Soil and Sediment Biodiversity: Cross-system comparisons and large-scale effects

Peter M. Groffman, Patrick J. Bohlen
BioScience
Vol. 49, No. 2 (February 1999), pp. 139-148
Published by: University of California Press
Article Stable URL: http://www.jstor.org/stable/10.1525/bisi.1999.49.2.139
10.1525/bisi.1999.49.2.139
« Previous Item Next Item »

Soil and Sediment Biodiversity

Cross-system comparisons and large-scale effects

Peter M. Groffman and Patrick J. Bohlen

Interest in the biodiversity of soils and sediments has increased in recent years as it has become clear that vast numbers of species live in these habitats (Fenchel 1992, Beare et al. 1995, Schimel 1995a, Giller 1996, Kennedy and Gewin 1997). At the same time, there has been renewed recognition of the importance of soils and sediments as critical resources that are subject to degradation and to management—that is, there is a new interest in "soil quality" (NRC 1993) akin to water or air quality. However, analysis of the relationships between soil and sediment biodiversity and ecosystem function has been hampered by difficulties in isolating and describing the organisms that live in these habitats and studying their activities under realistic conditions (Fenchel 1992, Wardle and Giller 1996, Brussaard et al. 1997, Freckman et al. 1997). More generally, analysis has been hindered by difficulties in defining ecosystem function and quantifying changes in function in response to changes in biodiversity (Zak et al. 1994, Tilman 1996, Chapin et al. 1997).

Peter M. Groffman is an associate scientist at the Institute of Ecosystem Studies, Millbrook, NY 12545. He studies the dynamics of microbial processes at the landscape level, nutrient cycling, and transformation of environmental pollutants in wetlands, forests, agroecosystems, and groundwater. Patrick J. Bohlen is an assistant research biologist at the MacArthur Agro-Ecology Research Center (a subdivision of Archbold Biological Station), Lake Placid, FL 33852. He studies organic matter dynamics, nutrient cycling, trace gas fluxes, and soil fauna.

A universal set of biotic functions is found in nearly all soils and sediments

Although soil and sediment biota are difficult to study, it has been possible to detect broad patterns in the links between soil and sediment biodiversity and ecosystem function among terrestrial and aquatic ecosystems. In this article, we describe these patterns and evaluate the significance of the links between biodiversity and ecosystem function at large (i.e., landscape, regional, and global) scales. We define biodiversity in a general, functionally oriented way, essentially asking the question: When do we need to know something about what organisms are present in an ecosystem to be able to understand or manage a specific ecosystem function? We explore three themes: first, that there are coherent patterns in the links between soil and sediment biodiversity and ecosystem function among terrestrial and aquatic ecosystems; second, that soil and sediment biota are critical to ecosystem function at all scales (micro, ecosystem, landscape, regional, and global); and third, that it is not clear if diversity per se is always important to soil and sediment ecosystem function.

We begin with a list of potential universal, cross-system functions of soil and sediment biota that we suggest should be used as a basis for functional evaluations of soil and sediment ecosystems. We then describe how these functions are differentially expressed and regulated in different ecosystems. Next, we give a series of examples of the importance of soil and sediment biotic functions at landscape, regional, and global scales. For each example, we examine whether information on biodiversity per se is critical to understanding and managing these functions.

A "universal" set of functions for soil and sediment biota

We propose a universal set of functions that are performed by soil and sediment biota. This set is drawn from the large body of work reviewed in the ecosystem-specific presentations in this issue of *BioScience* and represent the key ecosystem functions performed by soil and sediment biota. These functions, which can be used to evaluate the links between biodiversity and ecosystem function and to assess the effects of natural or anthropogenic disturbance on these links, include:

- Degradation of organic matter
- Cycling of nutrients
- Sequestration of carbon
- Production and consumption of trace gases
- Degradation of water, air, and soil pollutants