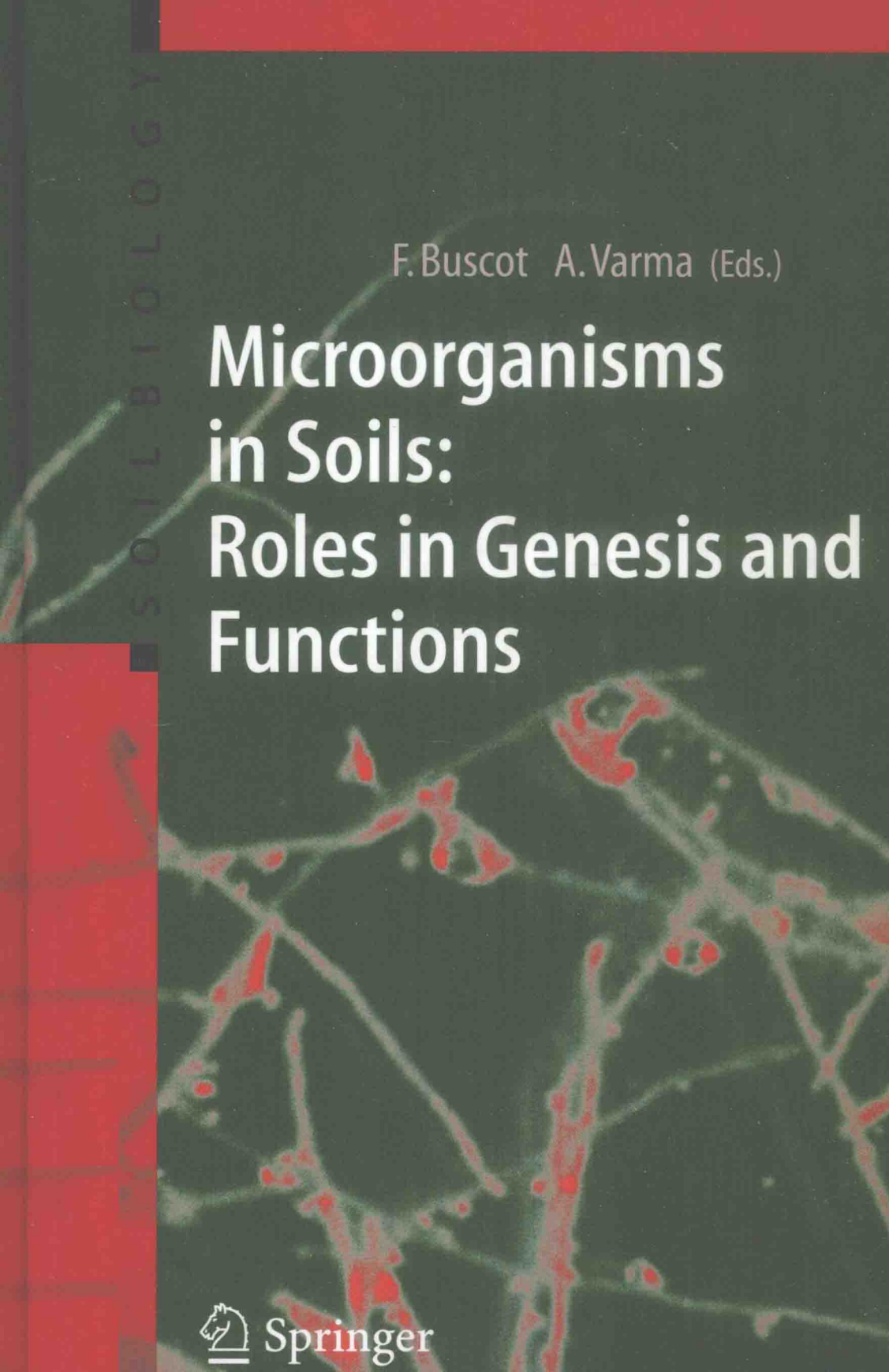
SOIL BIOLOGY

F. Buscot A. Varma (Eds.)

Microorganisms in Soils: Roles in Genesis and Functions



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François Buscot • Ajit Varma (Eds.)

Microorganisms in Soils: Roles in Genesis and Functions

With 71 Figures

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Preface

The inspiration and concept for preparing this volume were conceived while both of us were sipping a cup of Columbian coffee in the Goethe Gallery, Jena (Germany). The idea developed that soils are dynamic biological systems and certainly not a static substrate that supports the life of microbes, plants and animals. Microorganisms play a vital role in creating this universe and maintaining life in it. Dealing with the interrelationships of organisms and the relationships between organisms and their environment was formerly more or less confined to a small group of specialists within the scientific community. This has changed in the current scenario. Growing environmental problems have created a public awareness of the ecological disturbances and dangers related to excessive industrial expansion and the way of life in "disposable societies". As a consequence of the perceived importance of ecology, research in this field has developed rapidly. As one of the three environmental media besides water and air, soils have now become a central concern for a broad range of scientists.

In the golden era of microbiology, the study of soil organisms soon became an area of interest to a large number of early bacteriologists, and the pioneering investigations of Winogradsky, Omeliansky, and Beijerinck still stand as major contributions to our knowledge of the bacterial population. At the same time, it became apparent to soil scientists that the surface crust of the earth is not merely a static physiochemical matrix upon which green plants grow, but also a biological system in a continuous dynamic equilibrium. In the realm of pure science, information on the ecology, function, and biochemistry of microflora has grown considerably so that a clear picture of soil biology is beginning to emerge.

The innumerable developments in recent years make a complete review impossible within the scope of a single volume. Some of the more detailed points have been omitted for brevity, yet, where conflicts still exist, contrasting viewpoints are presented. Time may change these views, but it is in the very nature of science to be in a continual state of flux and for the errors of one generation to be amended by the next. Soil microbiology is not a pure discipline. Its parentage may be traced through bacteriology, mycology, and soil science; biochemistry and plant pathology have also made their mark, especially in recent years.

In the framework of agriculture, the microflora is of significance for man's ability to feed himself. For the microbial inhabitant, the soil functions as a unique ecosystem to which the organism must adapt and from which it must obtain sustenance. However, in the final analysis, microbiologists can find definitive answers as to how these processes are brought about only through biochemical inquiries.

We have attempted to bring together the major aspects of rhizosphere research and principles of rhizosphere ecology for the benefit of developing young scientists and technologies, as well as for the established professional researcher and teacher. A prime objective and hope is that this volume might generate ideas that will bring forth new approaches and methodology leading to further advances in our understanding of rhizosphere interactions and their implications for agriculture and forestry. Nevertheless, even if the rhizosphere is the compartment from which plants acquire their water and nutrients and a hot spot of microbial and animal activity, this compartment can only be understood in the context of whole soil functioning, from soil genesis to the nutrient cycling, and including the exchanges with water and atmosphere. These aspects therefore occupy a large part of the volume.

References are of great value not only to the research worker, but to the advanced student as well. The blind acceptance of secondary sources when primary material is readily accessible is not the hallmark of the serious student. Where available, reviews are included in the reference lists of each chapter so that the finer points of each topic may be sought out. Pertinent original citations are likewise included since these permit the student and researcher alike to examine the original source, observe the techniques utilized, and draw their own conclusions. However, a mere literature review is not intended, since much good work has not been cited. We have deliberately drawn upon some old research information, largely for the benefit of advanced students and young scientists, to show where research has come from and where it may be going. In doing this, we believe we have revealed many gaps in our knowledge which are yet to be filled. Emphasis is given to the more recent papers, but certain classical works are also included, particularly where the studies have been of such a nature as to define a unique approach. It may also be of value to students majoring in other fields, such as soil science, geology, hydrology, plant ecology, zooecology, phytopathology, agronomy, forestry, or the environmental, crop sciences, natural science management, agricultural engineering, biological sciences, animal sciences, and life sciences.

For meaningful contributions to be made in the future, the need for refined technology and a multidisciplinary pooling of expertise by soil microbiologists, phytopathologists, soil physicists and chemists, plant physiologists, and zoologists should be clearly evident.

The presentation is essentially arranged into six main parts. The Introduction or Part I outlines the definition of soils and dynamics to the microbial diversity. Part II deals with varied functions of the microorganisms and soil genesis. In Part III, we highlight the biogeochemical processes. The biotic interactions in terms of plant/microorganisms involving symbiosis are given in Part IV. Functions of microbes in specific soil compartments are discussed in Part V. Modern tools and techniques to understand soil biology are elucidated in Part VI.

It is hoped that the groundwork will be laid herein for a fuller enquiry on the part of the readers. If this goal is achieved even in part, the volume will have served its purpose.

Molecular microbiological studies have focused our attention in recent times on the characterization of known as well as unknown microbial species implicated in soil transformation and plant growth.

While assuming sole responsibility for any omissions or errors in the book, we are grateful to all those unselfish individuals who have contributed to the chapters. Finally, we would like to ask the reader to make allowances for our lack of linguistic proficiency considering that English is not our mother tongue.

We are grateful to the many people who helped bring this volume to light. We wish to thank Dr. Dieter Czeschlik and Dr. Jutta Lindenborn, Springer-Verlag, Heidelberg for generous assistance and patience in finalizing the volume. Finally, specific thanks go to our family, immediate, and extended, not forgetting the memory of those who passed away, for their support or their incentive in putting everything together. Ajit Varma in particular is very thankful to Dr. Ashok K. Chanhan, founder president, An Institute of Ritnand Balved Education Fondation (Amity), New Delhi, for the kind support and constant encouragement received. Special thanks are due to my Ph. D. students Ms. Rina Kamari and Mr. Ram Prasad for compiling the subject index.

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June 2004

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