

# Statistical Analysis of Microbial Community Structure Studies

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## Introduction

Recently, significant attention has been given to the study of sedimentary microbial biomass and community structure in watersheds as one way to investigate the potential effects of pollutants. A variety of environmental factors affect sedimentary microorganisms and their community structures. A close examination of the behavior of these living biological materials and their community structures might help us determine what effects a particular environmental change would have on them. In this study, we utilize multivariate methods to investigate and identify which environmental variables have the greatest influence on the microbial biomass and its community structure.

## Data

In order to examine the variability in total sedimentary microbial biomass over broad spatial scales and identify the determinants of microbial community structure, triplicate sedimentary samples were collected by microbiologist Sue Sutton. The samples were taken from two rivers (Four Mile Creek and East Fork of the Little Miami River,) in southwest Ohio, that are characterized by different land-use patterns within and between catchments. Microbial community structure was determined using phospholipid fatty acid analysis (PLFA or simply fatty acids). Various environmental variables, such as water temperature, water depth, dissolved organic carbon, conductivity, total suspended solids, and sedimentary grain size distribution, were measured on the day of sampling. Sedimentary microbial biomass and fatty acids (PLFA) of each river, along with the measurements of environmental variables, were examined from the six sampling stations over period from December 1998 through October 1999, three or four times per year.

## Statistical methods and applications

To study the effect of environmental factors such as climate, season, watershed hydrology, and land use, basic ordination analysis and an analysis of variance based on three-factor, partially nested design were applied to the environmental variables. The analyses revealed seasonal and spatial

variations in sedimentary microbial community composition in the regulated stream in southwest Ohio. In addition, among the several environmental variables that we studied, much of the observed variation was linked to seasonal changes in stream discharge and water temperature.

Multivariate analyses, including modified principal component analysis, canonical correlation analysis, and redundancy analysis (Aitchison J., 1986), were studied; (i) to study the variation in sedimentary microbial community structure and (ii) to examine the possible relationships between the set of environmental variables and the set of PLFA. These analyses show that most of the fatty acids are commonly represented in bacterial membranes (Findlay and Dobbs, 1993) and unduly abundant in samples. For example, the first principal component seems to contrast between phototrophic microeukaryotes (or algae) and heterotrophic microeukaryotes (or anaerobic bacteria). The first canonical axis, which represents phototrophic microeukaryotes (or algae), was strongly, positively correlated with the suspended solids and strongly negatively correlated with dissolved organic carbon. Redundancy analysis and canonical correlation analysis identify that dissolved organic carbon and total suspended solids explain most of variation in sedimentary microbial community structure.

## REFERENCE

- Aitchison J. (1986). The statistical analysis of compositional data. Chapman Hall, London
- Findlay, R.H. and F.C. Dobbs (1993). Quantitative description of microbial communities using lipid analysis. In P.F. Kemp, B.S. Sherr, E.B. Sherr, and J.J. Cole (ed.), Handbook of methods in aquatic microbial ecology. Lewis Publishers, Boca Raton, FL.
- Sutton, S.D., Abernethy A.M., See, K., and Findlay, R.H. (2000). Environmental Determinants of Microbial Biomass in Stream Sediments (preprint).
- Van Wijingaarden R.P.A., Van Den Brink, P.J., Oude Vashaar, J.H., and Leeuwangh, P. (1994). Ordination techniques for analyzing response of biological communities to toxic stress in experimental ecosystems. *Ecotoxicology*, **4**, 61-77.

## RÉSUMÉ

Récemment, une attention significative a été donnée à l'étude de la structure microbienne sédimentaire de biomasse et de communauté dans les lignes de partage en tant qu'one-way pour étudier les effets potentiels des polluants. Une variété de facteurs environnementaux affectent les micro-organismes sédimentaires et leurs structures de la communauté. Un examen étroit du comportement de ces derniers les matériaux biologiques de vie et leurs structures de la communauté pourrait nous aider à déterminer quels effets un changement environnemental particulier aurait sur elles. Dans cette étude, nous utilisons les méthodes multivariées pour étudier et identifier que les variables environnementales ont la plus grande influence sur la biomasse microbienne et sa structure de la communauté.