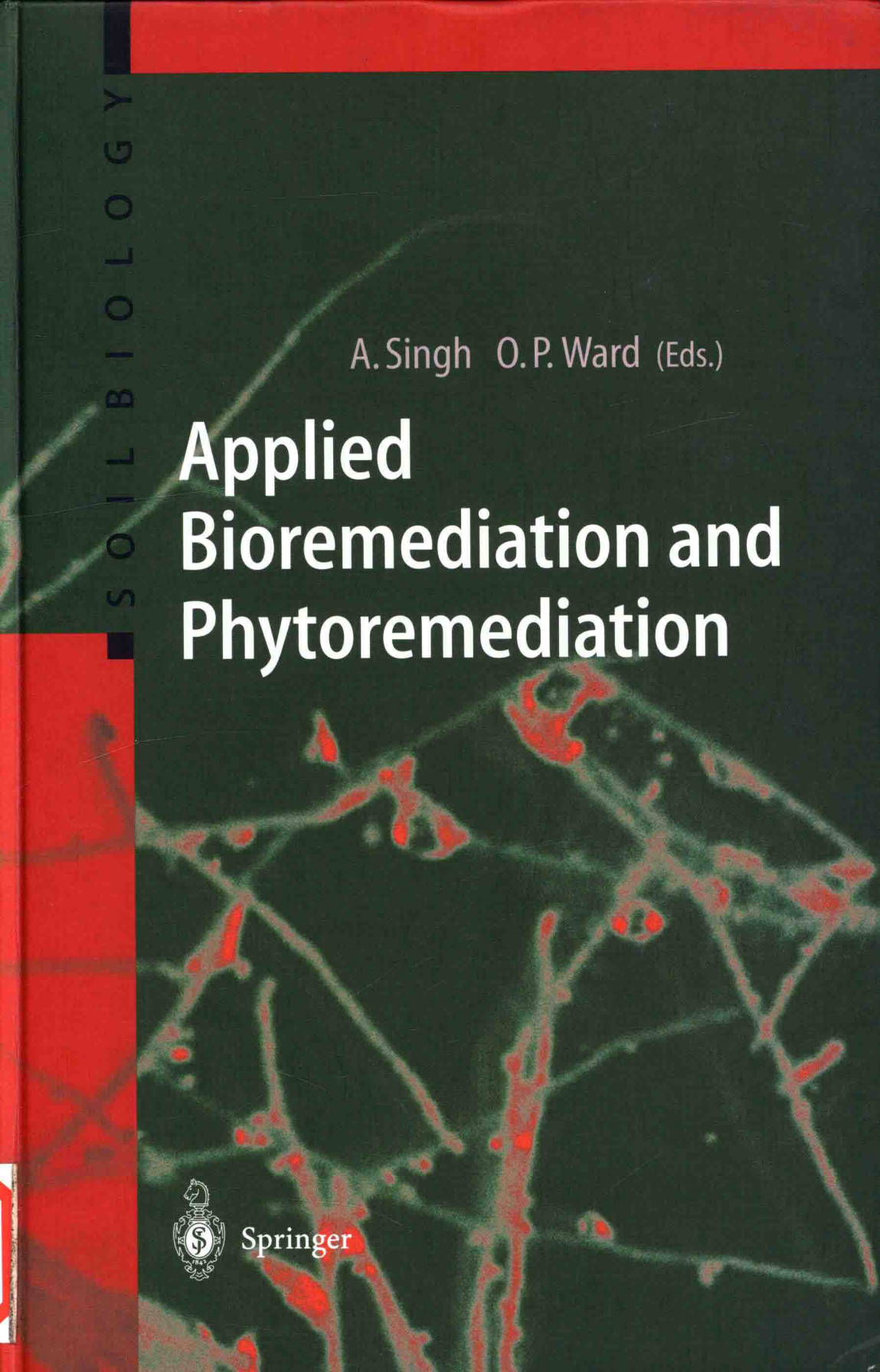
SOIL BIOLOGY

A. Singh O. P. Ward (Eds.)

Applied Bioremediation and Phytoremediation



Springer

Ajay Singh • Owen P. Ward (Eds.)

Applied Bioremediation and Phytoremediation

With 19 Figures and 27 Tables

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Preface to the Series

Soil is a complex mixture of inorganic matter consisting of mineral particles, organic matter from decaying biomass, microorganisms, plants, and animals. The uppermost soil layer supports the most life, including plants that send their roots into the topsoil from which they derive essential nutrients. In addition, soil is the home of many insects, worms, burrowing animals, invertebrates, and microorganisms. Soil microbes interact among themselves, with plants and animals, and provide a perennial source of organic matter, which can be recycled for plant nutrition. Soil provides the physical support needed for the anchorage of the root system and also serves as a reservoir for air, water, nutrients and microorganisms, which are so essential for plant growth. Unfortunately, integrated information on different aspects of the soil biology, chemistry, physics and topography is lacking. However, such data are important in order to extend our knowledge of the soil sciences. The *Soil Biology* Series, which is the first of its kind, deals with the study of the nature, types and functioning of soil and the inhabiting organisms (macro- and microorganisms).

Soil contains organic matter derived from microorganisms, animal wastes, and plants, which are potential sources of various nutrients. Much of this plant material is recycled by the biochemical activities of microorganisms into usable nutrients, and humus. Humus is a dark-colored soil material that is composed largely of decay-resistant organic matter. Soil influences a different group of microorganisms including bacteria, actinomycetes, fungi, viruses, algae, protozoa, nematodes and several other organisms. The fertility of soil depends not only on its chemical composition, but also on the qualitative and quantitative nature of the microorganisms inhabiting it. Microorganisms carry out a large number of metabolic activities of immense importance, namely, nitrogen fixation and chemical transformation of nitrogen, sulfur, carbon, iron, phosphorus, etc. They also play a significant role in bioremediation, biodegradation and heavy metal accumulation.

Bioremediation, i.e. the application of biological methods, has gained prominence as an option for soil remediation methods. Biological processes are environmentally compatible and can be integrated with

non-biological processes for remediation of environmental pollutants. Large-scale manufacturing, processing and handling activities in the petroleum and chemical industries result in the production of a large number of chemical compounds. Spills and unsafe disposal of these xenobiotic compounds cause a serious deterioration in environmental quality. These negative impacts have led to serious responses from the government and non-governmental organizations. New regulations are now being implemented requiring remedial action in support of environmental sustainability.

Bioremediation, the main topic of Volume 1 of the *Soil Biology* Series, *Applied Bioremediation and Phytoremediation*, has been used successfully to remediate contaminated sites. It is a rapidly advancing field and new bio-based remedial technologies are continuing to emerge.

It is my pleasure to work as Editor-in-Chief of the *Soil Biology* Series, primarily due to the stimulating cooperation of the volume editors. I would like to thank Dr. Dieter Czeschlik, Editorial Director Life Sciences, and Dr. Jutta Lindenborn, Springer-Verlag, for their help and friendly cooperation during the preparation of this volume. I am grateful to Professor Ajay Singh and Professor Owen Ward for their efforts in compiling the volume in record time.

New Delhi, March 2004 Ajit Varma

Preface

The huge expansion of the chemical and petroleum industries in the twentieth century has resulted in the production of a vast array of chemical compounds and materials that have transformed our lives. The associated large-scale manufacturing, processing and handling activities have caused a serious deterioration in environmental quality and created threats to human health. These negative impacts have led to responses and regulations requiring remedial action in support of environmental sustainability.

Application of biotechnological methods through bioremediation, has gained prominence as an option for soil remediation methods. Bioremediation is a multidisciplinary approach where biologists, chemists, soil scientists and engineers work as team to develop and implement remediation processes. Bioremediation has now been used successfully to remediate many petroleum-contaminated sites. However, there are as yet no commercial technologies commonly used to remediate the most recalcitrant contaminants. Nevertheless, bioremediation is a rapidly advancing field and new bio-based remedial technologies are continuing to emerge.

Applied Bioremediation and Phytoremediation, Volume 1 of the series *Soil Biology*, addresses a wide range of topics related to applied aspects of microbial and plant-based technologies for treatment of environmental contaminants. Topics include bioremediation of petroleum hydrocarbons, explosives, pesticides and metallic pollutants, bioremediation in extreme environments, natural attenuation and phytoremediation of persistent organic contaminants and metals. Chapters dealing with innovative methods address current bioremediation technologies, biofiltration and risk-based soil remediation approaches. Volume 2 of the series *Soil Biology*, *Biodegradation and Bioremediation* will focus on basic microbiological and biochemical processes in bioremediation.

This book contains contributions from authorities in the areas of bioremediation and phytoremediation. The authors are from diverse backgrounds, universities, government laboratories and industry, who do basic, applied and industrial research. This book should prove to be useful to under- and post-graduate students of biotechnology, micro-

biology, and soil and environmental sciences and engineering. We hope that teachers, scientists and engineers, whether in academia, industry or government, will find the contents, including its practical aspects, helpful.

We are grateful to all the authors for their excellent contributions. Several of our colleagues provided encouragement and help during the various stages of this editorial work. Continuous support and guidance provided by Dr. Ajit Varma, Editor-in-Chief of the series *Soil Biology*, and Dr. Jutta Lindenborn, Springer-Verlag, during the preparation of this volume, are highly appreciated.

Guelph, Waterloo, Ontario, March 2004
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