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Edited by Richard D. Bardgett, Michael B. Usher and David W. Hopkins
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Biological Diversity and Function in Soils

Soil has generally been regarded as something of a 'black box' by ecologists. The importance of soil is obvious: it provides physical support for plants, and both the living and non-living components contribute to a variety of important environmental functions. Soil is a species-rich habitat, but many questions about the ecological significance of the soil's biological diversity, and in particular how it affects ecosystem function, have never been asked. The linkages between above-ground ecology, which is rich in ecological theory, and below-ground ecology, where investigation has been restricted by methodological difficulties, have not been made.

Recent technical developments, including isotopic and molecular methods as well as new experimental and modelling approaches, have led to a renaissance in soil biodiversity research. The key areas are reflected in this exciting new volume, which brings together many leading contributors to the new understanding of the role and importance of soil biota.

RICHARD D. BARDGETT is Professor of Ecology at Lancaster University and has published widely on plant–soil interactions, nutrient cycling and soil ecology. He is especially interested in studying linkages between plant and soil biological communities, and examining how these links are affected by herbivores.

MICHAEL B. USHER is retired. For more than 40 years he has had a research interest in the soil biota, especially the Collembola (springtails), Isoptera (termites) and Mesostigmata (mostly predatory mites). He also has a strong interest in nature conservation, and is currently working on a number of aspects of the conservation of biodiversity.

DAVID W. HOPKINS is Professor of Environmental Science at the University of Stirling. His interests cover the microbiology and biochemistry of carbon and nitrogen cycling in soils, particularly processes of plant residue decomposition and nutrient cycling in soils at high latitudes and altitudes.

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Editors' Preface

Soil has generally been treated as something of a 'black box' by ecologists. It provides the physical support for plants, and both the living and non-living components contribute to a variety of important environmental functions. These include decomposition and the recycling of nutrients, which are both key functions in terrestrial ecosystems. Other roles, such as the breakdown of pollutants and the storage of bioelements, have immense applied significance in a changing environment. Soil provides a habitat for many species of bacteria, fungi, protists and animals; it is generally recognised as a habitat that is species rich. But many questions about the ecological significance of the soil's biological diversity, and in particular how it affects ecosystem function, have never been asked. Until fairly recently this has been because the linkages between above-ground ecology, which is rich in ecological theory, and below-ground ecology, where investigation has been restricted by methodological difficulties, have not been made. It is now time to open the 'black box' and to start to understand how it works.

At the end of the twentieth century and with the start of the twenty-first century, efforts have been going on around the world to gain a greater understanding of the diversity of life in the soil and of the functions that these many species perform. In the UK there have been two major programmes of research on biological diversity and the function of soil ecosystems. As a result of these, and research programmes in other parts of the world, and many other activities by soil ecologists, there have been numerous recent technical advances, including isotopic and molecular methods, as well as new experimental and modelling approaches to understanding the functions of life in the soil. Concurrent with these technical developments, there has been an increasing recognition within the wider ecological community of the importance of soil organisms. This has largely come from the increasing knowledge about the functions of the soil biota. For a long while it has been known that the soil biota regulates major ecosystem processes such as organic matter turn-over and nutrient mineralisation. But now it is suspected that it has a key role in feedbacks between

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above-ground and below-ground communities, and hence that it influences how the whole of the ecosystem functions.

It was, therefore, topical for the British Ecological Society to hold its 2003 symposium with the theme 'Biological diversity and function in soils', presenting a synthesis of what we know about soil biodiversity and its role in the soil ecosystem. Indeed, in 2003, under the heading 'Areas to watch for in 2004', *Science* (Vol. 302, p. 2040) highlighted soil biodiversity and ecosystem function as one of the research themes set for a big change. This is because of the happy coincidence of technique development, the advancement of a theoretical framework and concentration of effort. To put this into perspective, soil biodiversity featured alongside human genome research, exploration of Mars, subatomic physics and open-access scientific publishing. Soils and soil ecologists have joined the big league!

It seems likely that no soil is 'non-functional', but that all soils are either more or less favourable from a human point of view. We have known for a long time that soils host a huge variety of organisms, which jointly provide a range of 'ecosystem services', but we know very little about which organism is doing what and when it is doing it. Recently, molecular tools, clone libraries and a range of other taxonomic techniques have allowed researchers to gain new insights into biological diversity and the processes that these various organisms perform. But are all of these new techniques outstripping our theoretical framework and our ability to design experiments that can fully exploit and test their potential?

We are sure that the symposium in 2003, and these proceedings, will go a long way in demonstrating the recent advances in soil biology, the developments in soil ecology, and the research basis for both policy development and practical management of soil. We are equally sure that readers of this book will appreciate that at last we are beginning to open the soil's 'black box', and what we find inside is both wonderful and exciting.

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