two in the south-west and one in North Yorkshire), and the species may now be in the process of colonization. At our latitudes, resident populations are already well-known in north-east Germany and Poland (Parr *et al.*, 2004).

Given the spectacular nature of events it seems worth detailing records as fully as possible (one or two reports are omitted where it has proved impossible to obtain confirmatory details).

Isles of Scilly:	A female on St Mary's on 25 September (M., W. and T. Scott).
Cornwall:	Two near Sheviock on 10 June with at least one until 18 June (K. Pellow, L. Truscott). Three or four males at Dozmary Pool on 23 June; also noted on 27 June (one), 9 July (three) and 8 August (two) (K. Pellow). Pair ovipositing at Siblyback Reservoir on 26 June; two males seen on 16 July with one on 22 July (K. Pellow). One male at Colliford Lake on 27 June (K. Pellow). At least one male at Drift Reservoir on 11 July (D. Parker); unconfirmed reports of an ovipositing pair the following day. Up to two males at Bake Lakes over 11–22 July, then no more sightings until another two individuals on 9 August (K. Pellow, L. Truscott).
Devon:	One male on the Exeter Canal near Exeter on 22–23 June (D. Smallshire). A pair ovipositing at Squabmoor Reservoir on 17 July (R. & C. Carter).
Kent:	Up to three males present on the RSPB reserve/ARC pits at Dungeness during the period 22–24 June (P. Akers *et al.*), then intermittent records of singles on 3 July (Water Tower Pits), 17 July (Lade Pit), 20 July (Hooker's Pit), 1 August (Long Pits) and 25–27 August (New Diggings) (P. Akers *et al.*, D. Walker, J. Dixon).
Bedfordshire:	A male at Willington Gravel Pits on 21-24 August (S. Cham).
Worcestershire:	One near Droitwich, Worcestershire, on 23 June (M. Averill).
Glamorgan:	At least one male present at Kenfig NNR from 21 June (P. Garnett) until 23 July. Probably two males there from around 10 July, but one subsequently found dead on 12 July (D. Carrington).
Lancashire:	A male at Barrow Lodge, south of Clitherow, on 11–15 July (A. Holmes).
East Yorkshire:	One at Brandesburton on 3 July (P. Ashton).
South Yorkshire:	One at Treeton Dyke on 11-13 July (R. Platts).
West Yorkshire:	Male at Moorhouse Lane Ponds, Wintersett on 9–10 July (M. Thompson).
North Yorkshire:	One at Staveley on 2–20 July (P. Treolar). One at Nosterfield on 10 July (per S. Worwood). Male at Farnham Gravel Pits, near Knaresborough, on 17 July (D. Alred), with an ovipositing pair on 23 July (B. Darbyshire, A. Illingworth).

Libellula depressa **L. – Broad-bodied Chaser**

There were several unexpected sightings from near the northern limit of the UK range during early summer 2005, coincident with the appearance of *Sympetrum fonscolombii* in the same areas. Two were at Filey Dams, North Yorkshire on 18–19 June (JHa), five at Wintersett, West Yorkshire on 18 June (MTh), two at Heysham, Lancashire on 19 June (PM), one near Darlington, County Durham on 21 June (SCr) and another at Witton-le-Wear, County Durham on 23 June (APc). No less than 25 were seen at Speeton, North Yorkshire on 26 June and a male was at Brimham Rocks, near Harrogate, North Yorkshire on 2 July (PCu). In addition to these more northerly records, one was also seen on Skomer, Pembrokeshire on 19 June (per LM), this being the first site record since 2000. Although a few of these records may refer to locally emerged individuals, there is a clear suggestion of a movement having taken place during the second half of June. This might help to consolidate the status of the species at the current limits of its main range.

Libellula fulva **Müller – Scarce Chaser**

Further records were again received from new and unexpected areas, continuing the recent trend that suggests the species is currently undergoing a range expansion (see Parr, 2005). Two separate individuals were noted in Norfolk during late May up to 20km from the nearest known colonies (per PT), and in Devon individuals (including ovipositing females) were noted on the Grand Western Canal during late June and early July (per DS). This is only the second ever report from the County, the first being a solitary male seen near Exeter in 2003 (Parr, 2004). On 1 July, the first County records for Northamptonshire were also made on the River Nene near Oundle (MTy).

Orthetrum cancellatum **(L.) – Black-tailed Skimmer**

The year was notable for some considerable mobility of this species, particularly during the hot weather of mid-July. On 10 July the island of Skomer, Pembrokeshire recorded its first ever individual (per LM), and from 10–17 July up to four were noted at Gosforth, Cumbria (per DC); this providing the most north-westerly ever record for Britain. Record numbers were reported from Lancashire during 2005, probably as a consequence both of the increased mobility within Britain and the steady northwards expansion of the species' regular breeding range.

In Ireland, individuals were noted on 9 July at Ashford, County Wicklow and on 10 July at Tacumshin Lake, County Wexford (per AT). These sites are well away from known strongholds and, given the locations, there is a possibility that the individuals involved could have been of British origin rather than being wanderers from within Ireland.

Sympetrum striolatum **(Charpentier) – Common Darter**

There were a number of reports from southern and eastern coastal regions of individuals attracted to UV moth-traps during the late summer and autumn, particularly during September. These included 10 caught at Bradwell-on-Sea, Essex between 25 July and

27 September, with two together on 11 September (SD). Other records involved singletons caught at Bawdsey, Suffolk on 17 August, 22 September and 7 October (MD), one caught at Portland Bill, Dorset on 5 September (MC), two at the North Tees Marshes, County Durham on 8 September (AW) and one on the Lizard, Cornwall on 24 September (MTu). This may indicate a significant level of night migration at this time, although little of note was recorded visually. As a common resident as well as a migrant, movements of this species can be hard to detect.

Sympetrum fonscolombii **(Sélys) – Red-veined Darter**
Although not approaching the best invasion years of the last decade, 2005 saw increased immigration compared to 2004, with a good spread of records including several quite far to the north. In addition, there were signs that at least some breeding sites established in recent years were still active. Clearly *S. fonscolombii* remains a British 'regular'.

The season started during the second half of June (18 June onwards) with a series of reports from northern England, including sightings from the Wintersett area of West Yorkshire (MTh); Filey Dams, North Yorkshire (JHa); Spurn (BS) and Blacktoft, East Yorkshire; and also Middleton, Lancashire (PM). While most of these sightings no doubt refer to immigrants, it should be noted that both Spurn and Middleton are known breeding sites and there were many records from the latter site throughout the summer, although records from Spurn were fewer and more erratic. Lagging a few days behind, records of *S. fonscolombii* then started to occur in southern England – at Dungeness, Kent (PA); Paxton, Cambridgeshire (JP); and Dozmary Pool, Cornwall – where up to 35 were seen (KP). One was also at Gibraltar Point, Lincolnshire at the end of June.

July brought a further batch of new records, several apparently being associated with the arrivals of *A. parthenope* during the month. In eastern Yorkshire, individuals were discovered south of Filey (JHa) and at Kilnsea (BS), but most records came from more southerly regions. A freshly emerged teneral was noted at the South Huish Marshes, Devon on 9 July (VT) and records of mature adults were later received from Smallhanger on 10 July (VT) and Beesands on 16 July (NW). In Cornwall, sightings of small numbers of individuals were made at sites on the Lizard on 9, 10 and 17 July (MTu, APy) and up to 20 were at Drift Reservoir from 11 July (DP). Elsewhere up to nine were at Kenfig, Glamorgan from 10 July (per MP), and one was seen near Burley in the New Forest, Hampshire on 12 July (DD). The final discoveries of the year were of singletons seen on the Isle of Wight at Luccombe on 7 August and Godshill on 8 August (DD), plus an individual at Windmill Farm, the Lizard, Cornwall on 10 August (APy). No autumn records, either of fresh immigrants or of locally-bred individuals, were received.

Sympetrum flaveolum **(L.) – Yellow-winged Darter**
There was a very small immigration into southern England during August. Single males were noted on 1 August at North Warren, Suffolk (RM) and near Holt, Norfolk (BD),

with 1–2 further individuals observed at the latter site during the next fortnight. Another singleton was reported from Icklesham, East Sussex on 4 August (NBa). Later in the season, additional records came from Luccombe, Isle of Wight on 31 August (DD) and Old Bursledon, Hampshire on 14 September (JHo).

Conclusions

Although some migrant and new colonist species had an unspectacular year in 2005, the continued general trend was towards both an increased occurrence of 'southern' migrants (e.g. *Anax parthenope*) and range expansion of resident species whose traditional strongholds have been in southern England (e.g. *Orthetrum cancellatum*). This would be compatible with continued climate change and 'global warming' and it will be interesting to see what further events take place in the years to come. Certainly the sharp upturn in records of *A. parthenope* during 2005 seems of some significance, and may reflect incipient colonization. I wonder whether yet further species might start to follow this example – Southern Migrant Hawker *Aeshna affinis* being one that comes to mind. Although very rarely recorded from Britain at present, it too is increasingly reported from the near Continent.

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References

Dumont, H.J. 2004. A note on dragonflies collected at light in a forest in the Ivory Coast (West Africa). *Bulletin S.R.B.E./K.B.V.E.* **140**: 66–67

Parr, A.J. 2004. Migrant and dispersive dragonflies in Britain during 2003. *Journal of the British Dragonfly Society* **20**: 42–50

Parr, A.J. 2005. Migrant and dispersive dragonflies in Britain during 2004. *Journal of the British Dragonfly Society* **21**: 14–20

Parr, A.J., De Knijf, G. & Wasscher, M. 2004. Recent appearances of the Lesser Emperor *Anax parthenope* (Sélys) in north-western Europe. *Journal of the British Dragonfly Society* **20**: 5–16

Dragonflies in the Forest of Dean 1996–2005

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Introduction

Between 1996 and 2005 I spent many hours each summer looking for and recording dragonflies in and around the Forest of Dean, West Gloucestershire (Vice County 34). My original aim was simply to visit as many sites as possible, to record what dragonflies were there, and to send the records in to the national recording scheme. I was also interested to learn more of the status of some of the county rarities and national 'scarcities' mentioned by Holland (1983, 1991) and elsewhere. Much of my fieldwork took place in the 10km square SO61 (British National Grid Reference), which includes a large proportion of the eastern part of the Forest and some adjacent countryside. This paper presents some of the results from my fieldwork in this square, with particular reference to the distribution and abundance of the various species.

Methods

Sites and visits

Dragonfly sites were located mainly from Holland (1983, 1991) and by searching for potential sites on the 1:25 000 Ordnance Survey map. Sites that were known to be, or proved to be, productive for dragonflies were visited more often than others and sites known or suspected to support scarce species tended to be visited more during those species' flight seasons.

In total, 27 sites were visited between 1996 and 2005. The sites (Table 1) were very varied, but may be broadly categorized as follows:

1. Relatively small woodland ponds, shallow and often prone to drying out, either natural or 'scraped out' (ten sites).
2. Rather deep ponds, never drying out, most created by damming streams and tending to be steep-sided: 2a medium-sized (five sites), 2b larger (six sites).
3. Larger ponds/small lakes, or complexes of medium-sized ponds, not very deep, gently shelving (four sites).
4. Flooded clay pit (one site).
5. Large farm pond/small lake (one site, outside the Forest itself).

Most site visits took place in the middle of the day and in suitable weather conditions. A total of 421 visits were made but they were not evenly distributed throughout the season and almost all occurred between June and September. About half were visited between six and 15 times, while one favoured site (Washery Woods) accounted for 45 visits. None of the sites was visited in fewer than three different years within the survey period. The mean number of years during which each site was visited is 6.6; eight sites were visited during nine of the ten years and only one site was visited every year. Rather few sites could be visited in 2001, the year of Foot and Mouth Disease. Because the sites varied so much in size and character it is difficult to define a 'standard' visit, but usually I remained at the site until I was fairly satisfied that I had seen and recorded all the species present.

Table 1. Sites in the Forest of Dean (SO61): Site names and size categories, British National Grid References, number of species of Odonata, number of species for which there was evidence of breeding, number of visits over the years 1996–2005 and number of years in which a visit was made.

Site			Number of species			
Name	Size Category	Grid Reference (100km square SO)	Total	Breeding	Visits	Years
Blackpool Brook Lagoon	1	632126	18	12	31	9
Fairplay Mine Reservoir	1	658165	15	11	29	9
Foxes Bridge Colliery Pond	1	638135	7	5	4	3
Kensley Lagoon	1	625129	11	6	5	4
Lightmoor Colliery Pond	1	642121	10	3	5	3
Merring Meend Roadside	1	657168	10	6	7	4
Pete's Pond	1	644147	10	6	6	3
Pit House Pond	1	653193	12	2	12	6
Turley's Pond*	1	632096	8	3	7	5
Wigpool Common	1	652196	14	10	18	7
Blaisdon Wood Mine Reservoir	2a	699175	12	4	10	6
Lightmoor Angling Ponds	2a	642122	16	8	11	6
Sallowvallets Depot	2a	609125	10	4	10	7
Soudley Ponds (north)	2a	663117	16	7	14	8
Waterloo Screens	2a	618146	7	5	5	5
Westbury Brook Mine Reservoir	2a	658168	9	5	7	4
Cannop Ponds (north)	2b	608108	13	7	14	8
Cannop Ponds (south)	2b	608103	16	9	13	8
Merring Meend Angling Pond	2b	658169	11	5	6	3
Soudley Ponds (south)	2b	662107	17	5	15	9
Speech House Lake	2b	625113	18	9	12	7
Cinderford Linear Park (south)	3	650132	20	9	23	9
Dilke Lagoon	3	635127	20	14	35	9
Washery Woods	3	645150	21	13	45	10
Woorgreens	3	630128	19	13	35	9
Dam Green Claypit	4	645153	18	10	24	9
Flaxley Pool	5	694151	14	5	18	9

*Not in SO61 but very close to the boundary.

Recording dragonflies and estimating abundance

On virtually all site visits, the numbers of each species seen were estimated according to the scheme used for the British Dragonfly Society/Biological Records Centre RA70 recording cards:

A: 1 individual; B: 2–5; C: 6–20; D: 21–100; E: 101–500; F: 500+.

A disadvantage of this system is that the scale is non-linear. In an attempt to alleviate this problem I assigned a numerical score to each of the classes, as follows:

A: 1; B: 3; C: 10; D: 50; E: 250; F: 500.

These scores are mostly near the mid-points of the successive abundance categories, although I used 10 for 'C' and 500 for 'F' because I was aware that most of my 'C' were nearer 6 than 20 and the few 'F' scores were estimated to be only just into that category. To obtain an estimate of the total abundance of a species over a number of sites, I extracted the highest A, B etc. score ever assigned to it at each site where it was seen, then converted these to the numerical scores and added them together.

Indications of breeding were noted wherever and whenever seen, but I did not make special attempts to look for breeding behaviour and did not make separate estimates of breeding numbers. For the sake of simplicity, all the different indications of breeding (copulation, oviposition, exuvia, emergent adults) are treated as equivalent, although in practice they imply different levels of probability or certainty that breeding has occurred.

Results

Species and distribution

Over the ten years of the survey a total of 27 species was recorded at the 27 sites listed in Table 1. The number of sites occupied by the different species ranged from one site to 26, i.e. no species was found at all 27 sites (Table 2). The mean number of sites occupied per species was 13.8, but the distribution is very irregular, with a clump of species recorded at very few sites, another peak near the middle of the range and another group of species recorded at a large number of sites (Table 2). There was a marked tendency for the most widespread species to be more abundant where they occurred.

In total, 20 species were seen to be breeding, although several species were only seen breeding at a rather low proportion of the sites where they were found (Table 2). There is a general tendency for breeding to have been seen at a higher percentage of sites among the more widespread species, but some common species, notably Blue-tailed Damselfly *Ischnura elegans* (Vander Linden), Southern Hawker *Aeshna cyanea* (Müller) and Broad-bodied Chaser *Libellula depressa* L. were not seen breeding at some of their sites even over eight or nine seasons.

Table 2. The abundance of 27 species of Odonata at 27 sites in the Forest of Dean during 1996–2005, together with the number and percentage of sites at which there was evidence of breeding.

Species	Site abundances (scores in brackets)						Total	"Breeding" Sites	
	A (1)	B (3)	C (10)	D (50)	E (250)	F (500)	sites	No.	%
Zygoptera									
Pyrrhosoma nymphula		6	11	8	1		26	19	73
Coenagrion puella			3	14	8		25	24	96
Ischnura elegans	1	3	8	13			25	16	64
Lestes sponsa	3	4	7	6	1		21	12	57
Enallagma cyathigerum		1	3	7	8	1	20	17	85
Calopteryx splendens	6	5	1	1			13	0	0
Erythromma najas	5	2	2	3			12	5	42
Calopteryx virgo	1	5	3				9	1	11
Platycnemis pennipes	1	1	2				4	1	25
Coenagrion pulchellum	1						1	0	0
Anisoptera									
Anax imperator	4	13	9				26	21	81
Aeshna cyanea	5	14	6				25	9	36
Sympetrum striolatum		4	9	9	2	1	25	22	88
Libellula depressa	15	5					20	5	25
Libellula quadrimaculata	3	7	6	4			20	12	60
Sympetrum sanguineum	6	5	2	4			17	7	41
Aeshna mixta	6	4	5				15	3	20
Cordulegaster boltonii	5	10					15	5	33
Orthetrum cancellatum	4	3	6	1			14	6	43
Aeshna juncea	2	8	3				13	8	62
Cordulia aenea	5	6	1				12	3	25
Sympetrum danae		4					4	0	0
Orthetrum coerulescens	3						3	0	0
Aeshna grandis	1	1					2	0	0
Anax parthenope	2						2	0	0
Gomphus vulgatissimus	1	1					2	0	0
Sympetrum fonscolombii	1						1	0	0

Site species richness

The total number of species recorded per site ranged from seven to 21 (Table 1; Figure 1). The mean number of species per site was 13.8 but there was a marked tendency for smaller ponds to have fewer species than larger ones. At single smaller ponds (categories 1 and 2a – see Methods, $n=16$), the mean species total per site was 11.56 (s.d.=3.37), while for clusters of smaller ponds, and larger ponds and lakes (remaining categories, $n=11$) the mean was 17.00 species per site (s.d.=3.19). This is a statistically significant difference (F-ratio, $p=0.728$; $t=4.209$, $p<0.001$).

The number of species showing indications of breeding ranged from two to 14 per site (Table 1; Figure 1), with a mean of 7.26 (s.d.=3.36), and there is a tendency for smaller

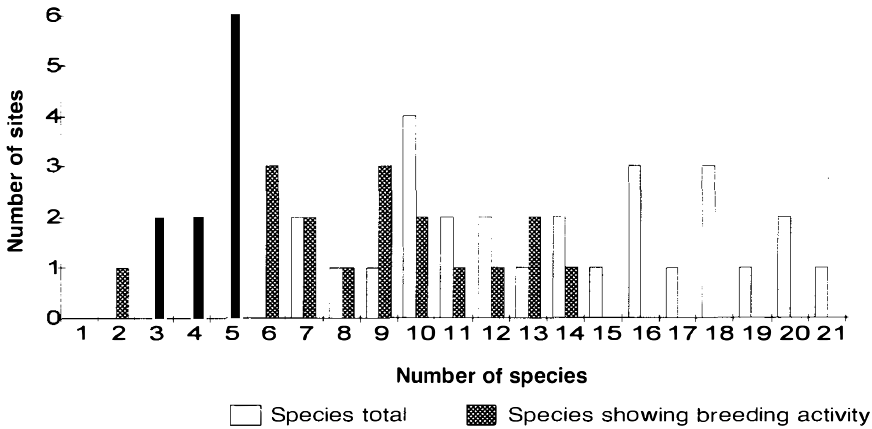

Figure 1. Species richness of sites

ponds to have fewer such species on average: at category 1 and 2a ponds the mean was 6.06 (n=16, s.d.=2.91) and at the other sites it was 9.00 (n=11, s.d.=3.32). This difference is just significant (F ratio, p=0.097; t=2.436, p=0.022). However, this finding should be treated with caution as the power of the performed test (0.565) is below the desired power of 0.800.

Temporal and spatial frequency

If all 27 species had been seen at all 27 sites, this would have given a total of 27×27=729 species-site combinations. By the end of the 10-year period I had accumulated 372 combinations. Over 50 per cent of these combinations had been registered by the time all sites had been visited for one year, and nearly 90 per cent after three years, but new species continued to be added to site lists even after eight or nine seasons (Figure 2).

Some of the later new additions were common and widespread species but, as might be expected by this stage of the study, the new species tended to be those that were seen comparatively infrequently overall, e.g. Downy Emerald *Cordulia aenea* (L.) and the two Demoiselles *Calopteryx* spp. In general, the fewer the sites at which a species occurred, the less often it was seen at those sites (Figure 3).

A potential source of bias in this pattern is that species with shorter flight seasons might be likely to be detected less often and also at fewer sites, even if they were really relatively widespread. To test this I divided 25 species (excluding two migratory species: Lesser Emperor *Anax parthenope* (Sélys) and Red-veined Darter *S. fonscolombii* (Sélys)) into two groups with 'short' or 'long' flight seasons, on the basis of the main periods excluding 'isolated outlying dates' given in Merritt *et al.* (1996), and compared these with the

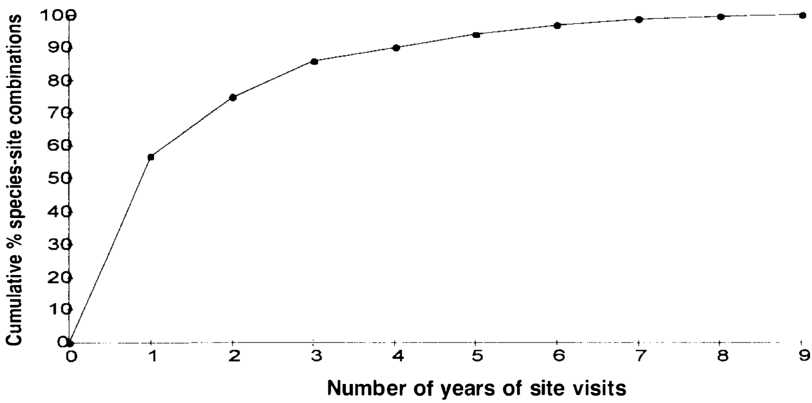

Figure 2. Rate of accumulation of species-site combinations (total = 372 combinations) based on accumulated numbers of years of visits to individual sites

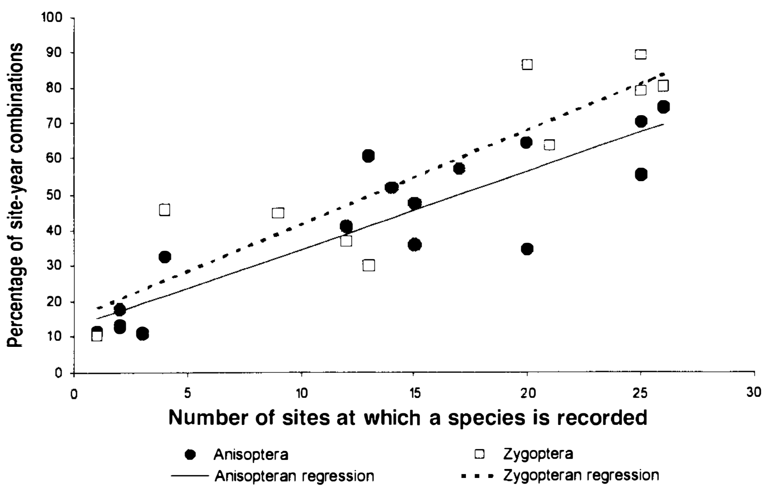

Figure 3. Temporal frequency in relation to spatial frequency

$$\text{y axis} = \frac{[\text{number of year-site combinations recorded for a species}] \times 100}{\text{total number of year-site combinations for all that species' sites}}$$

Table 3. Dragonfly species (n=25) categorized by number of sites and by flight period

Main flight period		Number of sites seen ≤ 14	≥ 15	Total
Short	9–14 weeks	8	4	12
Long	15–19 weeks	4	9	13
	Total	12	13	25

numbers of sites where the species were seen (Table 3). Species with a short flight period did tend to be seen at fewer sites, but the result is not significantly different from a uniform distribution at the $p<.05$ level (Fisher exact, one-tailed test).

Discussion

Species and distribution

The total of 27 species for this 10km square reflects the wide range of habitats in the square, the presence of some locally scarce species, several near either the eastern or western edges of their ranges, and the occurrence of some migrants.

The only species listed for the Forest of Dean by Holland (1991) that was not recorded was Scarce Blue-tailed Damselfly *Ischnura pumilio* (Charpentier), which is now apparently extinct in VC34. While the number of sites for several species has apparently increased since 1991 (notably Red-eyed Damselfly *Erythromma najas* (Hansemann) and Downy Emerald *Cordulia aenea* (L.)), this is no doubt partly a reflection of more intensive fieldwork.

The most widespread species (Large Red Damselfly *Pyrrhosoma nymphula* (Sulzer), Blue-tailed Damselfly *Ischnura elegans*, Azure Damselfly *Coenagrion puella* (L.), Southern Hawker *Aeshna cyanea*, Emperor Dragonfly *Anax imperator* Leach, and Common Darter *Sympetrum striolatum* (Charpentier)) are all nationally very common and found in a wide range of habitats. They were all relatively abundant here, although *S. striolatum* was the only anisopteran whose abundance ever attained the 'E' or 'F' level at any site. The wooded nature of much of the square helped to boost the incidence of *A. cyanea*. Common Blue Damselfly *Enallagma cyathigerum* (Charpentier), another nationally very common species, was rather less widespread here, due to a high proportion of smaller ponds in the square. However it was often very abundant where found and was the only Zygopteran species whose abundance ever attained the 'F' level at any site.

Of the eight species recorded from fewer than seven sites (Variable Damselfly *Coenagrion pulchellum* (Vander Linden), White-legged Damselfly *Platycnemis pennipes* (Pallas), Brown Hawker *Aeshna grandis* (L.), Lesser Emperor *Anax parthenope* (Sélys), Common Club-tail *Gomphus vulgatissimus* (L.), Keeled Skimmer *Orthetrum coerulescens* (Fabricius), Black Darter, *Sympetrum danae* (Sulzer), and Red-veined Darter, *S. fonscolombii* (Sélys)), only *P. pennipes* ever attained level 'C' on any one site visit. Away from the river Wye, this species probably only breeds in the Dean at two small lakes (Cannop Ponds) that were originally formed by damming a stream in a woodland valley. Here a very slow flow of water throughout the year creates conditions comparable to a small river and there has been a colony of *P. pennipes* since at least the mid-1980s. Small numbers were also found at two other sites, probably dispersing individuals.

Gomphus vulgatissimus is also mostly restricted to the Wye in this region, but I had one sighting of several individuals apparently 'displaying' at Cannop Ponds, and breeding there is probably not out of the question. There was also a single individual at one other site (Speech House Lake).

Aeshna grandis is near the western edge of its range here. Much of the habitat in the Dean is unsuitable for it, and I only had one record from within the Forest proper. The other sighting came from the large farm pond (Flaxley Pool), where conditions appeared suitable for breeding.

Recent sightings of *O. coerulescens* in the Dean were summarized by Phillips (2003). Its present status here is uncertain, although breeding was recorded in 1983 (Holland, 1991). The status of *C. pulchellum* is even more uncertain; a single individual of this species was found in apparently suitable habitat at Washery Woods in 1998 (Phillips & Phillips, 1999), but none has been seen since. *Sympetrum danae* survives at a few localities in the Dean, evidently in very small numbers. It has recently been recorded from a fifth site within SO61 (Ingrid Twissell, pers. comm.) and I have recorded it in ST59 (Tidenham Chase) where it was listed in Holland (1991) and where oviposition was seen in 2004. It appears to have been rather more common and more widespread during the late 1980s and early 1990s (Holland,1991).

The single migrant *S. fonscolombii* was found outside the Forest at Flaxley Pool during a fairly widespread immigration into the country in July 2002. Both records of single *A. parthenope* were within the Forest, in 1996 (Phillips, 1997) and 1999.

The two *Calopteryx* species normally breed in flowing water and hence most of these records would be of individuals that had dispersed away from their breeding sites. *Erythromma najas* is close to the western edge of its range in the Forest of Dean and is relatively scarce, tending to avoid acid water bodies with an 'upland' character and to select larger ponds and small lakes. The Migrant Hawker *Aeshna mixta* Latreille may have been under-recorded as it appears late in the season when there were relatively few visits, but it seldom appears in large numbers in this region. The Golden-ringed Dragonfly *Cordulegaster boltonii* (Donovan) is of some interest here, as the Forest of Dean population is rather isolated and at the edge of its UK range: there are likely to be few or no British sites due east of the Flaxley valley (SO6915), where it probably breeds. Numbers seen in the Dean as a whole vary considerably from year to year and it is probably vulnerable to prolonged drought, which may result in its breeding sites, often no more than narrow, shallow runnels within forestry plantations, drying out.

The status of *Cordulia aenea* in the Forest of Dean was summarized by Phillips (2004). It appears to be maintaining its status, and possibly extending its range slightly compared with the situation described by Holland (1991), but it remains vulnerable owing to the rather small number of sites at which it has been recorded.

Species that were not seen to be breeding anywhere were mostly migrants (*A. parthenope*, *S. fonscolombii*) and/or locally scarce or rare (*C. pulchellum*, *A. grandis*, *G. vulgatissimus*, *O. coerulescens* and *S. danae*). The only relatively widespread species not to be seen breeding anywhere was Banded Demoiselle *Calopteryx splendens* (Harris) (seen at 13 sites). This may be a reflection of the fact that it was generally present in low numbers, as well as the unsuitability of many of the water bodies.

Site species richness

The uneven distribution of number of species per site (Figure 1) partly reflects a discontinuity between larger, more species-rich sites and small, species-poor ones, with comparatively few in between. However, there will be a degree of bias in the result due to the fact that sites known to be 'good' were visited more often, and so would tend to accumulate more species records, while the opposite is true for 'poor' sites.

On average, about 50 per cent more species were recorded at larger sites than at smaller sites, whether species totals or breeding species are compared. This is likely to reflect a real difference. Larger sites are likely to support more breeding species as they will tend to provide a wider range of habitats. Larger sites may also be more likely to attract or detain transient migrants or non-breeding visitors.

Temporal and spatial frequency

In general, the species that were more widespread (seen at a large number of sites) were also seen most frequently (Figure 3). This is partly because widespread species also tend to be abundant at individual sites (Table 2) and so are more likely to be seen at those sites.

Some of the differences in observed frequency between species, and in particular between Zygoptera and Anisoptera, are no doubt influenced by the fact that individuals of some species spend most of their adult lives by the water, while other species only visit from time to time in order to breed. The recorded numbers of species such as *C. aenea* are certain to be underestimates of the true population levels, but they will certainly not be as abundant as Four-spotted Chaser *Libellula quadrimaculata* L., *S. striolatum* or the common Zygoptera

It is impossible to be certain to what extent the continuing additions to species lists for sites (Figure 2) are due to the delayed detection of species that are always present at the site, but are scarce and therefore less likely to be found in a given year, or to genuine first appearances of migrating or dispersed individuals. Probably both factors are involved. New records of scarcer species (e.g. *E. najas, C. aenea*) are probably due to inter-site movements. Widespread and abundant species will move between sites but their movements would go undetected unless a mark-release-recapture programme was to be carried out. In all likelihood the distribution of most species in this 10km square, the Forest of Dean as a whole, and possibly even beyond, is based on a metapopulation structure, with more or less frequent interchange between different 'sites'. This makes it difficult to define what is a single 'site' for a species, especially if, as in this case, some of the sites are quite close together.

Conclusions

Habitats in the 10km square SO61 support a wide range of breeding and visiting dragonflies, as does the Forest of Dean as a whole. The number of breeding species probably attains the threshold for SSSI status at several individual sites in the square, and a priority for fieldwork in the coming years is to look for proof of breeding (as outlined by Taylor, 2003) for more species and at more sites. It is useful to note that, whatever the reasons behind the observed patterns of distribution, it may take several years of frequent visits to record the complete range of dragonfly species that visit a site.

Some of the species are evidently scarce or rare here (*E. najas, A grandis, C. aenea, S. danae),* and the status of others is uncertain (*C. pulchellum, O. coerulescens)*. Fieldwork will be continued with the aim of clarifying the status of these species. In addition, there is the possibility that *G. vulgatissimus* may breed on slow-flowing lakes in the central Forest. These habitats may even prove to be suitable for Scarce Chaser *Libellula fulva* Müller, which has recently colonized the Severn in the northern part of Gloucestershire. Some of the ponds may be suitable for Hairy Dragonfly *Brachytron pratense* (Müller), which has recently been recorded in the county for the first time in many years, and Small Red-eyed Damselfly *Erythromma viridulum* (Charpentier), which continues to spread westwards across England. Here as elsewhere it will also be interesting to see whether *A. parthenope* and perhaps other recently arrived species in England will colonize in the coming years.

Acknowledgements

Thanks to Bob Godfrey and Daphne Lane for telling me about some good dragonfly sites, to Viv Phillips for her help and companionship during field work, and to Ingrid Twissell for information about the present and past distribution of dragonflies in Gloucestershire. Peter Mill and the editorial review board made very useful amendments to the original manuscript.

References

Holland, S. 1983. Dragonfly Survey Reports – 1. Gloucestershire. *Journal of the British Dragonfly Society* **1**: 1–3

Holland, S. 1991. *Distribution of Dragonflies in Gloucestershire.* Toddington Press, Cheltenham. 74pp.

Merritt, R., Moore, N.W. & Eversham, B.C. 1996. *Atlas of the dragonflies of Britain and Ireland*. ITE research publication no. 9. HMSO, London. 149pp.

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

Phillips, J. 2003. Recent records of *Orthetrum coerulescens* (Fabricius) (Keeled Skimmer) from the Forest of Dean. *Gloucestershire Naturalists' Society Journal* **48**: 299–302

Phillips, J. 2004. *Cordulia aenea* (Downy Emerald) in the Forest of Dean. *Gloucestershire Naturalists' Society News,* Spring 2004, 8–14

Phillips, J. & Phillips, V. 1999. A sighting of *Coenagrion pulchellum* (Vander Linden) in Gloucestershire. *Journal of the British Dragonfly Society* **15**: 10–11

Taylor, D.P. 2003. DCG special report – Criteria for proof of breeding in dragonflies. *Dragonfly News*, **43**: 26–27. British Dragonfly Society Newsletter

The use of binoculars to identify adult Odonata[1]

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Summary

Many current odonatological surveys are carried out by naturalists with a background in ornithology who employ the same visual identification methods as used by many birdwatchers. Identifications based solely on observation through binoculars must be treated cautiously and, whenever possible, should be supported by checking diagnostic features on captured specimens, which subsequently can be released. Identification keys designed for use with binoculars are of limited value and, considering the risk of misidentification, records based solely on binocular observation by inexperienced observers cannot be relied upon.

Introduction

Some entomologists, often those who come to entomology via ornithology, try to transfer methods applicable to their studies of birds to their work on insects. The use of binoculars to identify insects that fly actively and are difficult to capture appears on the surface to be a good method of recording, being all the more attractive because it avoids the necessity for capture (resulting in possible death or physical injury of the insect). However, that technique is appropriate for only a small minority of insects, namely those that are diurnal and readily identifiable by distinct colouration or markings. Accordingly it is inapplicable for the vast majority of insects and will not prevent the entomologist from facing the moral question: 'Do I have the right to kill insects in order to further knowledge?' Each person will answer this according to his or her personal feelings and conscience. Fortunately many odonate taxa fall within that minority category of insects potentially identifiable with binoculars. So what is the problem?

In ornithology the ability to identify a bird at a distance is absolutely essential. That is why guides have been designed exclusively with this objective in mind (e.g. the celebrated 'Peterson' guide (Peterson *et al.*, 1954) and its numerous successors). Nevertheless to use such guides effectively requires long practice, great discretion and constant communication between experienced ornithologists and novices so that the latter, from the outset, are made to realise the danger of excessive self-confidence (even,

[1]This article is a slightly modified version of the one published in *Martinia* **21**: 47–50 and is reproduced here by kind permission of the Editor of that Journal.

and above all, in good faith!) and acquire the prudence and humility that are indispensable. One must also bear in mind that additional 'safety measures' have been put in place with the institution of data validation committees (e.g. the British Birds Rarities Committee).

In odonatology the situation is quite different: an animal can normally be captured to provide assurance of its identity and then released. So why not do this? Certainly, from time to time there is a small possibility of injury; however, given a modicum of care and a little skill, the likelihood of damage is small. Moreover, the death of an insect is, objectively (speaking ecologically and devoid of all sentiment) something much less serious than that of a bird, the size of their populations being unaffected in the vast majority of cases, primarily because the reproductive capacity of invertebrates far exceeds that of warm-blooded vertebrates. It needs to be emphasized, with regard to collections made by entomologists, and despite what may sometimes be reported, no species of insect has been eliminated in Europe owing to excessive collecting. Admittedly, the situation is less clear when rare insects are collected for sale purposes. All experienced entomologists know that, as a general rule, species inventories can only be obtained by killing a certain number of individuals as this is usually the only way of securing reliable determinations. To decide to make an insect inventory presupposes implicit acceptance of this principle! It is well understood that each person will select methods that allow the anticipated result to be obtained with the least destruction. The great majority of entomologists today respect a code of practice and collect no more than is strictly necessary. In odonatology, we are particularly fortunate in that we are dealing with large insects that are normally (at least in western Europe) identifiable on site using the techniques of 'catching-releasing' (adults and larvae) and collecting exuviae. Also we are dealing with a very low number of species (fewer than 100, among a total of 37,000 already known among the insects of France; fewer than 50 in the UK).

Certainly, an experienced odonatologist (like an ornithologist) learns, with the passage of time, to recognise by sight – by eye or with binoculars– more and more species with which he or she is familiar, and this is most valuable. But, just as in ornithology, it is necessary that great care and humility are exercised in identifications. This may 'touch a nerve' as extensive experience is needed to acquire this capacity for self-evaluation and to be able to assess the reliability of such identification by sight. It follows that the novice, even if he or she thinks that he or she is already familiar with the group, risks a lot through an excess of confidence, and by failing to allow sufficiently for possible errors in his or her diagnosis, but what are the problems? Firstly, dragonflies are much smaller than birds, their movements rapid and unpredictable, and their appearance very variable, depending on sex, age and light conditions. Secondly, their behaviour (flight, posture, etc.) and habitat can sometimes vary depending on site, region and weather. Thirdly, dragonflies neither sing nor call and each ornithologist knows very well how vocal expressions allow many birds to be identified with certainty. In summary, identification by sight is much more difficult for Odonata than it is for birds. It thus follows that capture (and subsequent release) remains the only sure and reliable means of determining a species of dragonfly, even after spending many years studying them in the field. This applies particularly to the great majority of the Zygoptera, which fortunately, in most cases, present little difficulty for capture. Many anisopterans are difficult to capture but the odonatologist will come, in due course, to make reliable sight identifications for a certain number of well-known and easily recognizable species (notably Libellulidae). For others, that have less clear markings, he or she will only be in a position to express a strong likelihood. Knowledge of the behaviour and ecology of species helps the experienced odonatologist, but will rarely provide absolute certainty. Such certainty is absolutely necessary to validate a record and, if any doubts remain, the record is invalid.

Visual identification at a distance is a complex and very personal phenomenon which I liken to the capacity we have to recognize instantly a person we know by integrating a multitude of characteristics that we cannot analyse individually. As a result, it is extremely difficult to try to convey this to others by a simple method (e.g. a dichotomous key), and clearly the novice cannot, by definition, call on long experience. Indeed, a method that relies solely on binoculars should only be published with clear indications of the inherent risks involved since, once published, it carries the risk of being used over-enthusiastically and without due caution by the idealistic novice.

I may add that after 25 years in odonatology (and 35 in ornithology), I remain extremely cautious about my identifications at a distance of many Anisoptera (such as Corduliidae, *Sympetrum* and *Orthetrum* and many Aeshnidae). For example, in regions where more than one species of *Cordulegaster* co-exist, I never allow myself to make a formal identification to species solely on the basis of binocular observation. For Zygoptera a visual identification is only reliable at close range and can only be used most of the time to detect a less common species among a crowd of individuals; a swing of the (indispensable!) net will bring certainty to a determination. For some species, the identification of an isolated female will often necessitate microscopic examination and therefore retention of the specimen as a voucher.

This consideration raises the question of who should decide when and whether such a 'voucher specimen' should be collected. Nowadays many ornithologists subscribe to telephone information services to discover where and when a rare bird can be viewed. Having obtained such information, they may then travel far to view the rarity and thus add its name to their 'Life List.' A similar service is becoming available to observers wishing to view rare insects, especially butterflies and dragonflies. Having invested time and money to reach a viewing site, such observers will not take kindly to a specimen of the rarity being captured and retained as a voucher specimen. However, where there is a conflict of interest, the overall interests of science and odonatology should be considered. Indeed it should be borne in mind that without collecting Odonata in the past we would not now know the species. A decision regarding the need to obtain a voucher specimen should ideally be made by a *bona-fide* odonatologist whose sole interest must be in advancing the science of odonatology for the benefit of all odonatologists.

In conclusion: an inventory of the Odonata, notably the Anisoptera, of a locality must, ideally, always be made on the basis of larvae and exuviae, which indicate with precision the species actually breeding at the study site at the time and their abundance; there now exist at least two excellent books (Gerken & Sternberg, 1999; Heideman & Seidenbusch, 2002) for identifying these stages. An inventory based on the very mobile adults, particularly of some anisopteran species, presents a much less reliable indication of the resident population, unless it is obtained over a long period and on the basis of regular observations at the site and/or observations of adult breeding behaviour there. Consequently, it is not so crucial to obtain a definitive identification for each anisopteran seen. An observation can remain provisional, as a simple indication of potential presence, pending confirmation. It is evident that a serious record must never be based solely on identification by sight at a distance.

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References

Gerken, B. & Sternberg, K. 1999. Die Exuvien europäischer Libellen (Insecta, Odonata). Arnika & Eisvogel, Höxter & Jena, Germany. 354pp.

Heideman, H. & Seidenbusch, R. 2002. Larves et exuvies des libellules de France et d'Allemagne (sauf de Corse). Société Française d'Odonatologie, Bois-d'Arcy, France, 416pp.

Peterson, R. T., Mountfort, G. R. & Hollom, P. A. D. 1954. A field guide to the birds of Britain and Europe. Collins, London. 318pp.

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

Use of these terms is acceptable: 'exuvia' for cast skin (plural: 'exuviae'); 'larva' (instead of 'naiad' or 'nymph'); 'prolarva' to designate the first larval instar.

Dates in the text should be expressed in the form: 24 July 2004.

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Hammond, C. O. 1983. *The dragonflies of Great Britain and Ireland.* 2nd edition (revised by R. Merritt). Harley Books, Colchester. 116 pp.

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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 splendens	Banded Demoiselle
Calopteryx virgo	Beautiful Demoiselle
Chalcolestes viridis	Willow Emerald Damselfly
Lestes dryas	Scarce Emerald Damselfly
Lestes sponsa	Emerald Damselfly
Ceriagrion tenellum	Small Red Damselfly
Coenagrion armatum	Norfolk Damselfly
Coenagrion hastulatum	Northern Damselfly
Coenagrion lunulatum	Irish Damselfly
Coenagrion mercuriale	Southern Damselfly
Coenagrion puella	Azure Damselfly
Coenagrion pulchellum	Variable Damselfly
Coenagrion scitulum	Dainty Damselfly
Enallagma cyathigerum	Common Blue Damselfly
Erythromma najas	Red-eyed Damselfly
Erythromma viridulum	Small Red-eyed Damselfly
Ischnura elegans	Blue-tailed Damselfly
Ischnura pumilio	Scarce Blue-tailed Damselfly
Pyrrhosoma nymphula	Large Red Damselfly
Platycnemis pennipes	White-legged Damselfly
ANISOPTERA	**DRAGONFLIES**
Aeshna caerulea	Azure Hawker
Aeshna cyanea	Southern Hawker
Aeshna grandis	Brown Hawker
Aeshna isosceles	Norfolk Hawker
Aeshna juncea	Common Hawker
Aeshna mixta	Migrant Hawker
Anax imperator	Emperor Dragonfly
Anax junius	Green Darner
Anax parthenope	Lesser Emperor
Brachytron pratense	Hairy Dragonfly
Hemianax ephippiger	Vagrant Emperor
Gomphus vulgatissimus	Common Club-tail
Cordulegaster boltonii	Golden-ringed Dragonfly
Cordulia aenea	Downy Emerald
Oxygastra curtisii	Orange-spotted Emerald
Somatochlora arctica	Northern Emerald
Somatochlora metallica	Brilliant Emerald
Crocothemis erythraea	Scarlet Darter
Leucorrhinia dubia	White-faced Darter
Libellula depressa	Broad-bodied Chaser
Libellula fulva	Scarce Chaser
Libellula quadrimaculata	Four-spotted Chaser
Orthetrum cancellatum	Black-tailed Skimmer
Orthetrum coerulescens	Keeled Skimmer
Pantala flavescens	Wandering Glider
Sympetrum danae	Black Darter
Sympetrum flaveolum	Yellow-winged Darter
Sympetrum fonscolombii	Red-veined Darter
Sympetrum nigrescens	Highland Darter
Sympetrum pedemontanum	Banded Darter
Sympetrum sanguineum	Ruddy Darter
Sympetrum striolatum	Common Darter
Sympetrum vulgatum	Vagrant Darter

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A full checklist can be found on the inside back cover of Dragonfly News.

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