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Spatial distribution and temporal variability of some aquatic insects in the Franco-Geneva River, Allondon

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Abstract

The Allodon River, a tributary of the Rhône, has suffered considerably from the recent expansion of human activities in the Geneva region. This study documents changes in its benthic fauna by comparing species richness before and after 1986 and by considering the possibilities of recolonization by drift.

Résumé

L'Allondon, affluent du Rhône, est une rivière qui a considérablement souffert d'une expansion récente des activités humaines dans la région genevoise. Cette étude met en lumière l'évolution de certains éléments de la faune benthique en comparant les richesses specifiques avant et après 1986, année critique pour la macrofaune benthique du bassin genevois. Elle met en évidence les possibilités de recolonisation par dérive de certains recours de l'Allondon à partir d'affluents moins perturbés.

Introduction and sites studied

The Allondon River, the most beautiful one of the basin of Geneva, takes its vauclusian source in the region of Gex (France, Ain) at an altitude of 649 m and flows into the Rhône about 10 km downstream of Geneva at an altitude of 306 m after a long course of 17 km in a woody land. The Allondon receives two main tributaries, the Lion and the Allemogne, and several little brooks (the Roulavaz, the Eaux Chaudes, see Fig. 1). Downstream of St Genis, the river receives a high level of pollution mainly from the sewage treatment plants effluents (STP), but also from recent and dense urbanization of the upstream region, intensive tourist activities in the lower part, etc.

For these reasons, physico-chemical and biological investigations have been carried out at 10 stations on the Allondon itself and 11 others on the tributaries (Dethier *et al.*, 1985; de Sousa *et al.*, 1992) over the past 12 years. The results clearly show that the river is divided into 3 sections (Fig. 1):

1. Section 1 (stations 1, 2, 3), upstream of the effluent of the STP of St Genis: the chemical quality of the river is still very good, according to the water quality classification of OFEFP (1982). The values obtained by the IQBG (Indice de qualité biologique globale, Verneaux & Faessel, 1976) are high, with few variations (Fig. 2a).
2. Section 2 (stations 4, 5, 6), downstream of the effluent of the STP: water quality is much lower, the mean value of the IQBG is very low and the variations very important (a range of more than 10 units, Fig. 2a).
3. Section 3 (stations 7, 8, 9, 10): the junction with the high quality waters of the Allemogne together with the input from clean minor tributaries and autoepuration cause a partial recovery of water quality, both from a chemical and biological point of view.

Most of the tributaries are still in good condition and have a high richness value for benthic invertebrates. In this paper, we consider the tributaries as a

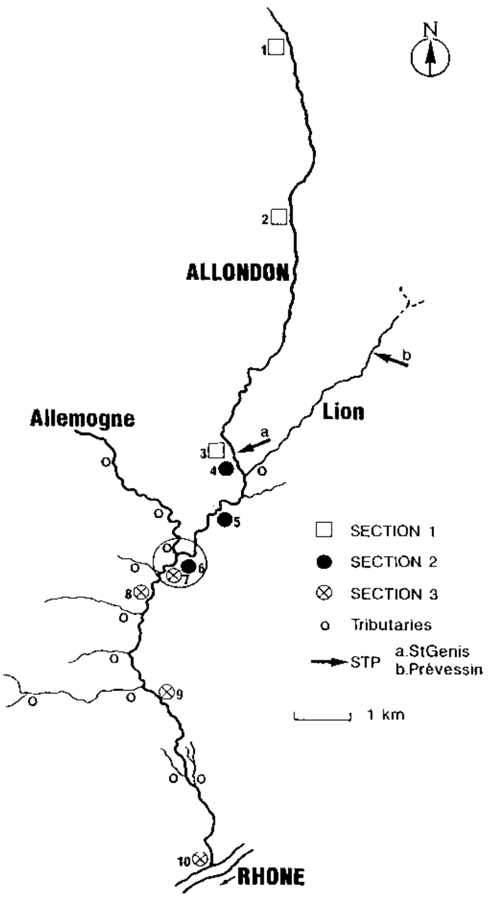


Fig. 1. Sampling stations in the Allondon River and its tributaries.

fourth section representing a potential faunal reservoir together with section 1.

Material and methods

Evolution of species richness

Species richness of Plecoptera (P), Ephemeroptera (E), and Coleoptera (Elmidae and Hydraenidae) (C) is shown in Fig. 2b.

If in Section 1 the increase of species richness is the result of more intensive investigations during the past 3 or 4 years rather than that of a real increase in richness, the decrease in richness in S2 and S3, especially for the Plecoptera and the Ephemeroptera, indicates a real and significant decrease of the species diversity in these groups. This was particularly evident in 1986. Because of this, we compare the species richness of each section between 1981–86 to 1987–92 using methods proposed by Delarze (1990).

In any systematic entity, species are put into groups or units according to ecological characteristics (Table 1).

For each of these groups, we consider the following values:

d: number of 'disappeared' or 'lost' species (found only in 1981–1986)

r: number of 'reappeared' or 'persistent' species (found both in 1981–86 and in 1987–92)

a: number of 'appeared' or 'recent' species (found only in 1987–92)

From these values, we compare the two periods for each group and each section from three points of view or indices that allow us to compare relative gains and losses of species:

1. Optimistic: we assume that the species 'd' are still present and that insufficient sampling is responsible for their absence during the second period. The relation is $B = a/r$.
2. Neutral: ancient (or historical) and recent data result from sampling of same importance. $B = (a - d)\,(r + d)^{-1}$.
3. Pessimistic: in this case, we assume that the species 'd' have really disappeared and that the species 'a' existed in 1981–1986 but were not collected in 1987–92. $B = -d\,(r + d)^{-1}$.

Drift

In 1989, we studied drifting macroinvertebrates at several stations, especially at the Allemogne–Allondon junction (circled area, Fig. 1). Drift nets were raised every 2 hours during 24-hour periods. At the same time water samples were taken for chemical analysis. At the same stations, samples of bottom fauna were also collected by means of a standardized Surber net (Molander, 1990). This study was conducted in order to evaluate the possibilities of recolonization of the Allondon by macroinvertebrates drifting from the Allemogne.

Results

Evolution of species richness

Figure 3 shows the estimates of species richness obtained by the Delarze method.

They indicate in particular:

Table 1. Groups or ecological units and ecological characteristics of Plecoptera, Ephemeroptera, and Coleoptera.

Orders	Groups		Ecological characteristics
PLECOPTERA (23 spp.)	Group 1 :	Perloidea	Predators - Rocky bottoms
	Group 2 :	Nemouroidea	Detritivores, algivores Diverse substrata
EPHEMEROPTERA (24 spp.)	Group 1 :	Heptageniidae	Rheophilous - Rocky bottoms - Scrapers
	Group 2 :	Leptophlebiidae Ephemeridae	More or less rheophilous - Sand or gravel- Grinders
	Group 3 :	Ephemerellidae Baetidae Caenidae	Less rheophilous - diverse substrata
COLEOPTERA (12 spp.)	Group 1 :	Elmidae	Rheophilous - Aquatic larvae and adults
	Group 2 :	Hydraenidae	More or less rheophilous - Adults only aquatic

1. In Section 1 (S1), the optimistic and neutral hypotheses point out an increase in numbers of species in the groups studied. However, as stated above, upstream waters of the Allondon were more intensely sampled during the second period (1987–1992) than the first. It would therefore be more appropriate to apply the pessimistic hypothesis. We suppose that the situation remains unchanged for the three groups.
2. For Sections 2 and 3 (S2, S3), both the sampling intensity and the method were practically identical throughout the two sampling periods. The neutral hypothesis is therefore applicable. It shows an undeniable regression in species richness among Plecoptera (particularly Perloidea) and among Ephemeroptera in almost all of the cases. If they decrease in Section 2 due to the direct influence of water from the STP at St. Genis, the Coleoptera seem to fare slightly better in Section 3. These organisms are less sensitive to pollution than the Perloidea and the Heptageniidae.
3. In the tributaries, conditions are less obvious. Our collections were carried out with practically the same regularity during 1981–1986 and 1987–1992, but two additional stations were taken into consideration in the upstream regions of the Roulavaz and the Allemogne. The biological quality of the Lion has suffered from important fluctuations over the 12 study years. This perhaps accounts for the divergences observed between the optimistic and pessimistic hypotheses for the Plecoptera (especially for the group 1). On the other hand, the Ephemeroptera show remarkable stability; even the smallest variation in species richness cannot be accounted for any of our hypotheses!

We confirm an obvious decrease in species richness for the Plecoptera and Ephemeroptera, especially in S2 and S3. Eight species of Ephemeroptera have probably disappeared from this part of the Allondon in the past few years, *i.e.* 40% of the fauna (Sartori & Dethier, 1985, Sartori *et al.*, 1989).

Drift

Results of the physical and chemical analyses carried out at the confluence of the Allondon and the Allemogne during the drift studies clearly show the difference in quality between these two rivers. The four parameters selected by the OFEFP for grading water quality (Fig. 4a) rank the Allondon upstream before the confluence (A) as well as the left half downstream after the confluence (Cg) as obviously or heavily polluted, whereas the Allemogne upstream just before the mouth (B) and the right half stream of the Allondon (directly influenced by the Allemogne water: Cd) are rated as non-, or only slightly polluted. Two hundred meters downstream, where the mixing of the waters

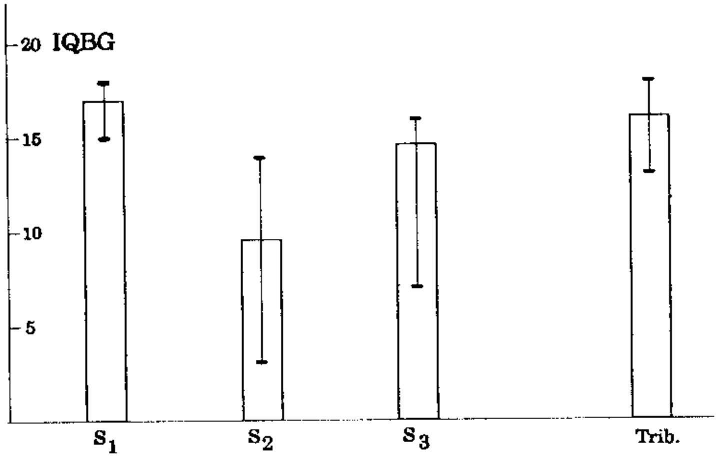


Fig. 2 A. Minimum, maximum and mean values of IQBG by section (regardless of stations or campaigns...)

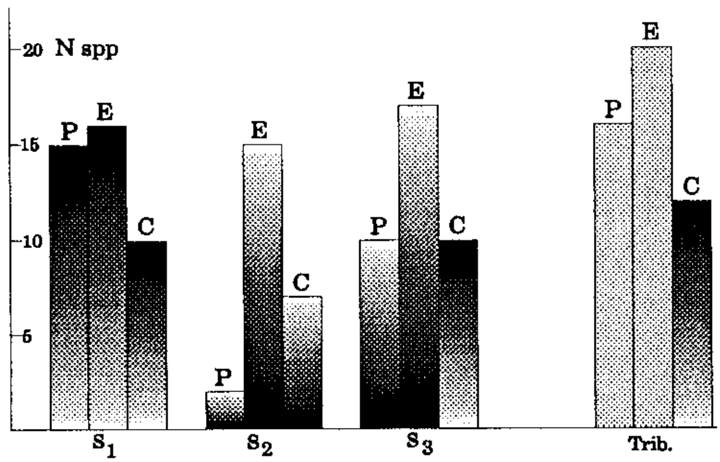


Fig. 2 B. Number of species of Plecoptera (P), Ephemeroptera (E), and Coleoptera (Elmidae and Hydraenidae) (C) in each section. Shading indicates whether species richness increased, decreased, or did not change (shading heavier at top, bottom or uniform, respectively) during 1981–1992.

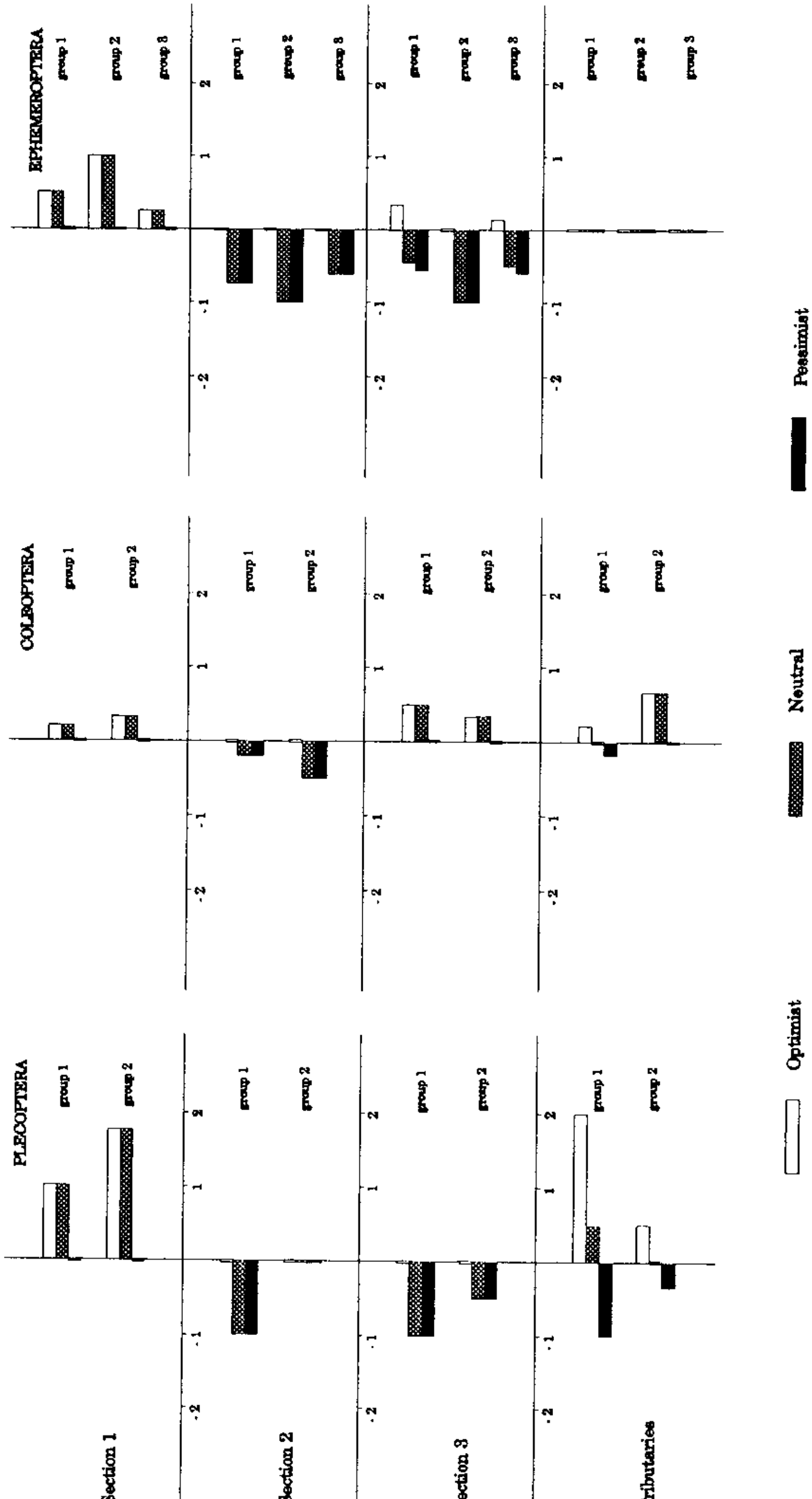
is complete, results of the analyses are comparable on each half stream of the river.

In Fig. 4b the values obtained by the IQBG and their variations also clearly demonstrate this condition: poor at A, but the annual IQBG averages are higher at B and Cd. At Cg and D the annual averages are slightly higher than at A, but the differences between maxima and minima are very important. This reveals that the benthic fauna is exposed to unstable living conditions which are among other factors caused by seasonal variations (Molander, 1990).

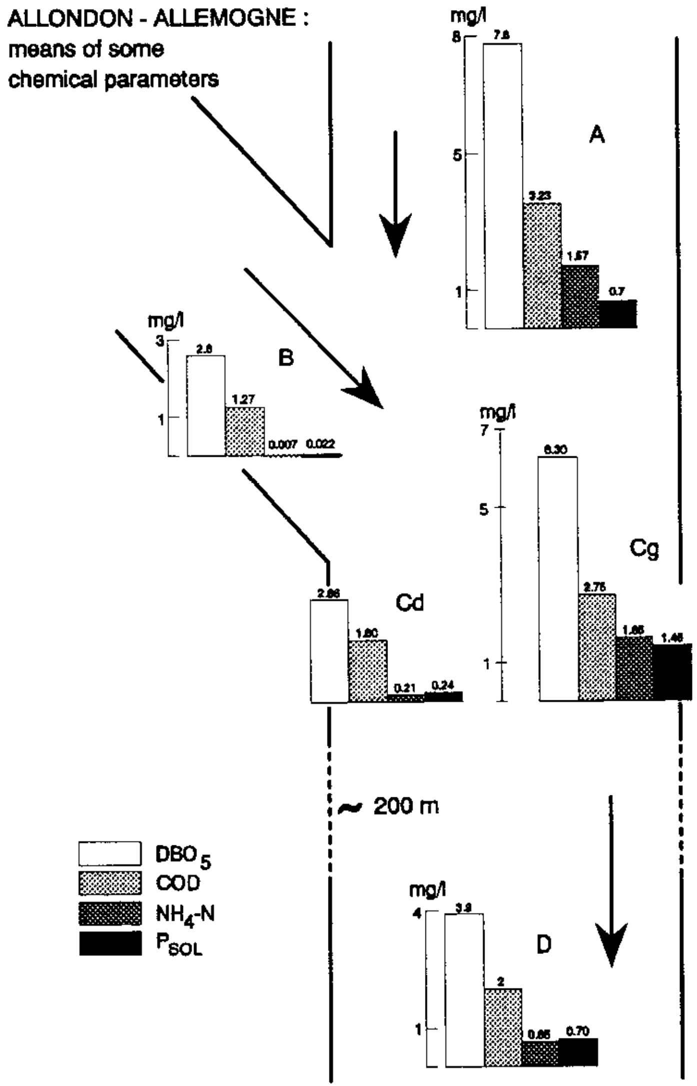
The comparison between the species captured by the standardized Surber net and those drifting shows far more clearly the difference between the Allondon upstream (A), which is poor in species, and the Allemogne (B), which has a diverse fauna. The comparison also indicates that, although drifting organisms from the Allemogne are caught 200 meters downstream of the confluence (Station D), their settlement downstream remains rather uncertain: only one species of Plecoptera was trapped at D by a Surber net. Ephemeroptera, especially Baetidae, can better maintain their position.

Conclusions

During the past 12 years, the Allondon has lost a number of species sensitive to pollution and it seems that with the river in its present state, the recolonization



g. 3. Comparison of species richness between 1981–1986 and 1987–1992 in the different groups of P, E, and C (see Table 1) in the three ctions and the tributaries and from three points of view: optimistic, neutral, pessimistic (refer to the text).



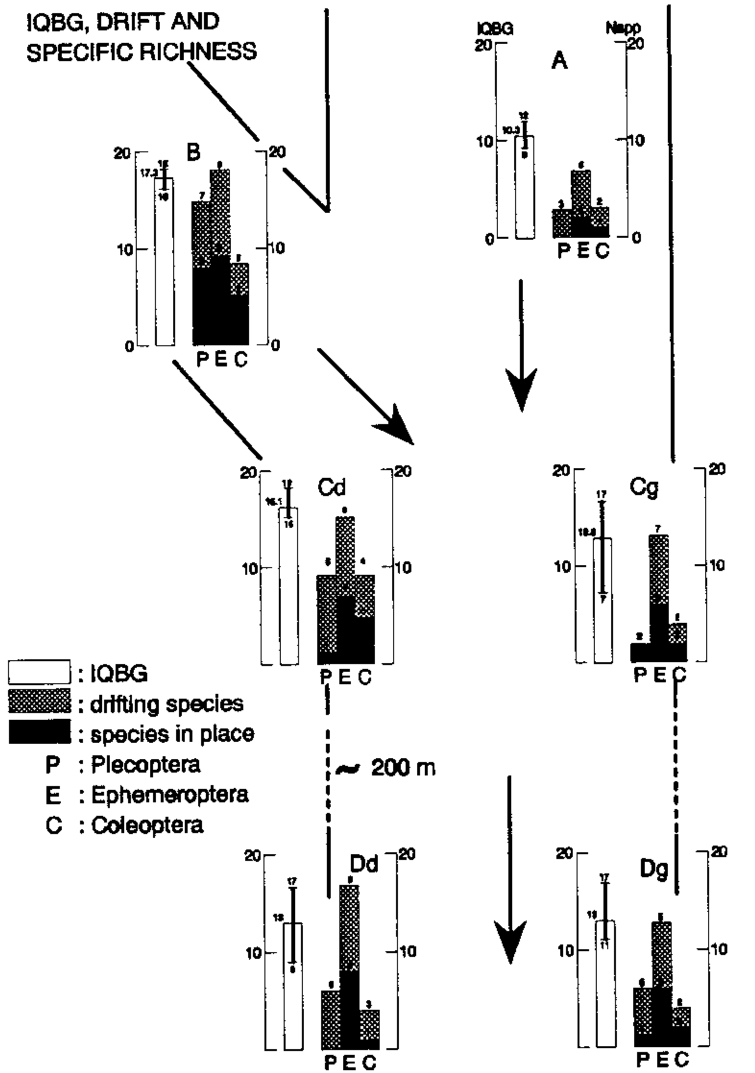


Fig. 4 A Allondon–Allemogne confluence: Mean values (1989) of four chemical parameters.

Fig. 4 B Allondon–Allemogne confluence: minimum, maximum and mean values of IQBG (1989). Number of drifting species of P, E, C and number of those found on the substrata.

by drift does not replace lost species. Nevertheless, species reservoirs exist and the improvement of the state of the Allondon will without doubt allow rapid recolonization. The fact that we captured larvae of *Perla marginata* downstream of station D as well as several species of Plecoptera at the mouth of the Allondon in the spring of 1993 supports this assertion. It remains to be seen whether these organisms are able to settle permanently. They must endure a stressful summer period when low-water level leads to higher concentrations of pollutants.

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