

THE FIRST REPORTED OCCURRENCE OF THE MAYFLY PARASITE *SPIRINELLA ADIPOPHILA* (SPOROZOA) IN A BRITISH RIVER

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Introduction

Spirinella adipophila is a microscopically small protozoan (less than 100 microns diameter) placed in a group of obligate parasites that are classed as Sporozoa - a group which includes the malarial parasites. *S. adipophila* was first described by Arvy & Delage (1966) as a vermiform organism contained in an oval chamber situated at the extreme end of a long flat ribbon, which is coiled in about ten turns. It communicates with the exterior by means of a small canal situated near the outer end of the ribbon. This flattened ribbon, or spiral, is formed by the secretion of protein into an envelope, producing the characteristic coiled shape which at present is the only stage known of this parasite (Fig. 1). It was originally found in the larvae (nymphs) of *Ephemera vulgata* and is carried through successive larval stages into the adults of certain mayflies. It is believed that the parasite is passed on to the next generation of its host by invading the latter's eggs before they are laid (Delvaux 1975).

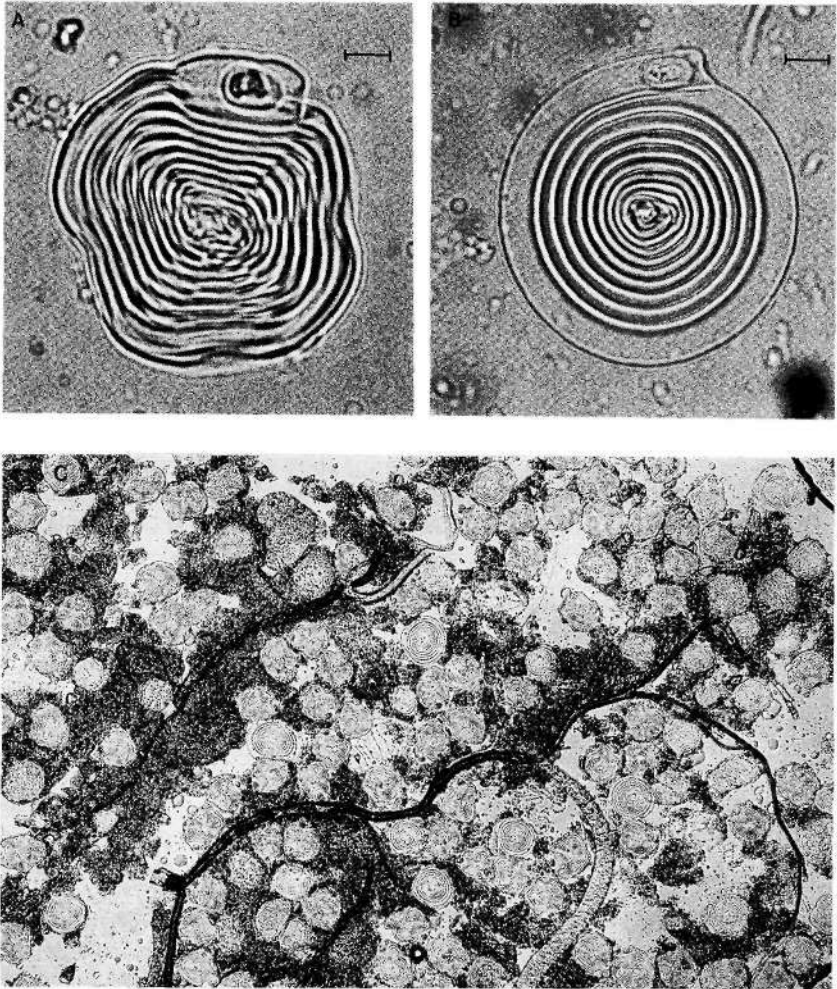


FIG. 1. The sporozoan parasite *Spirinella adipophila*, photographed by light microscopy at x 400 magnification (A and B) and x 100 magnification (C). A and B (above) show different forms of the coiled ribbon-like body (bars indicate 10 microns), and C (below) shows a massive infection in body tissues of *Ephemera danica* larvae from the River Wey in Surrey.

Hosts and distribution

The main hosts of *Spirinella* are mayflies: *Ephemera vulgata* L. (Arvy &

Delage 1966, 1973; Soldan 1980), *Ephemera lineata* Eaton (Soldan 1980) and *Ephemera clauca* Miiller (Delvaux 1975; Arvy & Sowa 1976). It has also been recorded in two other unrelated species, *Ephemerella ignita* Poda (Delvaux 1975, and this article) and *Heptagenia lateralis* Curtis (this article).

Spirinella was first reported from the Eyzies region of France (Arvy & Delage 1966) and has subsequently been recorded in Poland (Arvy & Sowa 1976), Luxembourg (Delvaux 1975), Czechoslovakia (Soldan 1980) and now in the United Kingdom.

Effects of *Spirinella* on the host

Infections of *Spirinella* are mostly restricted to the parietal and visceral fat-bodies of mayfly larvae (Soldan 1980) but it is not known what effect this may have on the host. No histopathological effects on infected tissues, or mortality of infected larvae have, as yet, been observed (Soldan 1980) but large infestations totally destroy the adipose tissue of the mayfly (Arvy 1979). Delvaux (1975) has shown that the presence of *Spirinella* in the ovaries of *£ danica* leads to a delay in the development of the eggs after laying, the subsequent larval period is extended to two or even three years (although this is not unusual in other populations of this species; see Elliott et al. 1988), and the larvae produce smaller adult mayflies.

Occurrence of *Spirinella* in the River Wey

During a 2-year survey on the distribution and ecology of mayflies in the upper reaches of the River Wey (a tributary of the River Thames) in Surrey, *Spirinella* was found in large numbers in the larvae of *£ danica*, and in low numbers in larvae of *£ ignita* and *H. lateralis*. The parasite was initially detected in February 1993 and subsequent samples, taken at three sites above and below the confluence of the north and south branches of the Wey (see Fig. 4), indicated that the infection was increasing, especially in the north branch where numbers in excess of 5000 *Spirinella* were recorded in some larvae.

It was also possible to look back to October 1991, using monthly samples previously taken at the three sites and preserved, although the numbers of *£ danica* available in some of these samples were limited to between five and ten larvae (Fig. 2). Infection was present throughout the *£ danica* populations at all three sites and, initially, somewhat higher numbers of the parasite were found in medium-sized larvae (length 8-15 mm) but during the latter part of 1993 infection became greater in the largest nymphs (length 15-30 mm) (Fig. 3a).

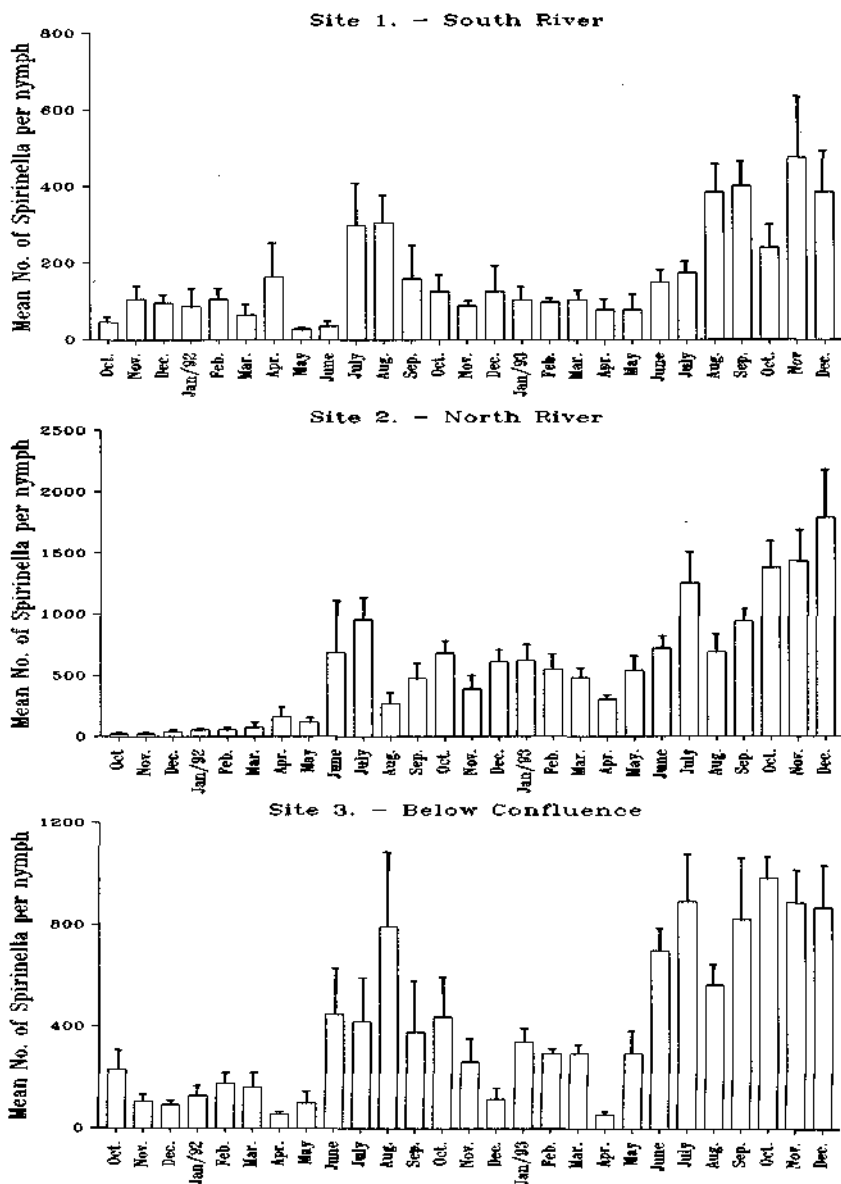


FIG. 2. Numbers per host (means, and standard errors (vertical bars) for 5-10 mayfly larvae) of *Spirinella adipophila* in *Ephemera danica* at three study-sites on the River Wey (see Fig. 4), for the period October 1991 to December 1993.

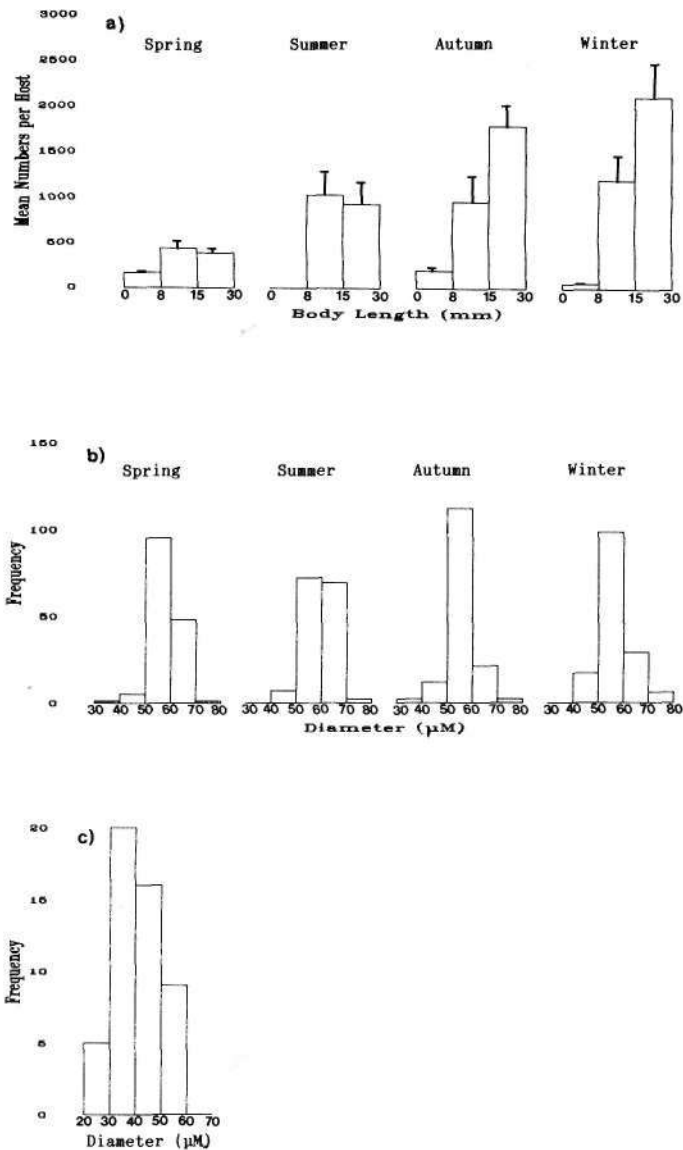


FIG. 3. Seasonal changes in the numbers and size of *Spirinella adidophila* in the River Wey during 1993. (a), Mean numbers (and standard errors, vertical bars) occurring in three size-classes (body length) of *Ephemera danica* larvae. (b), The frequency of various size-classes (diameter, in microns) of *Spirinella* in *E. danica*. (c), The frequency of various size-classes (diameter, in microns) of *Spirinella* in *Ephemera ignita* during the larval period April to August.

The overall size (diameter) of *Spirinella* found in *E. clauca* ranged from 30 to 80 microns, with a depth of 24 microns (Fig. 3b), whilst those in *E. ignita* and *H. lateralis* were somewhat smaller, ranging between 20 and 60 microns (Fig. 3c). The low numbers (4-5 per larva) and smaller size of *Spirinella* found in these two species is probably due to their much shorter larval stages and was only found in mature *E. ignita* larvae during July and August.

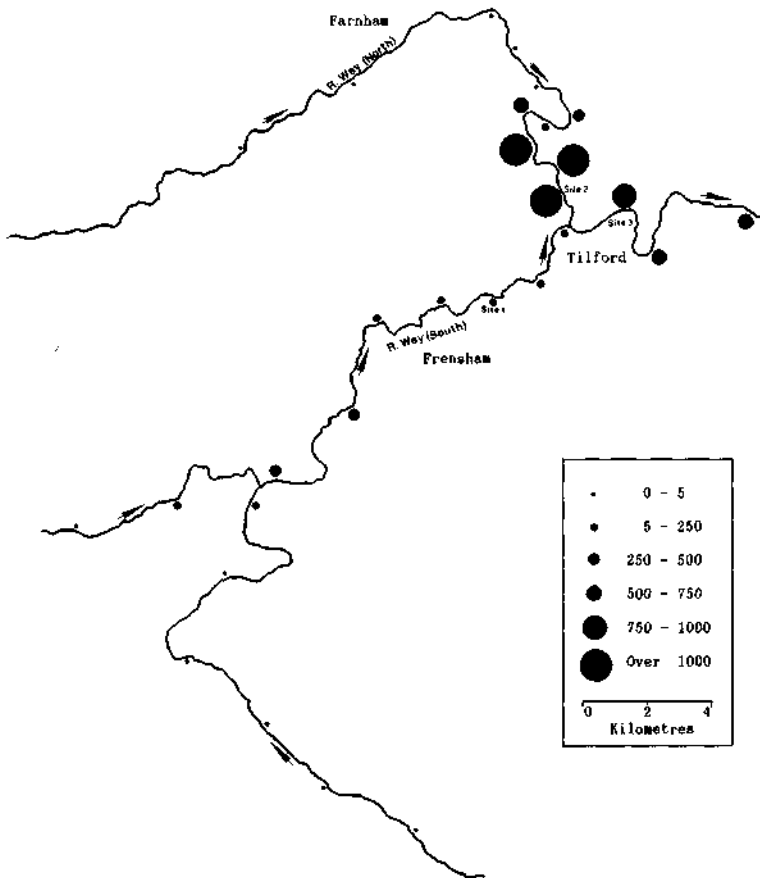


FIG. 4. The distribution of *Spirinella adipophila* (mean numbers per larva, based on 10-15 larvae) found in *Ephemera danica* in the upper reaches of the River Weir during July 1993. Study-sites 1-3 are indicated (see the text).

Fig. 4 shows the distribution of *Spirinella* in the River Wey during July 1993. In the lower part of the river, levels of infection by the parasite (numbers per mayfly larva) generally increased upstream, and *Spirinella* was more numerous in the north branch of the river. Further upstream the levels of infection rapidly declined and only small numbers were found in the higher reaches of both branches of the river.

Occurrence of *Spirinella* in other tributaries of the River Thames

Samples of *E. danica* taken from seven other tributaries of the Thames showed that *Spirinella* is present in most of them and often in high numbers (Table 1). Two sites were sampled on each river. This cannot give an accurate picture, due to the often patchy distribution of the parasite, but it does give an indication of how widely distributed it is in the Thames region. In the River Kennet, fairly high numbers in the lower reaches were contrasted by very low numbers in the upper reaches whilst the reverse was the case in the River Windrush. The numbers of *E. danica* larvae in the River Colnbrook were somewhat limited, which may explain the absence of *Spirinella* in this river, but a numerous population of *E. danica* in the River Chess was almost devoid of *Spirinella*.

Table 1. Infection by *Spirinella adipophila* on its host *E. danica* in seven tributaries of the River Thames, England. Samples were taken during September and October 1993, from two sites on each river.

River	Numbers of larvae examined	Numbers of larvae infected	Numbers of parasites per host
Windrush	15	9	0-1405
Loddon	20	20	1-733
Colne	10	10	15-146
Kennet	20	12	0-707
Pang	20	20	225-1513
Chess	20	2	0-3
Colnbrook	10	0	—

Conclusions

The life cycle of *Spirinella* and its method of transmission has yet to be established and it remains unclear as to what (if any) long-term effects it may have on *E. danica* populations. Clearly it is widely distributed throughout the Thames region but does it occur in other river systems in the British Isles? It is hoped that this short article will stimulate further

work on the parasite, especially as it has been suggested (Arvy & Delage 1966) that the appearance of *Spirinella* leads to a decline in mayfly populations.

Acknowledgements

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References

- Arvy, L. & Delage, B. (1966). Infestation massive des *Ephemera vulgata* du Manaurie (pres Les Eyzies) par *Spirinella adipophila* (protozoa) n.g., n.s. *Annales de Parasitologie Humaine et Comparee*, 41, 213-216.
- Arvy, L. & Delage, B. (1973). Permanence de l'infestation des *Ephemera vulgata* des eyzies, par *Spirinella adipophila* (Arvy et Delage 1966). In *Proceedings of the First International Conference on Ephemeroptera* (eds L. Peters & J. G. Peters), pp. 214-222. E. J. Brill (Leiden).
- Arvy, L. (1979). Nouvelles donees sur *Spiriopsis adipophila* (Arvy et Delage 1966) (*Spirinella adipophila* Arvy et Delage), Sporozoaire probable. In *Proceedings of the Second International Conference of Ephemeroptera* (eds K. Pasternak & R. Sowa), pp. 217-219. Panstowe, Wydawnictwo, Naukowe, Warsaw.
- Arvy, L. & Sowa, R. (1976). Researches on the internal parasites in Ephemeroptera around Krakow, Poland. *Annales de Parasitologie Humaine et Comparee*, 51, 111-120.
- Delvaux, L. (1975). *Spiriopsis adipophila* (Arvy & Delage 1966), parasite constant des populations d'*Ephemera danica* du Grand-Duche Luxembourg. In *Proceedings of the Second International Conference of Ephemeroptera* (eds K. Pasternak & R. Sowa), pp. 217-219. Panstowe, Wydawnictwo, Naukowe, Warsaw.
- Elliott, J. M., Humpesch, U. H. & Macan, T. T. (1988). *Larvae of the British Ephemeroptera: A Key with Ecological Notes*. Scientific Publications of the Freshwater Biological Association, No. 49, pp. 145.
- Soldan, T. (1980). Host and tissue specificity of *Spiriopsis adipophila* (Arvy et Delage) (Protozoa, Coccidia) and its distribution in the Elbe Basin of Czechoslovakia. *Folia Parasitologica (Prague)*, 27, 77-82.