

HABITAT HETEROGENEITY AND BIOTIC INTERACTIONS SHAPE THE RESPONSE OF BIOTIC COMMUNITIES TO HUMAN-INDUCED PERTURBATION



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Table 1: Variables included in the direct gradient analyses, grouped into four categories: habitat, water chemistry, catchment and biotic factors.

Variable type	Variables
Catchment	Road
Water chemistry	pH, TN, SRP, PAH, TOC, NO3
Biotic	ZOO1, ZOO3, MACRO1, PHYTO1, PHYTO3 Fish<10cm
Habitat	PVI, Depth



Figure 1: Location of the study ponds.

Road, road density in a radius < 150m; TN, total nitrogen; NO₃, nitrate; SRP, soluble reactive phosphorus; PAH, polycyclic aromatic hydrocarbons; TOC, total organic carbon; PVI, percent volume infested; ZOO1, ZOO3, MACRO1, PHYTO1 and PHYTO3, MDS axes scores used to summarize the distributional patterns of each assemblage.

•The aim was to identify and quantify the **degree of concordance** among the macroinvertebrate, zooplankton, phytoplankton assemblages and the **relative importance of several factors at the local** (water chemistry, habitat, biotic interactions) **and catchment scale** using 39 ponds located in north-western Spain and sampled once in the summer of 2003 or 2004.

•In general, the **degree of concordance** between the three assemblages was **weak** (2STAGE ≤ 0.60) indicating that differing variables affected the structure of the three biotic groups.

•**Local scale factors explained the largest part of the variability** of community assemblages (Fig.3). In particular **biotic interactions** appeared as the strongest predictors for the phytoplankton and macroinvertebrate assemblages followed by water chemistry. For the zooplankton, biotic interactions explained 8% of total variation. Habitat accounted for on average < 5% of total variation that, for the phytoplankton assemblage, was entirely due to PVI, revealing the importance of the **competitive interactions between macrophytes and phytoplankton** for physical (light) and chemical (e.g.nutrients) factors as well as the effects of allelopathy (Zimmer et al, 2003; Mulderij et al, 2006).

Our results also revealed the importance of the **top-down control exerted by macroinvertebrates** (MDS1 defined by the abundance of several predator taxa) **and fish < 10 cm** in structurally complex environments (Fig. 2), since they penetrate in the the vegetation stands and prey on several invertebrates (Crowder & Cooper, 1982; Diehl, 1992), their effects cascading down to lower trophic levels (e.g. phytoplankton).

•Among-site variance accounted for by **catchment variables was non-significant** (phytoplankton and zooplankton) or **low** (macroinvertebrates); however, it is likely that catchment and consequently, land-use, indirectly affect the composition of the community assemblages, through alteration of water chemistry (e.g. PAH, nutrients) habitat structure (i.e. low PVI) and biotic interactions (phytoplankton dominated ponds as a result of eutrophication and sediment removal).

REFERENCES

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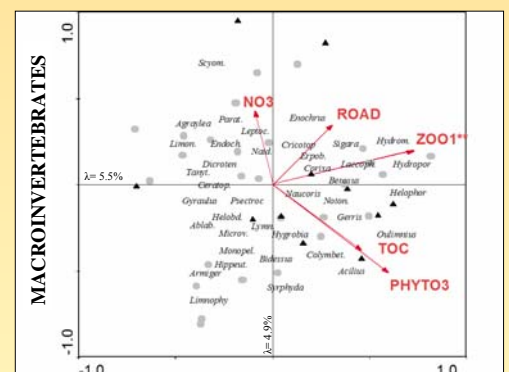
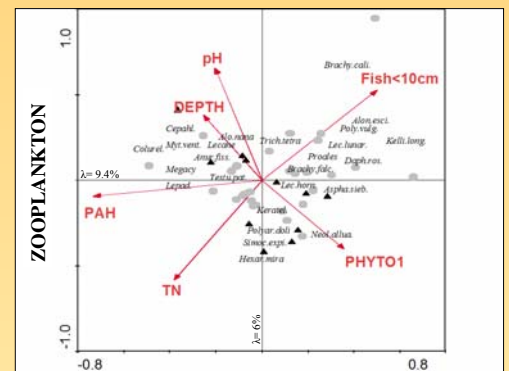
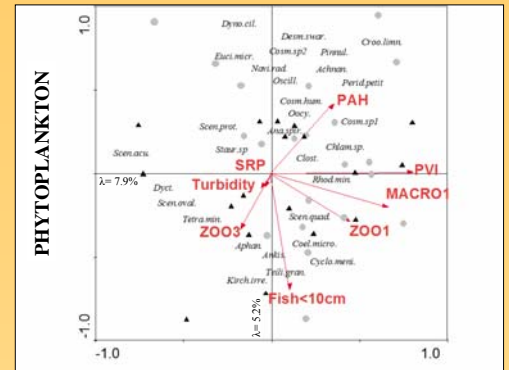


Figure 2: Ordination biplots (CCA) of species and environmental variables for phytoplankton, zooplankton and macroinvertebrates. Black triangles represent ponds with TP > 350um·L⁻¹. Significant (p<0.05) environmental variables were retained in the models after forward selection and Monte Carlo permutation tests (999 permutations). For macroinvertebrates, significance level of the environmental variables was 0.05** and 0.1. For variables' key refer to table 1.

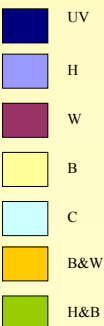
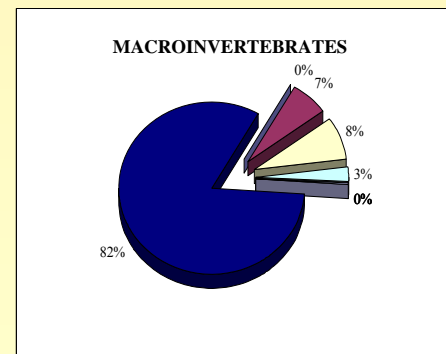
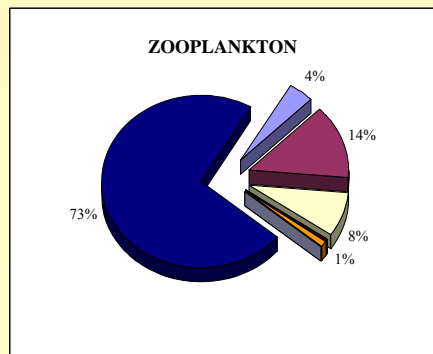
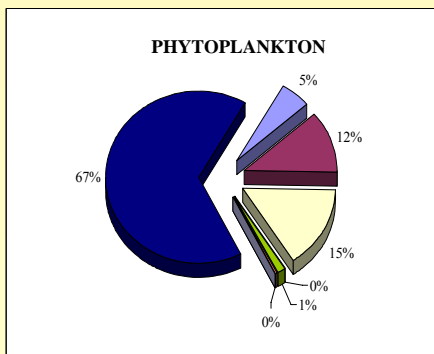


Figure 3: Variation partitioning of assemblage diversity for phytoplankton, zooplankton and macroinvertebrates. Results are shown as per cent variance explained by chemical (W), habitat (H), catchment (C) and biotic (B) factors and per cent unexplained variance (UV). Significant interactions were H&B (habitat-biotic) B&W (biotic-water chemistry).