Enrichment Disturbance

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Microbial degradation of leaf litter in freshwater streams: effect of low pH – *abstract*

Anne-Carole Chamier

Department of Biology, School of Life Sciences, Royal Holloway and Bedford New College, Huntersdale, Callow Hill, Virginia Water, Surrey GU25 4LN, U.K.

Many freshwater streams are predominantly heterotrophic, the energy source for all trophic levels of the biota being derived from allochthonous plant litter that is degraded by saprotrophic micro-organisms. Leaves falling into streams have most of their soluble constituents leached out within twenty-four hours of submersion. Few of the resident terrestrial saprotrophs survive in the aquatic environment and the leaves are rapidly colonised by freshwater fungi, particularly aquatic hyphomycetes (Chamier & Dixon 1982a; Chamier *et al.* 1984). These fungi produce all the enzymes required to degrade the structural polysaccharides of leaf cell walls and those of resident terrestrial fungi. Some species can degrade lignified tissue (Chamier & Dixon 1982b; Chamier 1985). Little is known of the enzymic capabilities of freshwater bacteria.

The majority of benthic invertebrate species ingest a substantial component of leaf detritus. Growth of species active in winter is based almost entirely on allochthonous litter. Aquatic detritivores prefer leaves with a rich microbial flora and grow best on this diet. Investigation of the role of fungi in the diet of the common freshwater shrimp, *Gammarus pulex* (L.), showed that the animal has endogenous gut enzymes which degrade hyphal walls and contents and extract more sugars from leaf cell walls partially degraded by aquatic hyphomycetes than from sterile leaves (Chamier & Willoughby 1986).

Environmental disturbance to the metabolism of aquatic fungi would have a deleterious effect on all trophic levels in a stream. Investigations of acidified aquatic environments ($pH < 5.7$) show impoverishment of the fauna. In acid streams there are fewer species of animals and smaller populations than in circumneutral streams. Absent taxa are mostly herbivorous.

A study was carried out on seven tributary streams of the River Duddon, Cumbria (chosen for contrasts in pH, water chemistry, riparian vegetation and upland and lowland sites), the aims of which were to determine the quality of detritus available for aquatic invertebrates in relation to degradative microbial communities inhabiting leaf litter and to assess the relative importance of pH, substrates, microbial populations, riparian vegetation and water chemistry in leaf degradation (Chamier 1987). Rates of degradation of alder, oak and grass leaf packs with associated microbial populations were measured in the seven streams (pH 6.8–4.9). It was found that the most important factor governing rates of degradation is the physical and chemical nature of the leaf material. Microbial colonisation and the decay coefficient (k) were greater at higher pH. For alder, oak and grass, "k" was respectively six, two and two times higher at pH 6.8 than at $pH \leqslant 5.5$. At lowland sites, pH 6.8, whether tree-lined or moorland, all three leaf species were completely degraded. There were high levels of microbial colonisation, including *c.* fourteen species of aquatic hyphomycetes. Similar decay rates were found on oak and alder leaves at upland sites pH 6.6 and 6.8 – regardless of riparian vegetation – but the grass was barely degraded. At these upland sites, fungal colonisation of oak and alder was comparable to the lowland sites, but fewer species were involved and bacterial counts were smaller. At pH 4.9–5.5, the decay rate of all three leaf species was slow. There were low levels of microbial colonisation and few fungal species. A relationship exists, therefore, between pH, microbial populations and decay rates, whatever the surrounding vegetation. Largest microbial populations at low pH associated with trees did not lead to markedly increased decay rates. Factors of water chemistry at low pH appear to inhibit microbial metabolism (Chamier 1987).

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