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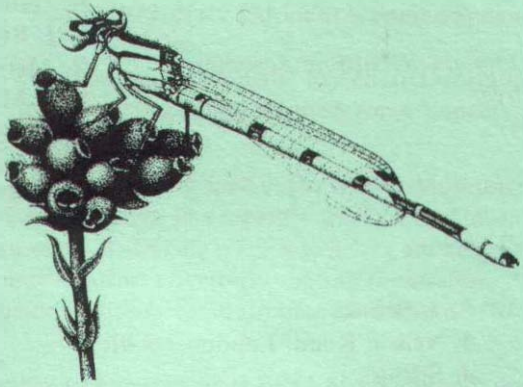

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affiliated to the Societas Internationalis Odonatologica

The *Journal of the British Dragonfly Society*, normally 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. The B.D.S. is affiliated to the Societas Internationalis Odonatologica (S.I.O.).

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Front cover illustration of *Enallagma cyathigerum* by Steven Jones.

The origins and early history of the British Dragonfly Society: a personal account[1]

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If I were to select three events which, in my view, were of most significance in leading to the eventual formation of the British Dragonfly Society, they would be:

- the setting up, in February 1968, of a scheme to map the distribution of dragonflies in Britain and Ireland, by John Heath of the Biological Records Centre (BRC), Monks Wood Experimental Station;
- the publication, in May 1977, of the Odonata Mapping Scheme Newsletter No. 1 by David Chelmick;
- the meeting between Roderick Dunn and myself, in December 1982, at which he showed me a ticket that he'd had printed for a concert by the rock band "Blackfoot Sue."

During Cynthia Longfield's long spell at the British Museum from 1927 to 1957, she was the centre pin of a network of dragonfly workers and, even earlier, in the days of Robert McLachlan or W. J. Lucas, there was a very active group, the members of which disseminated information effectively among themselves. The contemporary literature and museum collections provide impressive testimony to the contribution of these early workers.

The setting up of a mapping scheme at BRC, Monks Wood, was the first occasion that all available information on the status and distribution of dragonflies in Britain and Ireland was to be collated and stored, for future reference, in a central databank. Information was requested from, and supplied by, a small number of individuals. The establishment of the scheme provided the foundation for much of what was to follow.

1 At its first full meeting, on 26 October 1985, the Committee of the British Dragonfly Society decided to ask Bob Merritt to produce an account of the events leading up to the formation of the Society. The intention was that his account would be seen, and endorsed, by the Committee of the day and so could be regarded as an 'official' history of the Society's establishment. This intention has been fulfilled, and the Committee is grateful to Bob for undertaking this task so thoroughly and welcomes the fact that he has chosen to present it as a personal account. To help those who may wish in future to look more closely into the circumstances attending the Society's formation, Bob has also produced a version containing reference citations accompanied by copies of relevant publications and correspondence. This will be held as archival material by the Secretary of the Society.

Philip S. Corbet, President,
British Dragonfly Society

In June 1974, John Heath's assistant, Mike Skelton, produced a small booklet of preliminary distribution maps of Orthoptera, Dictyoptera and Odonata in the British Isles. The study of dragonflies was still considered to be a minority interest comparable to that applied to grasshoppers, crickets and cockroaches, but things were beginning to move and, in 1977, John Heath looked outside BRC for an unpaid volunteer to organize the mapping scheme. He recruited David Chelmick who had done sterling work on dragonflies in Sussex and who had several qualities that made him suitable for the job: interest, zest and the ability to tell a good story well.

In May 1977, David Chelmick produced Newsletter No. 1 of the Odonata Mapping Scheme. It was the first attempt, to my knowledge, to bring the loose assortment of people interested in dragonflies into a cohesive body with its own vehicle, the newsletter, for keeping people in touch with what was going on.

The response was encouraging and, in March 1978, Newsletter No. 2 was published. In this it was suggested that an indoor meeting be held, an all-day affair, probably in London. This meeting, chaired by David Chelmick, took place on 7 April 1979 when 72 people, travelling from as far afield as Penzance and Inverness, packed the conference room at the Nature Conservancy Council's headquarters in Belgrave Square, London. Among those present was Cyril Hammond, aged 75, whose book "The Dragonflies of Great Britain and Ireland" had been published 18 months previously. This book deserves special mention in this account because it greatly stimulated interest in dragonflies, providing many people with their first guide to dragonfly identification, all other books on the subject being out of print at the time.

A report of this meeting was given in Odonata Mapping Scheme Newsletter No. 3 in June 1979. The meeting was considered to have been a great success. By the time that Newsletter No. 4 appeared in Spring 1980, the name of the mapping scheme had changed to Odonata Recording Scheme in order to emphasize that the objectives of the scheme were not only to map distribution but also to obtain detailed information on breeding sites, habitat etc.

It was clear from looking at Newsletter No. 4 that the momentum generated earlier had come to a halt. The newsletter was much shorter than its predecessors and it contained the announcement that there was to be no indoor recorders' meeting that year, although there was to be an informal field meeting at Thursley Common National Nature Reserve in June 1980. The reason for these changes was evident from David's plea for help with the administrative burden of running the recording scheme.

I offered my assistance and visited David a few months later. I came away with the title of National Recorder which entailed responsibility for dealing with all the records. David would continue to deal with general queries and the overall

organization of the scheme. Unfortunately, David retired as scheme organizer in October 1981, and I took over this job in addition to my other responsibilities.

Around this time there were calls for a formal dragonfly society to be formed. Whilst David Chelmick and I were not against the idea in principle, we had serious misgivings about the practicalities of such a venture. We suspected that we would end up doing all the work and that we should then have insufficient time to spend on dragonflies. We considered ourselves to be field naturalists, not society functionaries. Nevertheless, on 2 September 1980 David sent an open letter to local scheme organizers and key recorders asking them for their views on a proposal to establish a British Odonatologists' Society, and whether they would be willing to help with the organization and administration of such a society.

Some 30 people replied. Most favoured the setting up of a society although only a small minority were able to offer help. Despite this, David was able to report in Newsletter No. 5 that the initiative to form a society was being taken by Mike Parr and Peter Mill and that recorders would be notified about developments in due course. For several months David heard nothing from Mike or Peter, who in turn did not receive the list of interested enthusiasts and so could not write to them. Meanwhile, I'd had a change of heart and decided that, subject to any developments pursued by Mike and Peter, I would form an Odonata Study Group with a much wider brief than the existing recording scheme.

However, an event then took place that brought an immediate halt to such plans. This event was a letter received by David Chelmick just before he retired as scheme organizer. It was from an entomologist, unknown to either of us, who wanted to form a society of people interested in dragonflies. He said that he had been through his lists of entomological societies' members and had selected about 100 people who had indicated an interest in dragonflies. He suggested that this number could be increased to 300-400 in view of the likely length of the Odonata Recording Scheme's address list. The type of society he hoped to create was one "that will have an annual newsletter containing original material by members, exchange of specimens, and collecting sites recommended with collecting expeditions arranged between ourselves." This letter worried me greatly, to such an extent that I no longer thought that it would be desirable for a study group or society to be formed.

In December 1981 I wrote to Mike Parr with the intention of finding out what progress he had made, if any, with the moves towards forming a society. He replied on 26 February 1982 saying that he thought it should be possible to set up a steering committee to launch the society, but that it was felt that it would be better if the society was organized by amateur rather than professional biologists such as Peter Mill and

himself, though both of them would be willing to help with mailing, correspondence etc. Mike Parr asked me to send him an up-to-date address list of contributors to the recording scheme but, because of my anxiety referred to above, I did not do this. I asked Paul Harding, who had taken over from John Heath at BRC in 1979, not to divulge the address list to anyone. Anyway, I heard no more from Mike, probably because financial cuts were requiring major restructuring of the university where he worked, and shortly afterwards he left the country to work abroad.

In the Odonata Recording Scheme Newsletter No. 6 (June 1982) I included for the first time articles about dragonflies from contributors to the scheme. However, I dropped the idea of forming a society. I gave emphasis to the fact that when, the previous year, I had sounded out those recorders who might have been willing to take an active part in a society or study group, many found personal reasons for not being able to do so and, moreover, questioned whether sufficient support would be forthcoming to make a society a viable proposition. For my part, and I did not express this view in the newsletter (in retrospect, I believe I should have done), I dropped the idea of forming a society because of my worries about the damage that unscrupulous collectors could inflict upon our rarer dragonflies. In this decision I was particularly influenced by a letter, dated 7 January 1982, that I had received from Alan Stubbs of the Chief Scientist Directorate, Nature Conservancy Council, London, who was a contributor to the scheme as well as being organizer of another of BRC's recording schemes. He wrote: "when David Chelmick first floated the idea of a Society, I made a number of severe reservations about the wisdom of doing so. We have had similar thoughts among dipterists, with the conclusion that their recording scheme organization is *de facto* an unofficial society so why impose a further admin. structure (committees, subscription gathering etc. — all involving the time of entomologists). At present, newsletters are free! Once you have a committee you are at risk of the people you speak of changing the entire character of the society envisaged."

During 1982 I received several letters from Peter Mill. In one, dated 20 September, he asked whether it would be possible for us to meet and have a talk about a British society. He said that he appreciated my concern about unscrupulous collectors but he felt sure that, by exercising control over what we published, we could solve that problem. The meeting took place in November 1982 at John Bower's house in Leeds over a dinner of very ripe pheasant, with John acting as ringside referee. Peter wrung some concessions out of me, but by no means all that he wanted. The result of the meeting was that I decided to widen the brief of the recording scheme, within the framework of a Dragonfly Study Group, and to produce two newsletters each year. I accepted that there would be a need to circulate a 'membership' list though I was not yet ready to give an absolute assurance that I would do so.

The event that changed everything occurred several weeks later, in December 1982, at the Northwood Club — a licensed club run by Roderick Dunn whom I met for the first time some nine months previously. He showed me a ticket which he'd had printed locally for a concert by the rock band "Blackfoot Sue" that was to be held at the club later that week. I could hardly believe that such a ticket could have been printed in Bakewell. However, Rod assured me that it had and proceeded to educate me on the subject of printing and printers about which I was so woefully ignorant. I immediately grasped the implications of what Rod was telling me: it would be possible for us to produce (and without difficulty) a professional newsletter, not just a stencilled broadsheet. It could have drawings, maps, graphs, tables, a fancy cover, central stapling — even binding! The possibilities were endless. All my closely argued, earlier reservations went straight out of the window. At that moment, as I sat there with Roderick Dunn, the British Dragonfly Society was born.

Things started to move quickly. Having settled on a name for the society, we now had to agree on a title for the society's newsletter. I asked around for ideas. It was suggested that we could follow a practice adopted by other societies of honouring a person who had made a great contribution in their particular field, and the names "Lucasia" and "Longfieldia" were put forward. Alternatively, we could name the newsletter after a dragonfly, and the names "Agrion" and "Cordulia" were suggested. In the end, for various reasons, we decided to call it simply the "Newsletter" (later to become the "Journal") of the British Dragonfly Society.

The months that followed were very exciting, for there was much to be done. I hope no-one minded that, whilst I consulted widely about many issues, most of the decisions were taken by Rod and me, often as we sat in front of a roaring fire at the Northwood Club after everyone else had gone home, talking until the early hours with a glass of beer in hand.

I do not want to dwell on the major events of that first year of the Society's life for they are well documented already. Suffice it to say that a committee needed to be formed and a subscription rate agreed. On 28 February 1983 I wrote to Philip Corbet and asked him if he would accept nomination for the position of President of the Society. He accepted with pleasure. David Chelmick accepted nomination as Vice-President, Roderick Dunn as Treasurer, and myself as Secretary and also as Editor of the Society's publications.

I decided to seek affiliation of the Society to the International Odonatological Society (SIO). If granted, this would enable us, in addition to gaining certain benefits, to place the SIO logo on the front cover of our Society's first publication. It was consistent with this, and with his continuing interest in the formation of a society, that

Peter Mill (the United Kingdom national representative of SIO) should be asked to accept nomination as an ex-officio member to the Committee, and I was pleased when he accepted.

Prior to this, in early January 1983, I found a printer in Chesterfield and he printed some headed notepaper in a rather stylish blue ink. He also gave me a very attractive quote for 400 newsletters, A5 size, approximately 20 pages per copy.

On 19 April 1983, the first publication of the British Dragonfly, Newsletter No. 1, rolled off the press. It was despatched to all contributors to the Scheme and to members of SIO in Britain. Included with the Newsletter was a membership form asking for £3 annual subscription, and a ballot form requesting that members indicate whether or not they accepted the Society's first Committee as nominated. We needed about 180 members to cover the printing and postage costs of the two issues of the newsletter that we were committed to producing that year. This figure was quickly reached, and after about two months was approaching 220, which was gratifying. The Committee was accepted.

It was stated in the Newsletter that the first function of the Committee would be to draw up a constitution. Peter Mill was asked to produce a draft document. I visited Peter shortly afterwards for a preliminary discussion. We agreed that, in addition to the draft constitution, Peter would produce a draft set of by-laws. On 23 November 1983 at York University, Philip Corbet, Peter Mill and I went carefully through Peter's draft ducuments. The resulting decisions were sent to David Chelmick and Roderick Dunn for comment, as they were unable to attend. The constitution and by-laws were approved.

Prior to this, the Committee had decided to publish two issues of a journal each year, in the same style as Newsletter No. 1, and a broadsheet newsletter once each year. The journal would contain articles about dragonflies, whereas the newsletter would be restricted to items of news about the Society and any other subjects of general interest. Members were notified of these changes in Newsletter No. 2 of September 1983.

In January 1984 the first issue of the Journal of the British Dragonfly Society was published, and distributed to members along with a booklet containing the constitution, by-laws and a membership list. Members totalled 291 at that time. The Committee decided that this Journal should be called Vol. 1 No. 2, and that Vol. 1 No. 1, which would be printed later in 1984, would consist of a selection of the more interesting articles in Newsletter No. 1. In this way, these articles would be more readily available to future researchers.

Also sent out with Vol. 1 No. 2 of the Journal was a notice, dated 14 January 1984, informing members that the Committee was to be enlarged, in accordance with article

1(d) of the by-laws, by three members and that Stephen Coker, Betty Smith and Tony Welstead had accepted nomination by the Committee to fill these posts. Their nomination was subsequently accepted by the membership. The notice also recorded my resignation as Secretary of the Society, and as Editor of the Society's publications. This decision was brought about because I could not cope with the heavy workload incurred through being an officer of the Society and Organizer of the Odonata Recording Scheme.

In accordance with article 1(e) of the by-laws, Roderick Dunn and Brian Bailey were appointed to the posts of Secretary and Treasurer, respectively. In due course, Stephen Brooks accepted an invitation to become Editor. The Society owes a debt to Rod, Brian and Steve for taking on these responsibilities at short notice.

This brief history is a personal account and so perhaps I may be allowed to pay a special tribute to Roderick Dunn, a tribute which is warmly endorsed by the current Committee. Had it not been for Rod, the Society might well have foundered in early 1984. Not only did he hold it together but since then has played a major part in bringing it to its present healthy state.

In conclusion, I would add that at the time of writing this account, I have found no evidence to suggest that the collecting of dragonflies constitutes a serious threat to their conservation in Britain. The main cause for concern continues to be the destruction of their habitats.

Gilbert White's observations on dragonflies

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In *The Natural History of Selborne*, Gilbert White (1789) refers to dragonflies (Odonata) on two occasions only; both are concerned with predation of the insects by birds.

The first observation is found in *Letter VII* to Daines Barrington where cuckoos are described catching dragonflies: "In July I saw several cuckoos skimming over a large pond; and found, after some observation, that they were feeding on the *libellulae*, or dragon-flies; some of which they caught as they settled on the weeds, and some as they were on the wing."

Such behaviour by cuckoos must be very unusual. The ordinary food of adult cuckoos consists largely of the larvae of moths (often hairy) or butterflies although, doubtless, resting dragonflies are captured if the opportunity occurs. Various tern species and hobbies hawk dragonflies in the air and swallows take the smaller species (Zygoptera); I do not know of any recent observations of cuckoos behaving similarly.

Gilbert White refers again to dragonflies in *Letter XX* to Daines Barrington; here, he mentions sand martins feeding the insects to their young: ". . . sometimes they are fed with *libellulae* (dragon-flies) almost as long as themselves." As swallows catch dragonflies it is not surprising that sand martins do as well, although I have not observed this personally; probably house martins are occasional dragonfly predators too.

Considering Gilbert White's ability as a field naturalist, his meticulous observations and his interest in insects, as recorded in *The Natural History of Selborne*, it might have been expected that dragonflies would have been referred to more frequently in the work. Had this been so, our knowledge of dragonfly status and habits in the Hampshire region in the 18th Century would, clearly, have been so much richer.

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Diets of three aeshnid species in an acid pond

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It is of considerable interest to ecologists to find three congeneric species occupying the same restricted habitat. We might expect that at least one species would be eliminated due to competition with its congeners. However, this is not the case at present at Risley Moss Nature Reserve, near Warrington (Taylor, 1984) where three aeshnid species, *Aeshna juncea* (L.), *A. grandis* (L.) and *A. cyanea* (Müller) all breed in several of the ponds on the Moss.

One obvious way in which competition between these species might be less intense and lead to their continuing coexistence would be if the diets of the larvae showed little overlap. Thus the aim of this note is to describe a short study in which the diets of the aeshnid larvae were analysed by means of examination of the faecal pellets.

Aeshnid larvae were collected from the smaller 'Educational Pond' (Taylor, 1984); three samples were taken, using a pond net, in late-May, mid-June and early July. Forty-eight aeshnid larvae were collected in total. In the field, larvae were placed in individual tubes containing pond water. In the laboratory they were identified, sexed and head widths and wing bud lengths measured. Any faecal pellets produced by the larvae were collected and stored in 70% alcohol until it was convenient to analyse them.

At the same time that the larvae were collected, a sample of potential prey items was taken. These were identified in the laboratory, then fed singly to larvae that had already finished voiding their gut contents. The second group of faecal pellets, derived from single, known prey items, was collected and stored in the same way as the original pellets. These pellets were used as a reference collection enabling us to know what to look for as characteristic remains for each potential prey item when we came to examine the larger field produced pellets. The larvae were fed on chironomid larvae and returned to Risley Moss within a fortnight.

The faecal pellets were dissected with fine needles under the microscope. Fragments of pellet contents were separated and mounted with gum chloral. The detective work then began and we attempted to identify what the aeshnid larvae had been feeding on.

Table I shows the taxonomic groups into which we divided the prey and gives a brief description of the principal identifiable remains that appeared in the pellets. In

reality, of course, it is the combination of characteristics which facilitates identification.

Table 1. The principal characteristic remains of the common taxa consumed by aeshnid larvae in summer at Risley Moss.

Taxon	**Principal identifiable remains**
Chironomidae (larvae)	Head capsule, mandible, proleg claws, tail tuft, heavily sclerotized hypostomium
Diptera (adult)	Wings (venation), compound eyes
Zygoptera (larvae)	Mandible, parts of labium
Trichoptera	Mandible, characteristic pronotum
Corixidae	Elytra
Coleoptera	Mandible, fragments of elytra
Acari	Usually intact
Hymenoptera (adult)	Wings (venation)

The results of the study are shown in Table 2; they are expressed as the percentage of pellets containing each taxon. No attempt was made to sub-divide the data into months or instars (obtainable from head width/wing bud length plots) since the sample sizes (particularly for *A. cyanea)* were too small.

Table 2. The diets of *Aeshna juncea, A. grandis* and *A. cyanea* at Risley Moss.

% of pellets containing each taxon

Taxon	*A. juncea* (n = 21)	*A. grandis* (n = 17)	*A. cyanea* (n = 10)
Diptera (Chironomidae larvae)	57.1	52.9	40.0
Diptera (adult)	9.5	29.4	20.0
Zygoptera (larvae)	52.4	11.8	50.0
Trichoptera (larvae)	28.6	11.8	20.0
Heteroptera (Corixidae)	14.3	29.4	40.0
Coleoptera	14.3	17.6	20.0
Acari	19.0	0.0	20.0
Hymenoptera (adult)	0.0	5.9	0.0
Unidentified	14.3	35.3	10.0

It is clear that chironomid larvae form a very important part of the diet of all three species. In *A. juncea* and *A. grandis*, over 50% of pellets contained chironomid larval remains. Four other taxa were present in more than 10% of the pellets of each species; they were Corixidae, Coleoptera and larval Trichoptera and Zygoptera. Sample sizes are too small to draw firm conclusions about species preferences but it is interesting to note that more than 50% of both *A. juncea* and *A. cyanea* pellets contained zygopteran remains (compared with 11.8% of *A. grandis* pellets). Almost 30% of *A. grandis* pellets contained remains of adult Diptera (mainly chronomids) indicating that surface feeding is common. Indeed, at the same site one of us (DJT) caught larvae of *A. grandis* on two occasions eating females of *Pyrrhosoma nymphula* as they oviposited. It is possible, too, that the unidentified remains that occurred in 35.3% of *A. grandis* pellets belonged, in part to terrestrial organisms since they were not familiar to us. Aeshnid larvae have been recorded feeding on non-aquatic prey. Staddon & Griffiths (1967) commented that *A. juncea* consumed several such prey items. Blois (1985) did not observe that *A. cyanea* fed on terrestrial prey items, though (except for Gastropoda) her data on summer diets of penultimate instars of *A. cyanea* are in remarkably close agreement with the very limited sample available for the present study; Zygoptera larvae were the most important prey items in her study too, forming around 35% of the diet.

From the data available to us the question of whether coexistence of the aeshnid larvae is brought about through differences in diet is largely unresolved, but they do give an insight into the diet of the three species.

Acknowledgements

We thank Ken Watt for permission to sample at Risley Moss and Crawford Young and the rest of the staff for many kindnesses during this and other work on the reserve.

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Ischnura pumilio (Charpentier) in Wales: a preliminary review

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Introduction

Although the 1987 field season marks the end of recording for the BRC British Atlas for Odonata, it is imperative that the status and distribution of Odonata continue to be monitored, particularly for those species whose status is still not well-known, for example, *Ischnura pumilio*. This paper briefly summarises the habitats of *I. pumilio* in Wales in the hope that readers will take a second look at all *Ischnura* species, lest *pumilio* be further overlooked.

Apart from the similarities in colour, part of the problem of distinguishing the two British species of *Ischnura* is the fact that they are on the wing at the same time of year (Fig. 1). However, experience in Ceredigion (Watsonian vice-county 46;

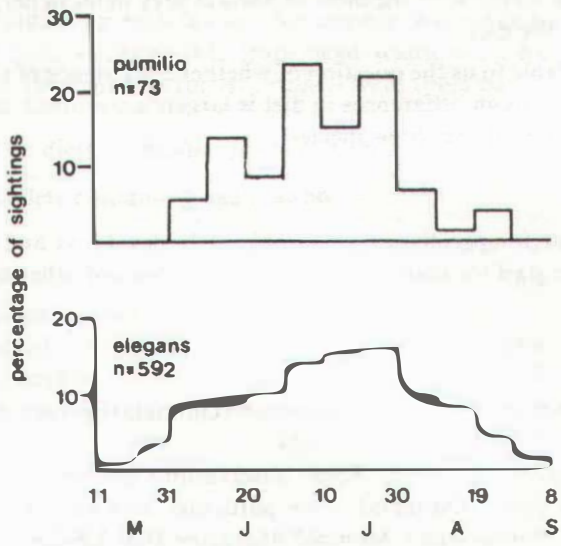

Figure 1. Flight period of *Ischnura pumilio* in Wales (BRC data). The flight period of *I. elegans* is also given from Dyfed, Wales for comparison (Coker & Fox, 1985).

Cardiganshire) suggests that the flight season for *I. pumilio* is confined to the period from the last week of June through to mid-July, with only stragglers surviving to early August. This is somewhat shorter than the BRC records from throughout Wales indicate and is a shorter flight season than *I. elegans* which in Wales is on the wing from mid-May to early September.

In Wales, *I. pumilio* shows a distinct preference for base-rich waters, of a higher pH than most other species, and is conspicuously absent from the acidic *Sphagnum*-dominated habitats which in western Britain form such important habitats for Odonata. The sites from which *I. pumilio* have been recorded can be broadly divided into two categories: those of running water and those of ponded, still water.

Streams

In Pembrokeshire, *I. pumilio* occurs on the base-rich flushes and spring-lines much beloved by *Coenagrion mercuriale*, a species also associated with high pH (Coker & Fox, 1985; Winsland, 1985). Using data from eight such localities, the typical Odonata species associated with *I. pumilio* include *Orthetrum coerulescens*, *Pyrrhosoma nymphula*, *Sympetrum striolatum* and *Cordulegaster boltonii* (Fig. 2).

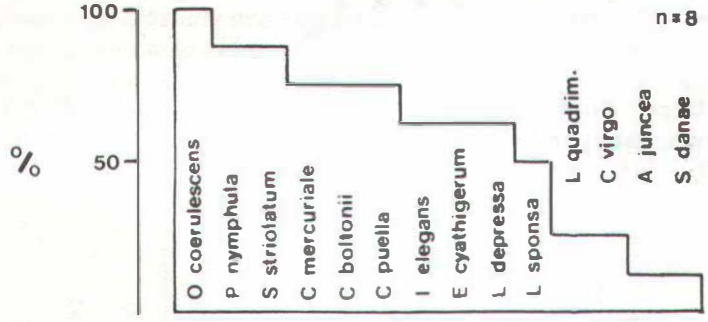

Figure 2. Occurrence of other Odonata species present with *I. pumilio* at stream and flush sites in Pembrokeshire, Wales.

In addition to the Pembrokeshire sites, one Ceredigion record came from a rush (*Juncus* sp.) dominated flush (Miles, 1978) and another was from an upland spring flush runnel in Glamorgan. Intriguingly, both these records were from sites above 360m, which also contrasts with *I. elegans*, which in West Wales is a lowland species (Fig. 3). Such habitats, with little ponded water and dense aquatic vegetation, would not appear favourable for Odonata and it is perhaps no coincidence that at both sites *I.*

pumilio was the only species present. This fact may well contribute to *I. pumilio* being overlooked in upland areas.

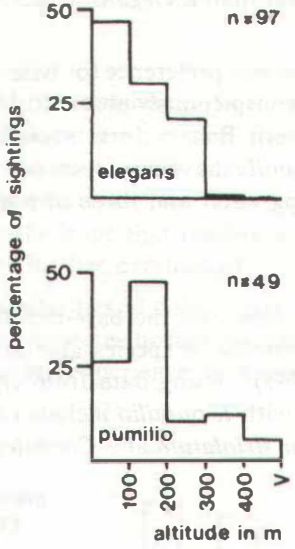

Figure 3. Upper: variation in frequency of *I. elegans* with altitude in Ceredigion, Wales. Lower: variation in frequency of *I. pumilio* with altitude throughout Wales (BRC data).

Ponds

Recent records from West Wales have mostly come from mesotrophic dew ponds and stock pools which are moderately base-rich waters on mineral soils. Several of these sites are recently dug ponds and others suffer disturbance; many are important drinking sites for stock, and the poaching of at least part of the edge of these small waters is a frequent feature of sites supporting *I. pumilio*. Such ponds are typically charactised by emergent soft rush *(Juncus effusus* and *J. conglomeratus)*, sweet flote grass *(Glyceria fluitans)* and lesser spearwort *(Ranunculus flammula)* and have a quite distinct flora from that of more acidic, peaty pools (Fig. 4). The Odonata species present in such ponds are also relatively constant. Whilst the almost ubiquitous *P.*

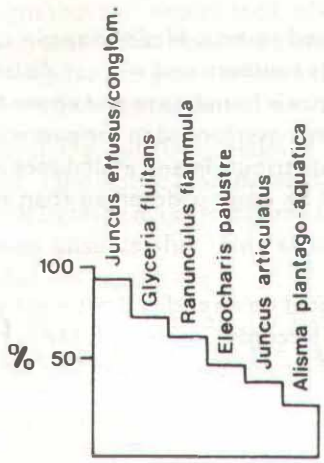

Figure 4. Occurrence of emergent flowering plants from 30 *I. pumilio* sites in Wales.

nymphula, *S. striolatum* and *Enallagma cyathigerum* are generally present, *I. elegans*, *Anax imperator* and *Libellula depressa* are all typical associates of *I. pumilio* in such situations, and species associated with more acidic peaty habitats, such as *Aeshna juncea*, *Libellula quadrimaculata* and *Sympetrum danae* (Fig. 5), are rarely present.

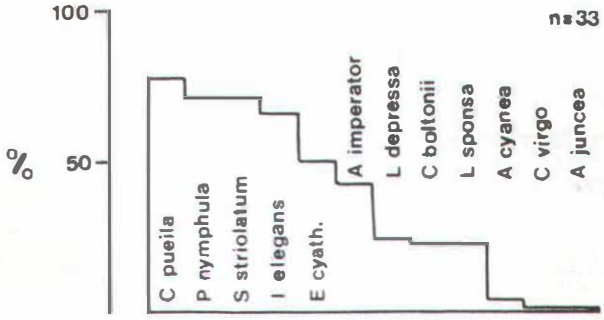

Figure 5. Frequency of other Odonata species present with *I. pumilio* at pond sites in Dyfed, Wales (Coker & Fox, 1985).

Discussion

I. pumilio is generally considered to be a Mediterranean species (Corbet *et al.*, 1960), which is thought to explain its southern and western distribution in Britain. It is thus a little surprising that the species is found up to and above 400m in Wales. Given that this species has undoubtedly been overlooked in the past within the Principality, there is a clear need to establish its distribution and abundance not only in Wales but also in England, where it may well be more widespread than is currently thought.

Acknowledgements

Stephen Coker kindly commented on an earlier draft and I am extremely grateful to Paul Harding and the Biological Records Centre, ITE Monks Wood, for supplying details of all *I. pumilio* records in their possession. Bob Merritt gave inspiration and support as ever.

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A feeding strategy of a Pied Wagtail (*Motacilla alba yarellii* L.) on *Libellula depressa* L.

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On the 14th June 1987 I watched a Pied Wagtail catching and eating adults of *Libellula depressa* at a small pool on the landslips above Ringstead Bay, Dorset, SY762820.

Often, the moment a male *Libellula* seized a female, the pair would momentarily soar in tandem to head height before retiring to a quiet spot for the brief mating. It was

during this initial flight that the wagtail took advantage of their pre-occupation to fly up behind the pair and snatch the female from the male's grasp in mid-air. It then took its victim to a patch of bare ground to remove the wings before consuming the body. Several wings scattered about this "anvil" testified to the success of the strategy.

The fast and low-flying, patrolling males of *Libellula* were watched by the wagtail but generally ignored. I did notice that the wagtail would intervene in their territorial squabbles (the clash of fighting males resembles the equally noisy meeting of the sexes) but this always proved unsuccessful. No examples of a wagtail chasing ovipositing females were recorded.

Pairs of dragonflies in tandem are far less manoeuverable than single adults, making them an easy target. Presumably the wagtail took only females as they are the trailing partner of a pair in tandem. However, an egg-laden female must provide a worthwhile nutritional bonus.

Odonate recovery following a major insecticide pollution of the River Roding, Essex

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Introduction

On April 2nd 1985 approximately 500l of the organophosphate insecticide "Dursban 4E" (active ingredient 480 g/l chlorpyrifos) spilled into a tributary of the River Roding following a road traffic accident on the M11 motorway. Within 48h the chemical had travelled 30km along the river and into the Thames estuary (Fig. 1). Chlorpyrifos is toxic to most freshwater fish and aquatic insects at very low concentrations ($< 10\mu g/l$); indeed, only molluscs, aquatic worms and leeches apparently survived the initial wave of pollution when chlorpyrifos concentrations in the water exceeded $300\,\mu g/l$. In response to this unprecedented pollution, Thames Water, Dow Chemical Company and London Wildlife Trust set up a two year study to assess its ecological impact and monitor recovery of riverine animal-life. The project, funded by Dow, started in November 1985 at the Polytechnic of Central London and part of this study, the recovery of the odonate fauna, is described in this paper.

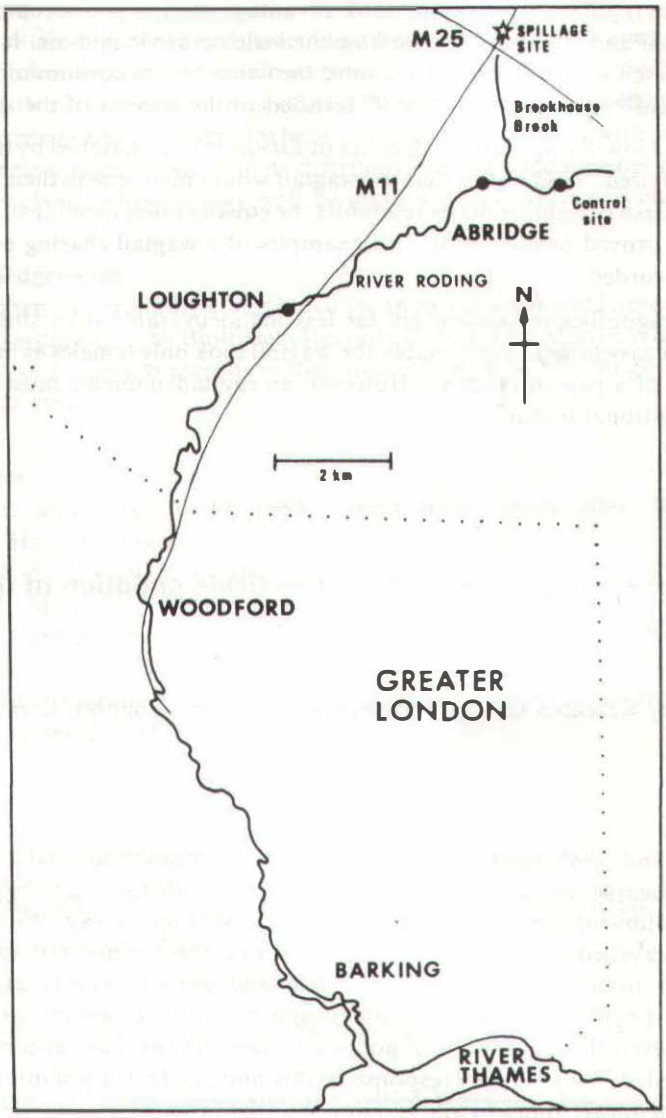

Figure 1. Reaches of the River Roding affected by the chlorpyrifos pollution. Microhabitat sampling sites for larval odonates indicated by •.

The Roding is a small eutrophic clay river which rises near Stansted Airport and flows south through western Essex to join the Thames near Barking (Fig. 1). During dry-weather flow, shallow fast flowing riffles alternate with deep pools and backwaters. The aquatic vegetation in the middle reaches, near Abridge, is dominated by *Sparganium erectum*, *Schoenoplectus lacustris* and *Nuphar lutea* (Raven, 1985). Channel morphology has been extensively modified, particularly in Greater London where extensive realignment and bank reinforcement has occurred. In the lower reaches, water quality is adversely affected by sewage effluent, urban and road runoff.

Chlorpyrifos persistence and toxicity to odonate larvae and their prey

Chlorpyrifos partitions rapidly from water to sediment and is strongly adsorbed by organic particles (Marshall & Roberts, 1978). Consequently, although residue levels in Roding water declined rapidly, the insecticide persisted in river sediment for considerably longer, particularly in the upper 10-15km of affected reaches where initial concentrations were greatest (Fig. 2).

A literature review revealed that chlorpyrifos toxicity data for odonates were very limited. However, 10 µg/l was sufficient to kill 50% of damsel and dragonfly larvae in static water laboratory conditions (Whitney, 1965). In shallow rice-field ponds *Ischnura* larvae were adversely affected by 12 weeks exposure to > 0.9 µg/l and 55 µg/l chlorpyrifos in water and sediment respectively (Nelson & Evans, 1973). Furthermore, many odonate prey items are extremely susceptible to chlorpyrifos (Table 1).

Table 1. The toxicity of chlorpyrifos to some larval odonate prey items.

Prey items		Lethal concentration of chlorpyrifos in water* (ug/1)
Oligochaeta	Aquatic worms	> 1500
Trichoptera	Caddisfly larvae	5-100
Copepoda	Water fleas	1-50
Coleoptera	Water beetles	< 10
Ephemeroptera	Mayfly larvae	< 1
Chironomidae	Midge larvae	< 1

* approximate values determined from laboratory and field experiments (Marshall & Roberts, 1978).

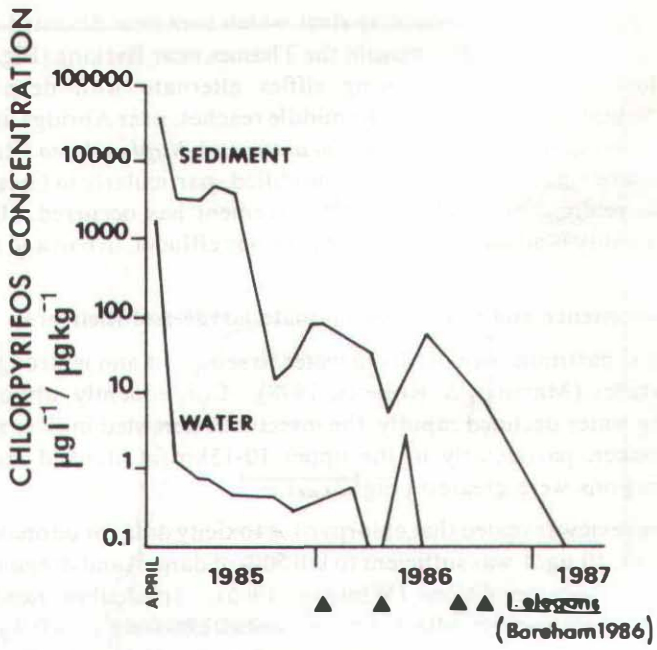

Figure 2. Peak monthly chlorpyrifos residue levels in river water and bottom sediments at Abridge and the occurrence of *I. elegans* in riffle samples.

Odonate recovery: methods and results

Adults

I had censused adult odonates along 3.5 km of river immediately downstream from Abridge (TQ 466969) during 1981-82 as part of a study into the ecological impact of a major flood alleviation scheme. The number of adult odonates observed in each of 8 equal subdivisions of the study stretch was recorded during a minimum of 9 field visits between June and September. At the end of the season the maximum numbers in each section were added together to estimate individual species abundances for the 3.5 km stretch. Unfortunately, no observations were made in 1985 but the same census method was used to re-survey the stretch in 1986. Records from other parts of the river provided useful additional information for comparing species presence-absence before and after the pollution.

All 11 species recorded prior to the chlorpyrifos pollution were present along the affected river in 1986 although only *Ischnura elegans* and *Orthetrum cancellatum* were recorded in the urban section (Table 2). Variations in weather and the timing of field visits undoubtedly influenced the census data near Abridge but comparison of species abundances suggests some subtle changes between 1981-82 and 1986. For example, *I. elegans* was more abundant and *Calopteryx splendens* less abundant in 1986 compared with 1981-82. The status of *Platycnemis pennipes* was similar but *Enallagma cyathigerum* was new to the area in 1986. The 3 dominant anisopterans were again present in 1986 but with *Aeshna grandis* less abundant and *Sympetrum striolatum* more abundant than in 1981-82. The relatively low abundance of *Aeshna mixta* in 1986 was almost certainly due to the lack of late season field visits.

Table 2. Occurrence of adult odonates along the River Roding before and after the chlorpyrifos pollution with special reference to species abundance near Abridge.

	Presence (+) along river downstream from spillage site		Maximum count along 3.5 km of river near Abridge		
			Pre-spillage		Post-spillage
Species	1979-82	1986	1981	1982	1986
Platycnemis pennipes	+	+	25*	(3)*	24
Enallagma cyathigerum	+	+	—	—	19*
Ischnura elegans	+	+	40*	(2)*	159*
Calopteryx splendens	+	+	87*	(1)*	20
Aeshna cyanea	+	+	1	2	1
Aeshna grandis	+	+	35*	27*	19*
Aeshna mixta	+	+	27*	49*	7
Anax imperator	+	+	—	—	4*
Cordulia aenea	+	+	—	—	1
Orthetrum cancellatum	+	+	1	—	—
Sympetrum striolatum	+	+	28*	16*	46*

Figures in parentheses represent relative abundance rank

* egg-laying observed

Larvae

Odonate larvae usually inhabit slack water areas especially where there is vegetation cover so they are rarely recorded in routine riffle macroinvertebrate surveys

carried out by Water Authorities. Therefore, to assess the impact of the chlorpyrifos pollution on aquatic invertebrates which normally occur elsewhere, four microhabitats (silt, tree roots, fringing vegetation and submergent macrophytes) were sampled at an upstream control and two polluted sites during December 1985, July and December 1986 (Fig. 1).

Six odonate species are known to lay eggs in the Roding (Table 2) but only 4 occurred as larvae in the microhabitat samples. Moreover, most larvae were *I. elegans* (Fig. 3). Although *I. elegans* was recorded in a riffle sample at Abridge in January 1986, it was absent from affected microhabitats in December 1985 and July 1986. However, by December 1986 it was widely distributed throughout affected reaches and was more abundant in fringing vegetation and tree roots at Loughton compared with the control site.

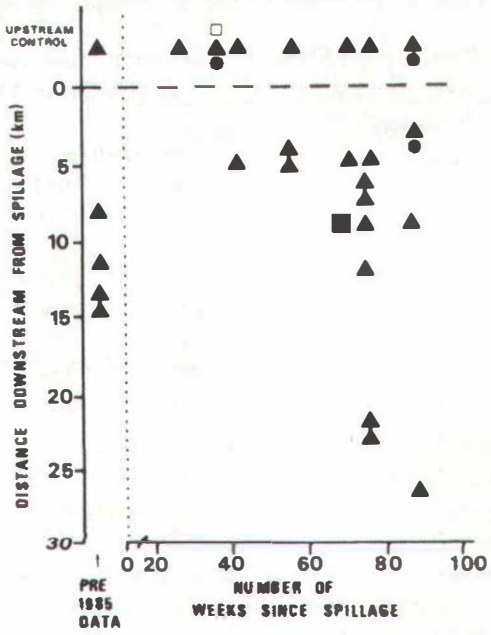

Figure 3. Occurrence of larval *I. elegans* (★)*, *C. splendens* (●), *P. pennipes* (□) and *A. mixta* (■) in affected reaches of the Roding following the chlorpyrifos spillage, compared with an upstream control. Pre-spillage data from Thames Water (unpublished) and Extence (1978);
* includes data from Boreham (1986).

Discussion

There can be no doubt that odonate larvae were eliminated during initial passage of the pollutant when chlorpyrifos concentrations in the water (> 300 µg/l) considerably exceeded the toxic level determined from laboratory and field observations (Whitney, 1965; Nelson & Evans, 1973). Moreover, the absence of larvae from affected reaches during December 1985 suggests that a significant adverse effect lasted throughout that season. This may have been caused by a number of factors including (i) inhibition of egg/larval development by chlorpyrifos residues in the water and/or sediment, (ii) a reduced food supply caused by the absence of prey items such as mayfly and caddisfly larvae and (iii) fewer egg-laying adults during 1985.

By early 1986, however, recolonization of affected reaches by *I. elegans* larvae had started, presumably the result of downstream movement from unaffected reaches (Fig. 3). Despite residue levels > 50 µg/kg in the sediment at this time (Fig. 2), larval survival was not unexpected because chlorpyrifos in the water column had been below the apparently critical level of 0.9 µg/l for some considerable time beforehand. Nelson & Evans (1973) reported that survival of *I. elegans* larvae was only affected if chlorpyrifos concentration in the water exceeded 0.9 µg/l even if the residue level in sediment was 74 µg kg. Consequently, the 2.3 µg/l level in water recorded during May 1986 might have had a temporary adverse effect on larvae near Abridge (Fig. 2).

The December 1986 microhabitat data suggest successful larval development of *I. elegans* in affected reaches. Suitable prey items were available since micro-crustaceans (e.g. copepods) were abundant during the 1986 summer and recovery by chironomid, mayfly and caseless caddisfly larvae was well advanced by August. Much reduced predation prior to the full fish restocking completed in March 1987 may have contributed to the greater abundance of *I. elegans* larvae at Loughton compared with the control site. However, larval development for some other odonates (e.g. *A. grandis)* takes 2 years or more; consequently, complete recovery (i.e. to a larval population comprising all age classes) by these species will take longer than for annual species such as *I. elegans*.

The return of all 11 previously recorded adult odonates during 1986 was encouraging, particularly *P. pennipes* which is considered sensitive to pollution (Corbet *et al.*, 1960). It is not clear if any changes in the relative abundance of odonates near Abridge between 1981-82 and 1986 were the direct result of the chlorpyrifos pollution but the increased abundance of *I. elegans* may reflect its apparent tolerance of polluted waters where it is often the sole odonate representative (Hammond, 1983). Assuming that larval development and emergence was severely limited in the affected reaches during 1985, the diversity and abundance of adult

species recorded in 1986 indicates substantial immigration and emphasizes the efficient and rapid recolonization by odonates when suitable unpolluted waters are available nearby. In this instance immigrants could have arrived from upstream reaches, gravel-pit lakes and the numerous small ponds found in the catchment.

Summary

Odonate larvae inhabiting a small Essex river were eliminated by a major insecticide pollution in April 1985 but recovery by *Ischnura elegans* was well advanced by December 1986. All 11 adult odonate species including *Platycnemis pennipes* recorded prior to the pollution had returned to affected reaches by the 1986 summer.

Acknowledgements

I would like to thank Thames Water and Dow Chemical Company for allowing me to use unpublished data on macroinvertebrates and chlorpyrifos residues respectively.

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Longfield, C. 1949. The dragonflies of the London area. *The London Naturalist* 28: 90-98.

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