

EFFECTS OF WATER POLLUTION ON ASSEMBLAGES OF AQUATIC FUNGI

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ABSTRACT

The assemblages of aquatic fungi in a river receiving strong mine and sewage pollution was analyzed. The structure of fungal assemblages was similar in all sampling sites suggesting that aquatic hyphomycetes are not reliable indicators of water quality.

INTRODUCTION

Many river systems depend upon allochthonous organic matter as source of energy and nutrients (KAUSHIK & HYNES, 1971; ANDERSON & SEDELL, 1979). Such material consists mainly of structural compounds, rich in energy but difficult for animals to break down. Fungi, particularly the aquatic hyphomycetes are able to exploit this energy by means of extracellular enzymatic digestion.

Stream detritivores select and survive better on substrates that have been previously colonized by fungi (KOSTALOS & SEYMOUR, 1976; ROSSI & FANO, 1979; BUELER, 1984). This has been interpreted as a way by which detritivores can overcome the lack of an efficient enzymatic system capable of digestion structural plant compounds.

Having a key role in the energy recovery from the leaf litter, it is reasonable to expect that interferences in the normal functioning in the assemblages of aquatic fungi, will be reflected on animal populations depending on it.

Here I examine the effects of pollution (organic and mine effluent) on assemblages of aquatic fungi at the Wallen stream (R. Trent system, central England).

MATERIAL & METHODS

In November 1987, two leaf packs (3 g) of sycamore and two leaf packs (3 g) of alder were placed at 4 sites in the stream, attached to submerged stones exposed to the current. Two weeks

later, two leaves were taken from each pack, washed with sterile distilled water and 10 leaf discs cut from each leaf using a cork borer. The cork borer was sterilized after each operation by submersing it in 80% ethanol and passing it through a flame. A total of 80 leaf discs were obtained for each site.

Leaf discs were individually incubated in sterile artificial pond water (APW - Ca, 80 mg l⁻¹; Cl, 145 mg l⁻¹; Mg, 12 mg l⁻¹; Na, 18 mg l⁻¹; K, 3 mg l⁻¹) at a temperature similar to the river water (15°C). Two to five days later, discs and conidia were stained with lactophenol blue, observed under the microscope and conidia identified. The relative importance of species (in terms of abundance and distribution) was determined using the RIV method described by SHEARER & WEBSTER (1985a, b). As a modification of the original method, RIV was divided by 2 in order to deal with a scale varying between 0 (an infinite number of species equally distributed in all leaf discs) and 100 (only one species present in all leaf discs).

At monthly intervals and for a period of one year several environmental parameters were measured in the river water in the referred 4 sites (1, 2, 4, 5), and in an intermediated site (3). The oxygen content in the water was measured, using a Harris Environmental Test Center oxygen-meter, and four 250 ml water samples were collected for other chemical determinations in the laboratory: conductivity with a Y.S.I. Model 33 S-C-T conductivity/salinity meter, pH with a Coming pH meter 109, alkalinity, by titration of 50 ml of the sample against 0.001 N hydrochloric acid until pH 4.5, recorded by a pH meter (MACKERETH MERON & TALLING, 1978); calcium, using

an ion specific electrode (Orion calcium electrode model 93-29) and the anions fluoride, bromide, chloride, nitrates, phosphates and sulphates, in a Dionex 2000 analyzer. Two of the 250 ml samples (BOD bottles) were incubated in the dark at 20° C and the oxygen content measured after five days to determine the BOD₅ (MACKERETH *et al.*, 1978).

RESULTS

Water chemistry at Sites 1 to 4 was very similar (Table 1). At Site 5 there was a reduction in the dissolved oxygen content of the water and an elevation in the BOD₅, temperature, calcium, chloride, fluoride, bromine, sulphate and conductivity values. These changes in the water chemistry were related to the input of effluent from a coal mine and sewage treatment works between Sites 4 and 5.

TABLE 1. Mean values for some physico-chemical variables at 5 sampling sites of Wallen stream (April 1987 to March 1988) and statistical comparisons between sites (ANOVA) (temp. = temperature in °C., mi = minimum, ma = maximum; variables other than pH in mg l⁻¹).

Variables	Sites					F (d.f.) P
	2	3	4	5		
Temp.(mi)	6.4	7.4	6.3	7.3	10.5	2.51(4,38) n.s.
Temp.(ma)	14.6	11.5	13.9	11.9	13.9	2.06(4,38) n.s.
O ₂	12.0	11.8	11.6	11.7	8.8	3.59(4,52) *
BOD ₅	1.6	1.6	4.1	3.8	24.2	13.72(4,42) ***
pH	7.8	7.4	7.6	7.5	7.5	3.80(4,52) **
Ca ⁺⁺	90	85	89	127	162	5.69(4,52) ***
Alkalinity	4.8	5.8	4.8	5.2	5.6	0.83(4,52) n.s.
Conductiv.	0.1	0.1	0.1	0.2	0.4	19.16(4,52) ***
F ⁻	0.1	0.1	0.2	0.1	1.0	1.93(4,25) n.s.
B r	0	0	0.5	2.0	15.5	30.85(4,29) ***
Cl ⁻	50	80	70	250	1400	5.20(4,29) **
NO ₃ ⁻	110	40	60	56	54	8.08(4,29) ***
HPO ₄ ⁻	0	0	4	1	2	10.80(4,29) ***
SO ₄ ⁻	126	124	120	150	156	3.63(4,29) *

n.s. = P>0.05; *, **, *** = P<0.05, 0.01, 0.001

Only 12 aquatic taxa were recorded in this survey. In Fig. 1 the species are plotted in order of decreasing importance (RIV value) for all sites. *Tetracladium marchalianum* was the most abundant species, followed by *Lemonniera aquatica*, *Anguillospora longissima* and *Articulospora tetracladia*. The other taxa present were *Tetracladium setigerum*, *Fusarium cavispermum*, *Tricladium angulatum*, *Cylindrocarpon* sp., *Heliscus lugdunensis*, *Clavariopsis aquatica*, *Fusarium* sp. and *Varicosporium graminea*. Sites in which the canopy covered the river bed (2 and 4) had a higher diversity, recorded as number of species. A lower diversity was recorded in Sites 1 and 5.

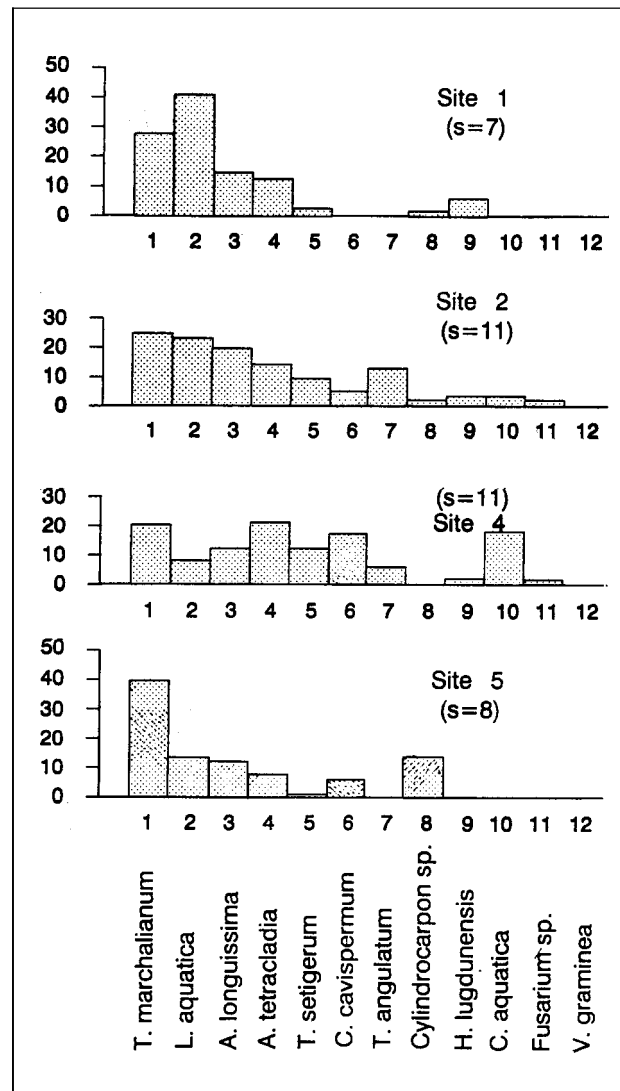


FIGURE 1. Relative abundance (RIV value) of 12 aquatic fungi in four sampling sites along the Wallen stream (s = number of species).

DISCUSSION

The diversity of aquatic fungi observed in the Wallen stream was very low when compared with other surveys carried out elsewhere in Britain (*e.g.* IQBAL & WEBSTER, 1973; SHEARER & WEBSTER, 1985a). This may be attributed to the chemical composition of the water. In all sampling sites the pH values were always higher than 7.5 and calcium content and conductivity were also high. A negative correlation has frequently been observed between Ca⁺⁺ content of the water, high pH values and species richness (BARLOCHER & ROSSET,

1981; WOOD-EGGENSCHWILLER & BÄRLOCHER, 1983; CZEZUGA & PROBA, 1987). The type of species recovered from the Wallen stream agrees with what has been found in streams and rivers with similar water characteristics. E.g. *L. aquatica* and *T. marchalianum*, the two most abundant species were referred to, by BARLOCHER & ROSSET (1981), as the dominant species in rivers with pH 7.3 - 8.4 (the authors also added to this list *C. aquatica*, *A. acuminata*, *C. longibranchiata*, and *H. lugdunensis*).

The structure of the community of aquatic hyphomycetes was very similar between all sampling sites in terms of number of species and their abundance. Site 5 can be regarded as polluted, but according to the results obtained here, changes in the water quality did not have a great effect on the composition of the fungal community. The influence of pollution on aquatic hyphomycetes is not well established. CZEZUGA & PROBA (1987) found a negative correlation between B.O.D. and species richness, but no significant differences between polluted and clean sites were observed by SUBERKROPP *et al.* (1988).

According to the data here presented, aquatic fungi seems to be relatively tolerant to the pollution (the polluted site was only inhabited by oligochaetes, red chironomids and *Asellus aquaticus* L.). However, we do not know how pollution may affect rates of growth and nutrient cycling. We can also speculate that sites 1 - 4 are already stressed due to the natural water chemistry and therefore only tolerant species are present at these sites and site 5.

Due to their role in the energy transference of rivers it is fundamental to further investigate the effects of pollution on the structure and functioning of assemblages of aquatic fungi. In particular, we need to investigate if aquatic hyphomycetes do accumulate toxic compounds and how decomposition rates are affected by pollutants.

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