

# Fens of Oxfordshire: their importance for invertebrates

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Originally published December 2002

Published online November 2023

## Summary

An invertebrate survey of the Oxfordshire fens revealed the unexpected. The number and quality of sites has led to a re-evaluation of the national significance of these small wetlands. One group of insects in particular, the soldierflies, reveals fascinating links to the fens of East Anglia and North Wales.

## Background

The link between Oxford based entomologists and Cothill Fen goes back many decades. The collecting visits by staff and students of the Hope Department of Entomology have left a rich legacy of rare species records. Many early records refer to sites around Oxford City that have long been built on or surrounded by houses and generally degraded, but Cothill Fen has always remained a favourite haunt of entomologists. The most famous link with Cothill is the pioneering genetic work on the Cothill population of scarlet tiger moths (*Callimorpha dominula*) of E.B. Ford and Bernard Kettlewell (Ford 1964). This species was chosen because of its distinctive colour forms and an assumption that the Cothill population was a closed one and could be used to explore the concept of genetic drift. Only when an enterprising young entomologist, Phillip Sheppard, joined the Air Cadets and took to the air was this assumption challenged. From an aircraft, Sheppard noticed the similarity between Parsonage Moor on Cothill and the nearby site called Barrow Farm Fen (Sheepstead Hurst) and he subsequently found the scarlet tiger on this new site. We now know that the scarlet tiger occurs nearby in a series of pockets along the north side of Wytham to Boars Hill and elsewhere in the Vale of the White Horse. Nevertheless, the genetic work on the scarlet tiger remains as a classic study and continues to be researched by new generations of population geneticists.

By 1980 the Oxfordshire fens were rarely visited by entomologists, save for a few local taxonomists who knew the secret value of these wetlands. In 1983, the Nature Conservancy Council (NCC) undertook a botanical survey of fens in Oxfordshire as part of the on-going review of Sites of Special Scientific Interest (Martin *et al.*, 1983). This survey revealed that Oxfordshire has the largest concentration of species-rich fens in southern England with 19 sites and an estimated 27 ha in total. The area of vegetation on peat, often colloquially called 'fen' is greater, but includes vegetation types widespread across the UK. The fen survey concentrated on the rarer fen communities associated with calcium-rich spring-heads. This survey work resulted in a new suite of sites being designated as Sites of Special Scientific Interest (figure 1). With the development of the National Vegetation Classification (Rodwell, 1991) the Oxfordshire fens were re-surveyed in 1990 to look at the detail of vegetation types (Fojt, 1991). This survey reinforced the importance of the Oxfordshire fens and identified the importance of one particular vegetation type; the black bog rush - blunt rush community, coded M13 (*Schoenus - Juncus subnodulosus*). This is a particularly

rich species-community with many attractive plants such as grass-of-Parnassus (*Parnassia palustris*), marsh helleborine (*Epipactis palustris*), and bog pimpernel (*Anagallis tenella*).



**Figure 1. The locations of Oxfordshire fen sites that have been designated as Sites of Special Scientific Interest.**

## Unworked ground

Following the designation of a suite of fen sites the Nature Conservancy Council began to look at the management needs of these sites. The first step was to look at the range of plants and animals for which these sites are 'special'. Whilst there was good botanical information on the fen sites, virtually nothing was known about the invertebrates. Most of the existing information was decades old, and given the loss of quality in sites, needed confirmation. Between 1987 and 1992 a programme of sampling invertebrates was undertaken using a range of techniques and involving many entomologists. The main sampling method was a trap known as a Malaise trap (figure 2). These large, tent-like traps use the behavioural trait, so well known to campers, of insects moving up towards the lighter roof of the tent. These traps can operate unattended for two-week periods, with insects collecting in a bottle filled with

preservative chemicals. Pitfall traps, water traps and hand collecting supplemented the sampling by Malaise traps. A network of entomologists all over Britain was engaged in the onerous task of sorting of these samples and identification to reveal a staggeringly rich fauna.



**Figure 2. A Malaise trap in use on Frilford Fen**

The invertebrate communities of these fens are important for the high proportion of rare species, rare because they are wetland specialists and their habitat is rare. Across all samples from the Oxfordshire fens the flies (Diptera) alone included 42 Red Data Book species and 115 species of Nationally Scarce status (found in less than 100 ten kilometre squares in Britain). Cothill exemplified the richer end of the series with 26 species of RDB status and 72 Nationally Scarce species of flies. This concentration of rare and vulnerable species underpins the special value of these species-rich fens. An equivalent sampling effort in other habitats will not produce as high a proportion of rare species.

## **Fens from an insect's perspective**

The valley-head fens typical of Oxfordshire are by their very nature restricted in size. They occur 'downstream' of springs that maintain a steady flow of water throughout the year and are characterised by sub-surface flows of water that create the right conditions for peat formation. A key characteristic of the ground water in these systems is that it is extremely rich in calcium and emerges at the surface as cold, pressurised springs. Through a natural process described elsewhere in this volume the phosphate in the spring waters is adsorbed onto the calcium carbonate or tufa. As a consequence of this process the waters that feed the fen are deficient in phosphate and thus produce a sparse, specialised vegetation. Only when the waters are modified by artificial nutrients from outside the site, or through natural eutrophication, do nettles and other luxuriant herbs flourish.

These small, boggy fens have often escaped the agricultural improvements that have destroyed so much of our wildlife heritage as attempts to drain them are doomed to failure because of the constant source of spring water. They exist in a variety of forms; a few are still open due to access to grazing stock, but most are best described

as wet woodland. The main invertebrate habitats occurring on the Oxfordshire fens are:

### **Fen Meadow/short fen**

This is typified by the short swards of Parsonage Moor with mixtures of black bog rush - blunt rush mire and the blunt rush - marsh thistle and purple moor grass - meadow thistle fen meadows. These areas are important as both nectar sources for insects and as habitat for many herbivorous species such as leaf beetles, sawflies and moths.

### **Reed Swamp**

These are the areas dominated by common reed (*Phragmites australis*) with hemp agrimony (*Eupatorium cannabinum*) or nettles (*Urtica dioica*) on the more disturbed, richer soils. Reed beds have a specific suite of invertebrates including moths, flies whose larvae bore into reed stems and specialised beetles of the deep litter layer.

### **Tall Fen**

This is tall vegetation dominated by meadowsweet (*Filipendula ulmaria*) and other tall herbs, often on the drier soils. These are the refuge for many flies and bugs, with large flower heads of umbellifers providing nectar for adult insects and herbage as food for many others.

### **Carr/wet woodland**

A product of succession, many areas of fen have a closed canopy of alder (*Alnus glutinosa*), willow (*Salix* spp.), birch (*Betula pendula*) and hazel (*Corylus avellana*). These dark, wet woods are rich in deadwood and abound in fungi and bryophytes. This is good habitat for a range of fly groups including crane flies, fungus gnats and hoverflies.

### **Sedge Beds**

This is where sedges dominate, for example the impressive tussocks of tussock sedge (*Carex paniculata*) and the treacherous floating mats of bottle sedge (*Carex rostrata*). Sedges have their own insect associates, especially living in the deep litter of dead vegetation.

### **Open water**

This can take the form of ponds, such as the one at Cothill, or small pools and runnels resulting where the lateral water-flows come to the surface. The shallow pools are where the semi-aquatic larvae of the rarest flies live. The open waters of Cothill and Dry Sandford Pit are regionally important for their diverse damselfly community.

### **A rich variety of insects**

Fens have a wide range of insect groups associated with them. Some are not necessarily fen specialists, but are simply there because of the semi-natural vegetation. The lepidoptera are amongst the most obvious insects with the comma butterfly (*Polyommatus c-album*), a common resident where nettles make strong growth in spring. Many moths, such as the obscure wainscot (*Mythimna obsoleta*), scarce burnished brass (*Diachrysis chryson*) and pinion-streaked snout (*Schrankia costaestrigalis*) are fen specialists whilst others are associated with wet woodland or open fen. A spectacular resident of Cothill is the emperor moth (*Pavonia pavonia*),

with its colourful larvae feeding on meadowsweet (*Filipendula ulmaria*), tormentil (*Potentilla erecta*) or bramble (*Rubus agg.*).

Bare peat in the fens is home to two elusive relatives of the grasshoppers, the common ground hopper (*Tetrix undulata*), and its rarer relative the slender ground hopper (*Tetrix subulata*). Both are easily found, with a little patience, on peaty patches on tracks and beside pools.

A wide variety of dragonflies and damselflies thrive wherever sufficient water collects to form a small pool. These include the national rarities of southern damselfly (*Coenagrion mercuriale*), the variable damselfly (*Coenagrion pulchellum*) and the small red damselfly (*Ceriagrion tenellum*). The southern damselfly is a priority species in the Biodiversity Action Plan and listed in the European Habitats Directive whilst the small red damselfly is a Nationally Scarce species. In addition the fens are regularly patrolled by a range of large dragonflies including the Emperor dragonfly (*Anax imperator*) and the keeled skimmer (*Orthetrum coerulescens*). Open water and margins are also home to a range of local beetles, like the water beetles (*Graptodytes granularis*, *Gyrinus suffriani*, and *Helophorus griseus*). Other wetland invertebrates include the water spider (*Argyroneta aquatica*) and the famous 'Newbury snail' (*Vertigo moulinsiana*).

Away from water the fen plants provide food for a large number of beetles, some with intriguing names such as the small buprestid beetle (*Trachys troglodytes*) that feeds on leaves of devil's-bit scabious (*Succisa pratensis*) and the longhorn beetles, *Anaglyptus mysticus* whose larvae feed in deadwood and *Agapanthia villosoviridescens* whose larvae feed in the stems of hogweed (*Heracleum sphondylium*) or thistle (*Cirsium spp.*).

Amongst the bees, wasps and ants the most common groups on fens are the parasitic ichneumon wasps and sawflies. The tall fen is home to an uncommon elongate sawfly called *Hartigia xanthostoma*, whose larvae feed in stems of meadowsweet, and the deadwood feeding sawfly (*Xiphridia camelus*) which was found on a deadwood pile of alder logs cleared from the open fen.

Flies are the most abundant group of insects on the Oxfordshire fens. Even a short foray onto any fen in June will remind the visitor of this fact. Many people reasonably associate fens with mosquitoes, and rightly so with their aggressive attacks deterring many from venturing too far into the fen. The more glamorous biting flies include the clegs, deer flies and horse flies. The Oxfordshire fens have a good range of species from the silent, common cleg (*Haematopota pluvialis*) to the buzzing deer fly (*Chrysops caecutiens*) and its rarer relative *Chrysops viduatus* and the large horse flies such as *Hybomitra bimaculata*. All horse flies have beautifully coloured eyes, each genus with a different pattern and range of colours. These bands of colour disappear once the fly is dead and are worth a closer look before swatting!

A general characteristic of flies is that their larvae are adapted to live in semi-liquid environments, thus the moist decay of a fen and the abundance of wet substrates make this habitat ideal fly country. The families of small black obscure fly are epitomised by the fungus gnats. Their larvae use fungi in various states of decay as food and the wet carr areas of the Oxfordshire fens are ideal habitat; the sampling programme of 1987 - 1992 produced a total of 212 species. Similar lovers of wet places are the dance flies, *Empididae*, and the dolichopodid flies. Again the Oxfordshire fens have produced long lists of species. These flies occur in large numbers and persuading

experts to wade through gallons of fly soup and identify the samples was difficult. In one case the expert received a whole cardboard box full of dolichopodid flies but was driven through the whole mountain of flies after finding the first male specimen of *Rhamphomyia plumipes* seen in Britain!

The hoverflies are a diverse group, with over 260 species in Britain. On the Oxfordshire fens the sampling programme found over 110 species including a number of rare and localised species. The most characteristic species of the tall and short fen is *Tropidia scita*, an attractive hoverfly with bowed hind legs. The wetland group of hoverflies include *Orthonevra brevicornis*, *Sericomyia silentis* and *Cheilosia chrysocoma*. Cothill has a 1953 record for a nationally rare hoverfly, *Chalcosyrphus eunotus* but this remains to be re-discovered on the Oxfordshire fens. Unconfirmed records like this provide a stimulus for future generations of entomologists.

## Soldierflies

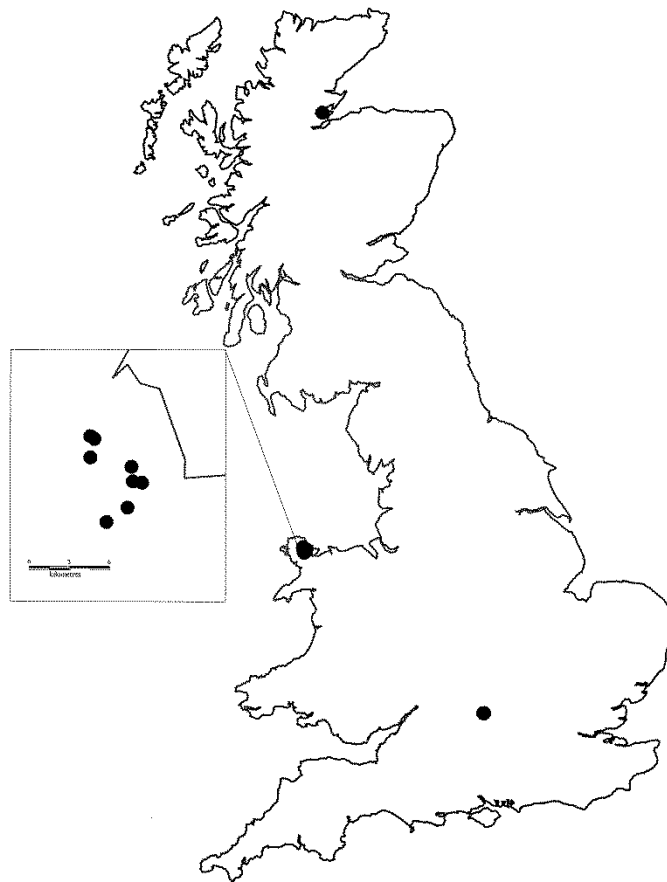
The soldierflies belong to a family called the *Stratiomyidae* and include many species restricted to fens. This group is fully described in an excellent guide to the 'British soldierflies and their Allies' (Stubbs and Drake, 2001). The name 'soldierflies' refers to their bright colour patterns that are reminiscent of the colourful uniforms worn by soldiers up to the start of the 20<sup>th</sup> Century. This group is well represented on the Oxfordshire fens with a total of 32 species recorded in the survey. Given that we have 47 named species in Britain, 68% of the British list were found in the Oxfordshire fens survey. When the number of British Stratiomyids is filtered to remove species that are coastal, or otherwise would not occur on the Oxfordshire fens, this brings the proportion of the British list to around 92%. Only one historic record, for *Odontomyia argentata*, has yet to be rediscovered on the Oxfordshire fens. Of the 32 species found in the fen survey, four are listed in the Red Data Book and a further ten are listed as 'Nationally Scarce'. This reflects the restricted distribution of this group and their association with a specialised habitat. A further characteristic is their association with calcareous fens and especially with the existence of tufa deposits within the springheads.

The fen soldierflies can be considered in two groupings: those whose larvae live in the cool springheads amongst tufa-encrusted moss, and those whose larvae live in open rills and shallow pools within the fen. The larvae are often the easiest life stage to find as many of the adult flies spend much of their life in the canopy of tall shrubs and trees. Springs are dependent upon groundwater, and in times of low rainfall their flow is reduced, or may even stop. The aquatic soldierfly larvae are adapted to such conditions by having a remarkable resistance to desiccation. In one instance, moss and mud that unknowingly contained tiny soldierfly larvae was put into a net covered aquarium that subsequently dried out, was re-wet in the autumn rains and frozen solid in the winter. In the following spring, healthy larvae were seen wriggling in the water and went on to produce several adult *Stratiomys* over the following two years. Recent work (in Stubbs & Drake, 2001) suggests that these larvae can take as long as five years to reach maturity, no doubt influenced by the disruption of their habitat by seasonal changes in wetness.

The genus *Oxycera* typifies the moss-dwelling group and eight species of *Oxycera* occur on the Oxfordshire fens. One species, the hill soldier (*O. pardalina*) was common at all springheads where tufa deposition occurred and was found in some unexpected places along the spring-line where small seepages were known to exist within woodland. This association between flies and habitat works in both directions.

The discovery of a specimen of the dark-winged soldier (*Oxycera anali*), during a hoverfly identification workshop at Little Wittenham led to the discovery of tufa-rich seepage areas that have subsequently proved to hold a rich fauna of soldierflies in these small spring fens (Steve Gregory, pers. comm.)!

The aquatic group of fen specialist soldierflies are also associated with tufa, but often in the form of tufa-rich mud and silt of shallow pools within the short fen-meadow vegetation. Cothill and Dry Sandford Pit are two of only seven current localities in Britain for the spectacular clubbed general (*Stratiomys chamaeleon*). This large black and yellow soldierfly has an unusual current distribution with the main British populations on Anglesey in Wales and in one site in eastern Scotland. This is essentially an Atlantic/western distribution with the Oxfordshire fens on the eastern margin (figure 3). A common, and more widespread, related species on the Oxfordshire fens is the banded general, (*Stratiomys potamida*) whose larvae share the same habitat with *S. chamaeleon* but whose adults are on the wing earlier.



**Figure 3. The current distribution of the clubbed general soldierfly (*Stratiomys chamaeleon*) with inset of concentration of sites in Anglesey (data supplied by Mike Howe and author).**

The most intriguing species from Cothill Fen is the orange-horned green colonel (*Odontomyia angulata*) whose abdomen has beautiful apple-green bands on a black background. This remains a very rare species with only four current British localities, the other three being in Norfolk (figure 4). This distribution is best

described as continental and thus the opposite of *Stratiomys chamaeleon*. Until the fen survey the last record for Cothill was 1934 and its re-discovery owes much to a thunderstorm when a single female adult was seen whilst the entomologist sought shelter under an umbrella! Once confirmed on the site a search produced many larvae that ultimately grew into adult flies of *O. angulata*. The larvae live in pools and runnels flowing from the springheads and typically their habitat contains the tufa-rich stonewort plants (*Chara* spp).



**Figure 4. The current distribution of the orange-horned green colonel soldierfly (*Odontomyia angulata*) (data supplied by Mike Howe and author).**

The occurrence of these two rare soldierflies suggests that the Oxfordshire series of fens holds a truly unique mixture of western and eastern faunas. This pattern of distribution may reflect historical extinctions, as the limited historical records for these two species extend as far as the Somerset levels, Kent and Cheshire (Stubbs & Drake, 2001). This western and eastern pattern is mirrored by another rarity on Cothill, Pugsley's or narrow-leaved marsh orchid (*Dactylorhiza traunsteineri*). This



species is likewise associated with these calcareous fens and its current distribution includes the Norfolk, Oxfordshire and Anglesey fens, as well as a scatter in eastern Scotland and the North Yorks Moors. The match between orchid and soldierfly distributions poses some interesting questions and the orchid localities may guide us to as yet unknown locations for these two species of fly.

## Overall Impressions

Cothill Fen has long been known as an important site for both plants and invertebrates, yet until the NCC fen survey of 1983 and the work reported here, the value of other fens in Oxfordshire was not appreciated. The botanical work focused on vegetation types and key plant species and thus produced an overview of the best classic botanical fens. The sites derived from botanical survey formed the basis of the invertebrate survey and indeed were found to have a rich fen invertebrate fauna. The difference between the botanical and invertebrate survey is one of focus. Invertebrates draw attention to the small-scale elements of habitat and this was especially true of the fens. The sites with greatest variety of habitats had the richest invertebrate fauna. This is a common outcome of any invertebrate survey and reflects the fact that invertebrates often live in micro-habitats within a broader habitat, thus the greater the diversity of habitat the greater the number of different niches for species to occupy. The key conclusion from the Oxfordshire fen invertebrate survey was that the early successional series of habitats, from open water to short fen, were of greatest importance. These early successional habitats held a disproportionately large number of nationally rare or scarce species as compared to carr, reed beds and later successional habitats. The reedbeds, sedge beds, tall fen and carr all held a wide range of species, but were comparable with sites elsewhere in the UK. The specialised habitats associated with the tufa-rich spring fens are by their very nature small in extent and very restricted in distribution. This is where the primary interest of the Oxfordshire suite of fens lies.

In the botanical survey the springhead fens were largely ignored because of their small size and lack of extensive areas of fen vegetation. Good examples of these springhead fens occur in Wychwood Forest and along the valley sides of the Oxford Heights west of Oxford. They are typically very small, often less than a few square metres, with either an open flowing spring and tufa deposits, or a mound of tufa covered twigs and debris. Traps placed adjacent to these sites produced records of all the key soldierflies and many other groups. The tufa encrusted mosses and muds were clearly supporting good populations of key species such as *Oxycera pardalina*, *O. analis* and *O. terminata*. The presence of tufa is the link between these flies and the fens. In other situations where the spring waters are held in small valleys they create a larger area of fen and become recognisable as valley-head fens. Good examples include Wytham Flushes, Taynton Quarries and Lye Valley SSSIs where springs create hanging and valley bottom fens.

The extreme example of the invertebrate fen occurs at Dry Sandford Pit, SSSI and Local Wildlife Trust reserve. This was a working sand quarry as recently as the late 1950s - early 1960s and has developed tufa-rich mud where springs emerge in the quarry floor. This is really a primeval fen that in the coming centuries will begin to deposit peat and ultimately will resemble nearby Cothill. The nearest equivalent to Dry Sandford would have been the landscape emerging from the last ice age where ecological succession was literally starting from bare ground. At present the fen elements are represented by a few typical species such as swathes of marsh

helleborine and a number of fen fly species. To the botanist the vegetation on Dry Sandford Pit defies classification.

As described elsewhere in this volume, the fens of Oxfordshire depend upon particular hydrological conditions. This influences the water quality and subsequently the vegetation. A characteristic part of these fens is a constant supply of mineral rich, but phosphate-deficient spring waters and the deposition of tufa at the springhead. Each spring can be located by following the evidence of white tufa-coated twigs or leaves up through the water runnels. Where flows are intermittent, or of long standing, this tufaceous material can form deep deposits that may eventually reduce the flows by creating a hard cap of material that holds back the spring. This is believed to be a feature of Spartum Fen where groundwater is held back by a hard tufa-plug. In level sites the tufa deposition can be found as gritty white particles within peat or as hard, crust on bryophytes or on the surface of Charophytes. The intriguing link is between this tufaceous character and the soldierflies that appear to select habitats that contain this material. This association has enabled several new localities to be found for these rare flies.

Overall, the richness of the Oxfordshire fen suite reflects the diversity of vegetation and structure across these sites. Whilst each site differs in the mix and extent of habitat types, all have the common thread of geology and hydrology. The nationally important invertebrate interest centres on the early successional habitats that lie between open water at the springheads and short fen. These contain the vast majority of the nationally threatened and scarce species. These habitat types are fairly stable provided the water supply is secure, but rapidly change to reedbed, carr and ultimately woodland if this balance is disrupted. Hydrology of springs mean that these habitats are always small, scattered and therefore vulnerable. Hopefully a comprehensive understanding of the importance of Oxfordshire fens and what makes them tick will enable this unique resource to be maintained for future generations.

## Acknowledgements

This work would have been impossible without the help from a large number of entomologists. Special thanks go to the energetic group of Oxfordshire entomologists who enthusiastically contributed time and expertise to this survey and to Debbie Russell for help with maps, Mike Howe for up to date views on distribution and John Campbell for access to the Record Centre data for Cothill. I also record my thanks to the anonymous referees who corrected my rusty entomological memories!

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