Preface

The volume *Soil Heavy Metals* was conceived during the summer of 2007 at an informal Indian–German get-together at Jena. We believe that brilliant ideas crop up over either a cup of Indian tea or a jar of German beer!

All life on Earth depends on the photosynthetic activity of plants, which produce oxygen and reduced carbon for all autotrophic and heterotrophic life. Most of the nutrients needed by plants come from the soil, which is the outermost solid layer of the Earth and is a combination of inorganic and organic materials. The quality of the soil has a strong influence on the overall health of plants and their existence, and the plant ecosystem controls our planet. Soils are certainly not static substrates; they are dynamic biological systems that support microbe, plant and animal life.

The innumerable developments that have taken place in recent years in the field covered by this book 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 do exist, contrasting viewpoints are presented. Time may change these views, but it is 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.

Human activities have dramatically changed the composition and organisation of the soil on Earth. Industrial and urban wastes, in particular the uncontrolled disposal of waste and the application of various substances to agricultural soils, have resulted in the contamination of our ecosystem. Another oft-cited example is mining activity, which has resulted in the deposition of unusually high concentrations of heavy metals onto the soil surface. Plant and soil microorganisms must cope with the resulting elevated levels of heavy metals in the soil, and so they have developed sophisticated techniques for surviving and coexisting in such environments.

Soils are both an important reservoir of chemical elements and a living matrix, as clearly described in Chap. 1 by Helwig Hohl and Ajit Varma. A definition of heavy metals and their role in biological systems is provided by Klaus-J. Appenroth in the following chapter. Soil microbial diversity in relation to heavy metals is expressed in detail by Shwet Kamal, Ram Prasad and Ajit Varma in Chap. 3. The uptake and effects of heavy metals on the plant detoxification cascade in the presence and absence of organic pollutants is then discussed by Ljudmila Ljubenova and Peter Schröder, who show that there is a clear-cut interrelationship between...
inorganic and organic pollution. In the next chapter, Hermann Bothe, Marjana Regvar, and Katarzyna Turnau introduce the biology of arbuscular mycorrhizal fungi, and biochemical and molecular aspects of heavy metals and salt tolerance.

Analytical options and (im)possibilities relating to the trace element determination of environmental samples, placing special focus on different X-ray methods, are critically reviewed by Katarina Vogel-Mikuš, Peter Kump, Marijan Nečemer, Primož Pelicon, Iztok Arčon, Paula Pongrac, Bogdan Povh and Marjana Rengvar in Chap. 6.

In subsequent chapters, special attention is devoted to physiological and biochemical behaviour of different microbiological species, populations and communities.

The relationship between metal hyperaccumulation and glucosinolates is presented by Paula Pongrac, Roser Tolrà, Katarina Vogel-Mikuš, Charlotte Poschenrieder, Juan Barceló and Marjana Regvar. The combined effects of heavy metals and salinity on plants from various ecological groups are the focus of Chap. 8, provided by Valentina Kholodova, Kirill Volkov and Vladimir Kuznetsov. The use of the structure and functionality of the microbiological community as indicators to evaluate the health of heavy metal polluted soils is then presented by M. Belén Hinjosa, Roberto Garcia-Ruiz and José Carreira. Extra- and intracellular mechanisms of heavy metal resistance by streptomycetes are explained by Erika Kothe, Christian Dimpka, Götz Haferburg, Andre and Astrid Schmidt, and Eileen Schütze. Chapter 11 gives an assessment of the relationship between soil enzymes and heavy metals, as provided by Ayten Karaca, Sema Camci Cetin, Ozun Can Turgay and Ridvan Kızılkaya. Effects of heavy metals on saprophytic soil fungi are then discussed by Petr Baldrian, followed by a description of copper-containing oxidases, their occurrence in soil microorganisms, and related properties and applications, by Harald Claus.

The analytical detection of the biomethylation of heavy metals in soil and terrestrial invertebrates is presented in Chap. 14 by Burkhard Knopf and Helmut König, with special reference to Hg, Se, As and Bi. Andrea Zanuzzi and Angel Faz Cano then describe the possibility of phytostabilizing lead-polluted sites using native plants. The next chapter describes the impact of heavy metals on sugarcane, and is presented by D.V. Yadav, Radha Jain and R.K. Rai. In Chap. 17, the effects of the activities of earthworms on the availability and removal of heavy metal in soils is discussed by Ayten Karaca, Ridvan Kızılkaya, Oguz Can Turgay and Sema Camci Cetin. Then the phytoremediation of heavy metal contaminated soils is presented by T.J. Purakayastha and P.K. Chhonkar. Finally, Preeti Saxena and Neelam Misra focus their attention on the remediation possibilities associated with heavy metal contaminated tropical land.

In this volume, we have made great efforts to throw light on some aspects and mechanisms of how microorganisms interact with biological systems and allow them to survive in contaminated soil. An attempt has been made to highlight the mechanisms that prevent uptake or allow the detoxification of heavy metals from contaminated soil.

In planning this volume, invitations for contributions were extended to leading international authorities working with nutrients to heavy metals. We would like to
express our deep appreciation to each contributor for his/her work, patience and attention to detail during the entire production process. It is hoped that the reviews, interpretations and concepts proposed by the authors will stimulate further high-quality teaching and research, as the information presented tends to highlight both the need for further work in this field and the lack of agreement on some fundamental issues.

It has been a pleasure to edit this book, primarily due to the stimulating cooperation of the contributors. We wish to thank Dr. Dieter Czeschlik and Dr. Jutta Lindenborn, at Springer Heidelberg, for their generous assistance and patience in finalizing the volume. Finally, we give specific thanks to our families – immediate and extended – for their kind support and their incentives to put everything together.

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