SOME ASPECTS OF THE ECOLOGY OF *LEPTOPHLEBIA VESPERTINA* (L.) (EPHEMEROPTERA: LEPTOPHLEBIIDAE)

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ABSTRACT

Larvae of *Leptophlebia vespertina* (L.) have been studied in two environments. Lake Conzieu (Bas-Bugey, France) has a dense univoltine population with emergence in early May. The species extends only a short distance into the lake outlet stream, where *Paraleptophlebia submarginata, Habroleptoides confusa* and *Habrophlebia lauta* also occur.

The second environment is more complex, consisting of the former channels of the Rhône and Ain rivers. These habitats are now isolated from the main channel but have groundwater inflows. *Leptophlebia vespertina* seems to be an excellent indicator of lentic or slowly flowing habitats with a phreatic water supply.

RESUME

Des précisions écologiques concernant l'espèce *Leptophlebia vespertina* (L.) sont apportées grâce l' étude des larves dans deux milieu différents:

- un milieu "classique", stagnant: le lac de Conzieu (Bas-Bugey, France) abodamment peuplé par *L. vespertina* qui s'y comporte en espèce univoltine avec envol des ailés début mai. Dans l' émissaire du lac, milieu courant, *L. vespertina* se maintient sur une très courte distance (dérive?) alors qu'apparaissent *Paraleptophlebia submarginata, Habroleptoides confusa* et *Habrophlebia lauta;* la microrépartition de ces espèces en fonction de la vitesse du courant est étudiée.

- un milieu beaucoup plus complexe correspondant à d'anciens chenaux du Rhône et de son affluent l'Ain, abandonnés par l'axe fluvial actif, et conservant avec le fleuve et avec le domaine aquatique souterrain des liens plus ou moins étroits.

Ces études amènent à penser que *L. vespertina* serait une bonne espèce indicatrice de milieux stagnants ou faiblement courants dans lesquels l'alimentation phréatique intervient da facon non négligeable.

INTRODUCTION

Leptophlebia vespertina is widespread in Europe, occurring in a range of lentic habitats and lotic habitats with moderate current (Kimmins 1954, Grandi 1960, Macan 1961, Brittain 1976a, b), even in brackish estuaries (Lingdell & Müller 1979). Macan (1961) has pointed out its preference for limestone-free environments and it has often been found in peaty or acid habitats (Kimmins 1954, Kjellberg 1972, 1973, Brittain & Nagell 1981).

Studies reported here were carried out in the Conzieu lakes and their outlet which flows into the Gland, a tributary of the Rhône river (Fig. 1), and a complex fluvial environment consisting of

I.C. Campbell (ed.) Mayflies and Stoneflies, 275–280.

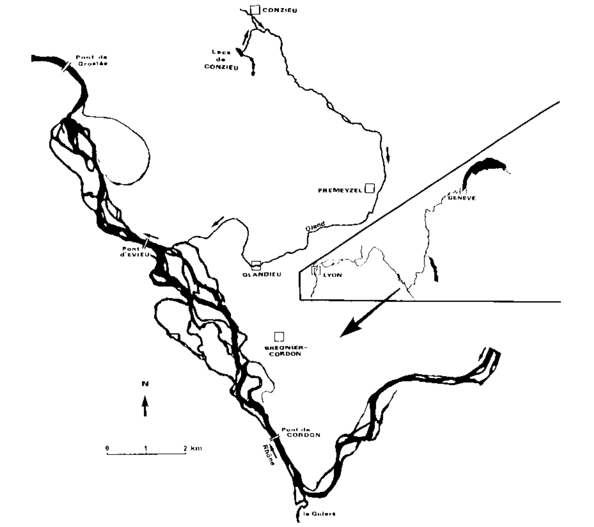

Fig. 1. Conzieu Lakes (IGN map 1/20000 La Tour du Pin No. 3, 854,6 × 84,7, altitude 342 m), the Gland River and the Rhône River.

sixteen former river channels (known locally as "lones") abandoned by the Rhône and its tributary the Ain, near their junction upstream of Lyon (Fig. 2). The lones varied in morphology, hydrology, sedimentology, age, origin and their links to the main channel and groundwater (Amoros *et al.* 1987, Bravard 1985). We used the data to clarify some aspects of the life history of *L. vespertina* and also its possible role as a descriptor (see Bournard & Amoros 1984) of a type of ecological functioning in a complex fluvial hydrosystem.

LEPTOPHLEBIA VESPERTINA IN THE CONZIEU LAKES SYSTEM

Between 1973 and 1976 the species was collected in large numbers in the aquatic vegetation of the Conzieu lakes. It was also present in the lake outlet where three other species of Leptophlebiidae were found: *Paraleptophlebia submarginata*

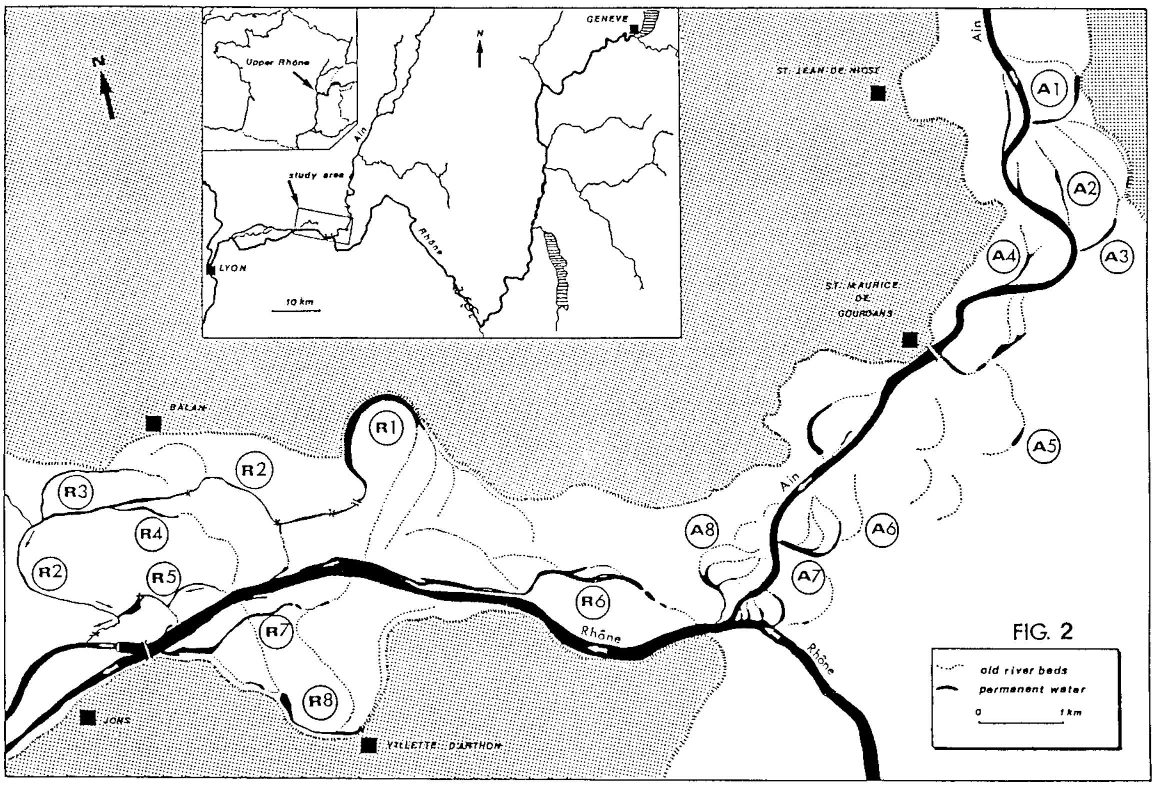

Fig. 2. The Rhône river, upstream from Lyon and its tributary, the Ain River. A1–A8 = sampling sites on the Ain River, R1–R8 = sampling sites on the Rhône river.

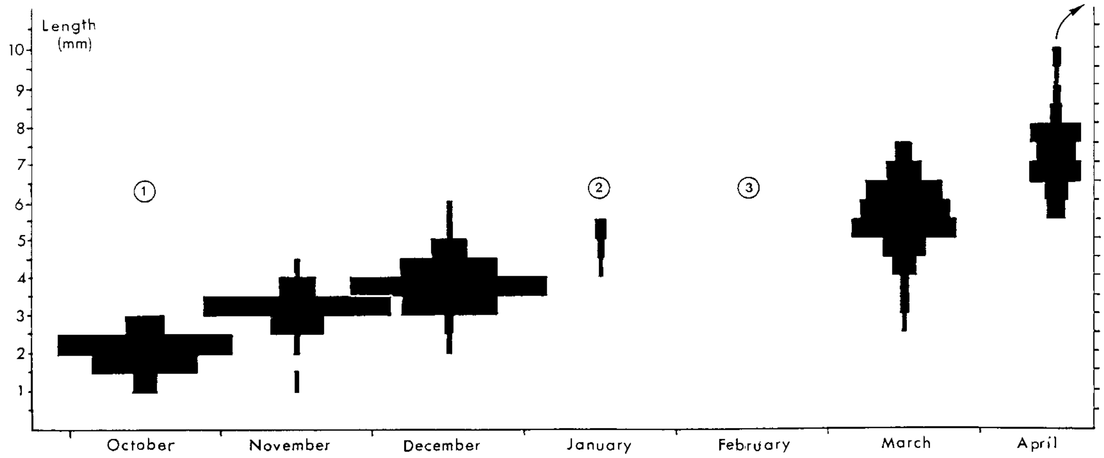

Fig. 3. Life cycle of *Leptophlebia vespertina* (L.) at Conzieu (mean values for several years and for sampling the lake and its outlet). 1 = lake sample only, no nymphs in the outlet. 2 = outlet sampling only, no sampling in the lake. 3 = no sampling in February.

(Stephens), *Habroleptoides confusa* (Sartori and Jacob) and *Habrophlebia lauta* Eaton.

Life cycle of *Leptophlebia vespertina*

The nymphs collected were immediately preserved in formalin before return to the laboratory where they were measured, under magnification, from the tip of the head to the base of the cerci. The nymphs seem to grow at an identical rate each year so that the large number collected made it possible to establish a mean histogram for sizes for each month (excluding February) (Fig. 3). The species is univoltine as is already known elsewhere (e.g. Brittain 1972, Kjellberg 1973, Brittain 1978 and Saettem & Brittain 1985) but the life cycle in the Conzieu region diverges from that described for northern Europe. The smallest larvae collected (from 1.0–1.5 mm) are found only in early October whereas the subimagoes fly at the end of April and no nymphs can be found after the beginning of May. Thus *L. vespertina* behaves in the Conzieu Lakes like *L. marginata* in northern Europe (Brittain 1972). It is likely that local factors are responsible. The water is quite pure and slightly alkaline (pH 7.6–7.9) with a high level of mineralization (alkalinity (TAC) 195–210 mg CO3Ca l^{-1}, conductivity 295–375 $\mu S\ cm^{-1}$) and an adequate dissolved oxygen level (78-95% saturation). The oxidability level (1.5-1.7 mg $O_2\ l^{-1}$, BOD_5 (at 20°C) 0.1-1.5 mg $O_2\ l^{-1}$) is probably due to the density of vegetal debris arising either from the aquatic flora of the lake or from the riparian vegetation. Water temperatures in the lake outlet are 2 to 3°C (occasionally lower in some winters) rising to over 24°C in summer, but the most striking aspect of the water temperature is a slow belated fall from August to October and a precocious rise from March onwards when daytime temperatures exceed 5° (usually ranging from 5–8°) reaching at least 10° in April The buffered temperature variations, high conductivity and high calcium content all point to the existance of a subterranean water supply.

Temperature has often been cited as the main factor regulating the life cycle of *L. vespertina* (e.gg. Macan & Maudsley 1966) and Brittain (1976a) demonstrated experimentally that water temperature plays a fundamental role in controlling the growth rate of nymphs.

Microdistribution of Leptophlebiidae nymphs in the Conzieu Lake outlet

In the last of the three lakes water is retained by a small dam with a grating through which water flows all year into a channel with a bed of pebbles and gravel and fine sediments in areas where the current is slower. Thirty-five metres of channel, from the dam to a small bridge, together with 35 m of channel downstream of the bridge, were selected as a study site because it provided a series of lentic and lotic zones forming a rich and diverse biocoenosis in which 4 leptophlebiid species occurred viz. *L. vespertina, Paraleptophlebia submarginata, Habroleptoides confusa* and *Habrophlebia lauta.*

The discharge is fairly steady (mean flow 15 l sec^{-1}), but large quantities of plant detritus tend to accumulate on the grating and under the bridge partially or completely blocking flow under the bridge, which leads to considerable variations in water level and current speed.

Paraleptophlebia submarginata was the dominant species in the sampling area, accounting for more than half the leptophlebiids collected. It was found everywhere in the channel but with a marked preference for zones with a current velocity between 40 and 65 cm s^{-1}. *Habroleptoides confusa* represented 7% of the population and the nymphs occurred only in the swiftest water. *Habrophlebia lauta* was only found in small numbers in the upstream half of the sampling zone, but was more abundant downstream of the bridge, with a preference for lotic zones. In periods of very low water the species abounds in pools isolated from the ain channel.

Leptophlebia vespertina accounted for more than 30% of the leptophlebiids collected, with a distribution the inverse of that of *Habrophlebia lauta.* Its abundance was not apparently linked to current velocity, but decreased downstream from the lake outlet until it practically disappeared after the bridge. The nymphs are probably carried by drift only a short distance from the lake. Drift was sampled twice for 24hrs at the dam but no nymphs were found in the samples, so the hypothesis was not confirmed, but still remains plausible. However, in October nymphs could only be collected in the lake, none occurred in the outlet, indicating that drift must occur later in the year.

LEPTOPHLEBIA VESPERTINA IN FORMER CHANNELS OF THE RHONE AND AIN RIVERS

Sixteen former channels of the Rhône and Ain Rivers (Fig. 2) were surveyed during two periods, April 26 – May 6 and June 16 – July 1, in 1983. *L. vespertina* occurred mainly in the channels associated with the lower Ain where it was present in 5 of 8 channels surveyed: abundantly in A1 and A4, in smaller numbers in A7 and rarely and in small numbers in A2 and A3. It was also present in 2 of the 8 channels of the Rhône on the Jons plain, most abundantly at R5 where it occurred in similar numbers to those at A1 and A4, and in smaller numbers at R1.

Characteristics of the channels containing *L. vespertina*

A comparison of the characteristics of the sites at which *L. vespertina* occurs with those from which the species is absent allows us to define the features which characterize the biotopes. Physically the species always occurred where chemical analyses indicated that the water was of subterranean origin, and the substratum had a layer (< 20 cm) of fine organic silt. The vegetation was characterized by species indicative of oligotrophy and the subterranean origin of the water including *Berula erecta, Mentha aquatica, Groenlandia densa, Potamogeton coloratus* and Characae. The first three are characteristic of oligotrophic calcareous water, the fourth is pollution sensitive and the Characae are characteristic of water of subterranean origin (Carbiener & Kapp 1981, Ortscheit *et al.* 1982, Castella and Amoros 1984).

Of the sites where *L. vespertina* was absent, several had a flora indicative of eutrophication (i.e. *Myriophyllo-Nupharetum)* (R7, R8) or had signs of local pollution (R2). Several had periods when they were dry, and were virtually semiaquatic habitats (R3, R4, R6), and two others were periodically subjected to water level fluctuations due to flooding by the Ain leading to swifter currents and substrate disturbance.

Thus the presence of *L. vespertina* is linked to biotopes where the main water supply is oligotrophic and of subterranean origin (fluvial groundwater in all cases except R1). The nymphs settle downstream of the point of origin of the water, or areas where the inflow is diffuse, and never occur where fluctuations in water level are extreme.

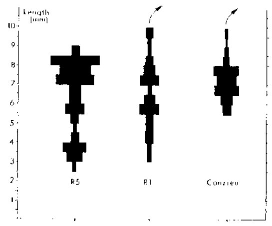

Fig. 4. Leptophlebia vespertina nymphs caught in the same month, April, in R5, R1 (*cf.* Fig. 2) and at Conzieu (*cf.* Fig. 1).

DISCUSSION AND CONCLUSION

Comparing the life cycle of the Conzieu population of *L. vespertina* with that of the populations in the floodplain channels of the Rhône and Ain rivers (Fig. 4), there are significant differences. The life cycle at Conzieu resembles that found by Brittain (1972) in Great Britain for the species *L. marginata*. The April histogram for the site R5 at Jons resembles that found by Brittain (1972) for *L. vespertina* in North Wales while the population at R1 appears intermediate between these two.

The occurence of *L. vespertina* in localities with a subterranean water supply at both Conzieu and the Rhône-Ain floodplain channels corresponds to the situation in Øvre Heimdalsvatn Norway (Brittain 1978, Groterud & Kloster 1978). *L. vespertina* was not found on the alluvial plain of the Rhône at Brégnier-Cordon 60 km upstream of Jons (Castella *et al.* 1984) where the supply of subterranean water is less significant (Amoros *et al.* 1987).

L. vespertina may be considered as a descriptor of a stage in the succession of ecosystems abandoned by rivers. This stage, of short duration, occurs when the biotope is in an advanced stage of silting up, with a coarse substratum covered by fine organic sediment, dense hydrophytes and helophytes, but which retains a permanent oligotrophic water supply. These biotopes are particularly abundant on the alluvial plain of the Ain River.

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