

**SOME OBSERVATIONS ON THE UTILIZATION
OF GROUNDWATER HABITATS
BY ODONATA LARVAE IN AN ASTATIC POOL
OF THE RHÔNE ALLUVIAL PLAIN (FRANCE)**

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Since 1979, samples of groundwater fauna have been pumped out of the alluvial plain of the Rhône River, upstream from Lyon (France). At several times they revealed early larval instars of Odonata from 0.5 to 2.0 m deep in the water-logged sediment of a neglected, unsilted gravel pit. This astatic pool is an outcrop of the underground water table. The data suggest the possibility for some Odonata (Libellulidae e.g. *Sympetrum striolatum* (Charpentier), Coenagrionidae) to effect a complete larval cycle in this kind of environment by the utilization of the phreatic biotope.

INTRODUCTION

Since 1975, our laboratory has undertaken a study of the groundwater biocenoses in the alluvial plain of the Rhône River. Some of the biological interactions between surface and underground interstitial faunas were analysed (GIBERT *et al.*, 1977, 1981 ; REYGROBELLET & DOLE, 1982 ; DOLE, 1983). The study area is situated 20 km upstream from Lyon, just below the confluence of the Rhône and Ain Rivers (Fig. 1).

Ever since the last glaciation, the Rhône has created a bed of greatly aquiferous alluvial deposits. More recently, it has gradually abandoned wide meanders, mostly because of lateral embankments. The oldest ones (oxbow lakes) are at present a drainage system for surrounding groundwater. Unsilted, neglected gravel pits are often found near these dead arms and are temporary pools where groundwater often surfaces. Samples of underground

fauna in these sites have revealed early larval instars of Odonata deep in the water-logged substratum. This paper will discuss our preliminary data, which represent but a small contribution by phreatobiologists to odonatology.

SAMPLING METHOD

Most of the phreatobiologists sample interstitial populations with a modified version of the portable device developed by BOU & ROUCH (1967). It consists of a perforated pipe (diameter : 35 mm) with 5-mm holes, which allow even the largest animals of the alluvial habitat to be drawn up. This pipe is sunk manually in the ground at a maximum depth of 3 m. A light, soft-valved pump draws up the water, sediment and animals without damaging the latter. Each sample is filtered through a 160- μ m mesh net, which retains the macrofauna and most of the meiofauna. Interstitial biocenoses are known to be richer in the upper part of the aquifer, so the samplings were generally carried out at depth of 0.5 to 1.5 m ; some reached a depth of 2 m.

SAMPLING SITE

Our main sampling station was a gravel pit, neglected for 10 years, near the outlet of one of the oldest dead arms of the Rhône ("lône du Grand Gravier", Fig. 1). A large aquifer, situated on the northern side of the Rhône, meets the river and its underflow in this area (see the groundwater flow directions on Fig. 1). Presently, the station is situated outside the flood plain but the water level in the pool is still linked more with the variations of fluvial discharge than with the annual rainfalls. These features are quite uncommon for a temporary pool : - 1 - the surface water of phreatic origin (high in HCO_3^- and calcium content) is chemically buffered ; and - 2 - the pool can dry up when the groundwater level is low (not an annual phenomenon). In any case, the size of the pool is greatly reduced in summer (e.g. 30 \times 30 m, 1 m deep in March 1985 and 2 \times 2 m, 0.2 m deep in July 1985). The variability of the surface water volume is therefore the main feature in this kind of environment ; it can be classified as "perennially astatic with dry periods at longer and irregular intervals" (WIGGINS *et al.*, 1980).

Since the termination of gravel extraction, some helophytes have settled in the pool (*Phragmites australis*, *Typha latifolia*, *Juncus articulatus*, *Equisetum* sp.) and during the perennial water phases, pioneer hydrophytes such as Characea can overgrow the pool.

RESULTS

The results can be divided in two sets :

a) *From October 1979 to June 1985 :*

The samplings were carried out on 21 dates, principally for phreatobiological purposes, and revealed on 7 occasions early larval instars of Odonata as deep as 2 m in the water-logged sediment of the gravel pit (Table I). These small larvae belong to two families : -1- Coenagrionidae, encountered in the upper pumping levels on 3 different occasions, especially in late summer (05-IX-1980, 09-IX-1983). The body lengths were heterogeneous (from 1.7

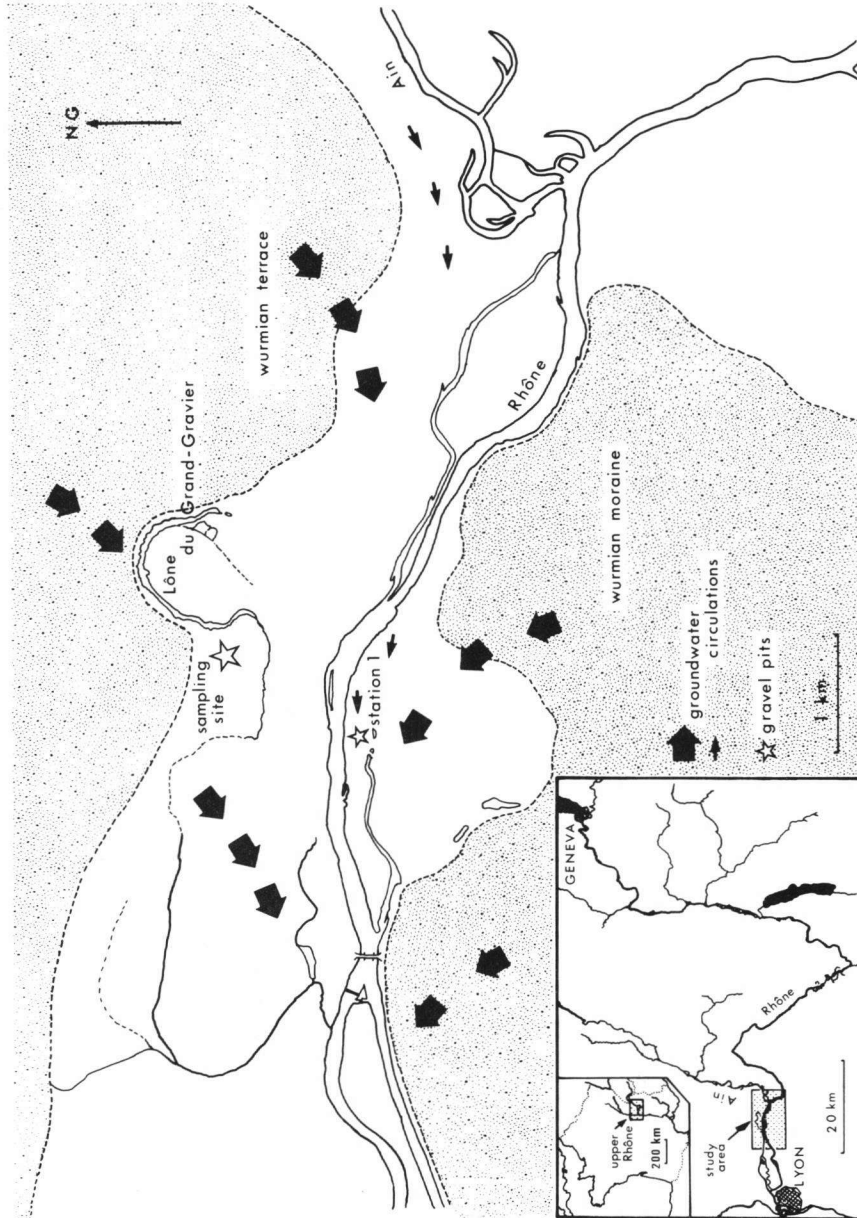


Fig. 1. Study area and sampling site.

to 5.0 mm) ; -2- Libellulidae, encountered on 5 occasions down to the lower levels (2 m deep on 05-IX-1980) but they were collected mainly in the first metre of sediment. During the seven years studied, their seasonal occurrence took place from the end of summer to the beginning of spring. The body lengths were homogeneous (from 1.0 to 1.7 mm).

Table I

Occurrence and body length of Odonata larvae in phreatic samples
At each level, the volume of phreatic water sampled is 60 L
except on 11-IV-1985 (30 L pumped)
0 : no Odonata in the sample. - / : no sample

Sampling dates	Depths			
	- 0.5 m	- 1.0 m	- 1.5 m	- 2.0 m
06.08.1980	0	1 Coenagrionidae 1.0 mm	/	/
05.09.1980	4 Coenagrionidae 1.7,2.7,3.0,4.0 mm 3 Libellulidae 1.5,1.0,1.0 mm	2 Libellulidae 1.7,1.0 mm	0	1 Libellulidae 1.0 mm
23.10.1980	0	1 Libellulidae 1.0 mm	0	/
08.03.1982	4 Libellulidae 4 × 1.0 mm	5 Libellulidae 5 × 1.0 mm	1 Libellulidae 1.0 mm	/
09.09.1983	2 Coenagrionidae 3.5,5.0 mm	0	0	/
13.01.1984	1 Libellulidae 1.0 mm	/	/	/
11.04.1985	1 Libellulidae 1.5 mm	/	/	/

b) *From March 1985 to June 1985 :*

The larval populations were studied on 5 occasions in the superficial pool using a hand net. *Sympetrum* larvae have only been found during this period. All the larval instars identified belong to the *striolatum-sanguineum-vulgatum* complex. The taxonomic separation of the larvae of these three species remains quite dubious (CARCHINI, 1983) although collection of teneral adults emerging upon riparial helophytes (21.VI.1985) allowed the identification of *Sympetrum striolatum* (Charpentier). Furthermore, the breeding of older larvae, sampled in June 1985, led to adults identified undoubtedly as *S. striolatum* ; thus, we have good reason to believe that the larval population living in the pool in 1985 belongs only to this species.

Because no collection of adults or older larvae was done before 1985, the young larvae found in the sediment prior to 1985 cannot be identified to species. However, we were able to relate the Libellulidae to *Sympetrum* through the comparison of larvae of the same size found in 1985. Some species of this genera, especially *S. striolatum* (Charpentier) and *S. sanguineum* (Müller) are frequently found living in this kind of astatic pool (WIGGINS *et al.*, 1980 ; DEGRANGE, 1981 ; GEUSKES & VAN TOL, 1983).

Though not very precise on a taxonomical level, the groundwater data obtained before 1985 are first steps for discussion and further research.

DISCUSSION

The occurrence of young Odonata instars among phreatic biocenoses, already mentioned in SEYED-REIHANI (1980) and SEYED-REIHANI *et al.* (1982) in another gravel pit near the Rhône River (Station 1, Fig. 1), has not yet been analysed in the literature.

The number of larvae sampled by pumping is always small (at most, 7 individuals in 60 L of phreatic water on 05-IX-1980), but we must point out that the phreatic environment of the pool is of a considerably larger volume than the surface water ; thus, the impact of pumping is then smaller on phreatic biocenoses than is hand-net sampling on superficial biocenoses. In fact, we can assume that some individuals of the *Sympetrum* population are able to spend a part of their larval cycle in the water-logged sediment. This possibility is due to the existence of sediment interstices of sufficient dimension and to the relatively high dissolved-oxygen content of the constantly renewed phreatic water surfacing here in the pool. The dimensions of the sediment interstices can be estimated by the size of the largest animals pumped out : here, the 11-mm long hypogeous Amphipod Crustacea *Niphargus renei* Karaman.

These young interstitial larvae live in a rare and very productive biocenose composed of typical phreatic organisms (e.g. the rare blind Dytiscidae *Siettitia avenionensis* Guignot, the cenozoic era relict *Troglochaetus bera-necki* (Delachaux) (Archiannelida), *Microcharon* sp. (Isopoda), *Niphargus* spp., etc.), and superficial invertebrates that migrate like Odonata (e.g. Mollusca, planctonic Crustacea, Ephemeroptera, etc.). While in an interstitial biocenose, young Odonata can have a normal predatory activity.

The seasonal occurrence of these young larvae suggests that, after hatching in summer, some young larvae might migrate immediately to the interstitial biotope and overwinter there. The early instars found in autumn

and winter clearly belong to a species in which the first eggs laid hatch without delay; *S. striolatum*, for example, has a facultative embryonic diapause; the first eggs hatch 30 to 50 days after laying while those laid late in summer would overwinter (ROBERT, 1958; CORBET, 1962; DEGRANGE, 1981; GEJSKES & VAN TOL, 1983; D'AGUILAR *et al.*, 1985).

For the young late-summer larvae, the ability to migrate underground could be a means of resistance to the low water levels and drought that occur during this season (e.g. September and October 1980). Phreatic water is always warmer in winter than that of the surface (Table II); therefore, underground overwintering could also be a means of resistance for the frost-sensitive young instars against the long freezing that might occur in such a shallow pool. Back migration to the surface could occur with the vernal warming of the surface water.

Table II

Two examples of vertical thermal gradient between surface and phreatic water at three depths in the sampling site (°C)

Date	Surface	- 0.5 m	- 1 m	- 1.5 m
6 August 1980	31° 5	23° 6	16°	14°
8 March 1982	3° 6	9° 8	10° 4	11°

When the volume of superficial water decreases, groundwater Odonata larvae could also avoid increased concentration of surface predators — 30 species of Hydrophilidae larvae and Dytiscidae recorded in the sampling site (P. RICHOUX, pers. comm.) —, while *Siettitia* and *Niphargus* are the only potential underground predators.

CONCLUSION

The whole *Sympetrum striolatum* population (and the other unidentified species of Coenagrionidae and Libellulidae) does not seem to obligatorily migrate underground, and this phenomenon remains numerically limited. On the other hand, its ecological significance appears in the event of drastic perturbations, which endanger early instars at the surface (long, late summer desiccation e.g. 1980 or long winter freezing e.g. 1984/85). In these critical periods, groundwater larvae represent a potential stock for recolonization.

After settlement of aquatic vegetation, the ability to migrate would progressively decrease with the natural filling of the pit with silt; thus, this

phenomenon is limited in time and seems to be a characteristic feature of young pits.

Vertical migration down to groundwater habitats can add to other well-known means, such as drought resistance and diapause during the egg stage (WIGGINS *et al.*, 1980), by which some Odonata ensure their larval cycle in astatic environments.

The environmental conditions for migration, gathered here in a man-made pool, can be encountered in other sites created naturally by fluvial dynamics. Some old meanders of the Ain River where *Sympetrum* of the *striolatum-sanguineum-vulgatum* complex abound could be future sites for further research of this kind.

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