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Book review

Microfloral and faunal interactions in natural and agroecosystems. 1986. M.J.Mitchell and J.P. Nakas (eds.) Martinus Nijhoff/Dr W. Junk, Hingham MA, USA, 505 pages

Mitchell and Nakas's volume is comprised of papers reviewing various aspects of biological control of biogeochemical cycling in soils. The stated objective of the book is to present current information on how interactions between microflora, fauna and higher plants regulate the flux and availability of energy and nutrients. The book also contains considerable discussion of the role of interactions between the biota and non-living portions of ecosystems. The authors come from both ecological and agronomic backgrounds. The juxtaposition of their viewpoints makes it clear that there are no fundamental differences in the principles governing carbon and nutrient dynamics between agricultural and natural systems.

Heal and Dighton's chapter discusses nutrient cycling and organic matter in the context of ecological theory, and integrates two areas of ecology that are rarely in contact. They examine changes in decomposition and nutrient dynamics through succession in a variety of ecosystems and attempt to present a generalized framework to describe such changes. This framework is presented in a figure (Fig. 7). It presents a useful set of testable hypotheses. I cannot end my discussion of this chapter without adding that I found the list of "key features of ecosystems" listed on pages 15–16 to be very debatable. I am not sure that either homeostasis or succession are necessary features of ecosystems.

In the second chapter, Juma and McGill present a summary of research on nitrogen and organic matter dynamics in agroecosystems,focussing on mineralization and immobilization of N. The paper contains copious amounts of data on organic matter in agroecosystems assembled from the literature, and some new results. The authors forcefully argue for a kinetic approach to soil organic matter dynamics; that is they argue for characterizing soil organic matter (SOM) fractions by turnover time rather than by chemical identity. They then demonstrate the application of isotope techniques and simulation modelling to the kinetic analysis of SOM. They also provide a very thought provoking example in which isotope fluxes are computed using two different models, yielding two quite different results. This example should be pondered by anyone using either isotopes or simulation modelling or both in their own research.

The third chapter, by Burns and Martin, takes the opposite approach to that of Juma and McGill's, and discusses the organic chemistry of litter decomposition and SOM formation in some detail. The chapter is dense, thorough and detailed. The discussion of radical chemistry is concise and points out the importance in soils of these poorly understood reactions. The authors discuss

both the biochemical and microbiological aspects of soil organic chemistry and also discuss the importance of organo-mineral interactions in SOM stabilization. The chapter had two shortcomings. First, there should have been more discussion of the utility of newly developed techniques relying on solid state NMR, which have already changed many of our ideas about SOM chemistry. Second, it was hard to tell which processes the authors thought were of quantitative importance in soils, and which were only included for completeness.

Smucker and Safir review root-microorganism interactions, focussing on the exchange of carbon between plants and soil organisms. They present an interesting and compelling arguement for increasing research on the role of root physiology in the study of plant stress response. They draw attention to the role of root responses in anaerobic environments, as an example. They also provide a concise review of the role of mycorrhizal fungi in plant water and nutrient acquisition, and in plant carbon budgets. They asserted that mycorrhiza may be important in acquisition of N in natural ecosystems where NH_4 is the dominant N ion. This is an interesting conjecture but much recent work does not support the assumption that NH_4 is dominant over NO_3 in natural systems. Implicit in much of this paper is the assumption that agricultural productivity is limited by carbon gain, and that more carbon efficient root systems will lead to higher yields. I question this assumption on both biological and economic grounds. The effects of root-released carbon are of both long and short term significance in nutrient retention; the value of root-released carbon in nutrient cycling should be carefully assessed in long-term experiments before it is assumed to be a detriment to sustained agricultural production.

Smith and Rice provide a review of microbial N transformations, concentrating on pathways of N gain and loss. The review is up-to-date, and places attention on control and interactions of processes. Although this chapter does not deal with fauna, it does include an unequivocal and brief statement of their importance and role (page 247). The authors, with refreshing candor, make no apologies for their bias as soil microbiologists (see p 274). Their focussed and (reluctantly) broadminded approach makes for a very clear chapter.

Nakas's chapter broadly reviews sulfur cycling. He summarizes microbiological effects on organic and inorganic S transformations. He discusses the regulation of sulfur enzyme activity by both induction and de-repression as an important aspect of S cycling. Studies of enzyme regulation seem to have been more generally used, and more successful in elucidating controls over biogeochemistry of S than of the other major elements. Nakas also reviews interactions of the C, N and S cycles in the most explicit consideration of element intertactions in this volume. The chapter also contains a brief discussion of the effects of S deposition on S cycling, and a discussion of measurements of microbial and organic S uptake, currently an area of active research.

Coleman's chapter is wide ranging, and considers the role of the soil biota in processes including pedogenesis, horizonation, and nutrient availability. The breadth of perspective is impressive but the coverage of each subject is necessarily brief. The chapter has two main virtues. First, Coleman introduces his

chapter with a discussion of the role of biotic interactions in "slow" soil processes, such as pedogenesis. This introduces a long-term perspective largely lacking in the book. Second, his section on belowground food-webs continues the unification of belowground studies with ecological theory. Coleman also mentions the role of soil structure in mediating biotic interactions, previewing what has become a major theme in soil biology.

Curry reviews the effects of management on soil processes. Most of his chapter deals with effects in intensely managed pastures, although he also briefly discusses cropping effects. Much of the data in this chapter is on system level fluxes and pool sizes, and microfaunal community composition. This chapter is less process oriented than most of the others, but presents copious data on the effects of many common management practices, including fertilizing, burning and manuring on numerous soil properties. A community analysis of soil microarthropods along a pig slurry gradient particularly caught my attention.

Freckman, Cromack and Wallwork review methods for studying the soil biota. They cover enumerative direct and indirect methods for soil flora and fauna, as well as techniques for measuring decomposition and nutrient availability. The advantages, disadvantages and limitations of the methods described are covered carefully, and this chapter should be a useful reference. The microbial biomass methods derived from Jenkinson and Powelson's work (the chloroform fumigation-incubation method-CFIM) are not described, but have probably generated more interest, controversy and research in soil microbiology than almost any other topic over the past 5–8 years. The author's statement that indirect methods (i.e. CFIM) should be best viewed as complementary to direct techniques may be true but the literature indicates an opposite trend. A related topic given scant attention is the use of radioisotopes in soil studies. Isotope techniques have been critical to many major developments in soil biology (see chapters 3 and 7), and will become more important in the future.

The final chapter discusses the role of simulation modelling. The Hunt and Parton argue that a simulation model constitutes a complex hypothesis, and that such models are required tools in understanding complex systems, such as the plant-soil system. They preface their discussion of specific models with a brief discussion of their philosophy of modelling, including the need for models of varying levels of resolution. The discussion of case studies illustrates some of the concepts of appropriate level of resolution and hypothesis testing discussed in the introduction. More concretely, they also discuss the role of soil inorganic properties in modelling soil biology, and the importance of active, rapidly turning over organic matter fractions in element cycling. This chapter serves to integrate much of the material presented earlier, a key role for models in any endeavour.

This volume summarizes a period of successful research on the role of soil processes and organisms in biogeochemical cycling. To borrow terminology from Coleman (ch 8), the actors and the sets in the theater of soil processes seem to be fairly well described. Many of the controls over activity in the soil are known, and successful models can be built. In my view, the book's major

deficiency is lack of coverage of phosphorus cycling, an area of importance where much development has taken place. Chapters in this volume hint at what appear to be key future research topics; the role of large and small scale spatial structure, trace gas emissions, and interactions between the element cycles. This book will serve as a benchmark reference, and several of the chapters may be useful topical reviews for teaching ecosystem ecology or biogeochemistry.

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