

BOOK REVIEWS

Earthworm Ecology, 2nd ed.

2004. Clive A. Edwards, ed.

CRC Press, P.O. Box 409267, Atlanta, GA
30384-9267, 441+ pp., \$99.95 (H). ISBN 0
8493-1819-X.

The first edition of *Earthworm Ecology* was published in 1998. It was edited by Clive Edwards, and included 16 chapters by various distinguished scientists who were invited to give review and final overview papers at the Fifth International Symposium on Earthworm Ecology in Columbus, Ohio in July of 1994. The second edition of *Earthworm Ecology*, published in 2004 and also edited by Professor Edwards, includes updated and extensively revised versions of the original chapters, as well as four new chapters. It is a welcome addition to the growing body of work on the science of earthworms.

The book has 20 chapters grouped in nine parts: I. Introduction; II. Earthworm Taxonomy, Diversity and Biogeography; III. Earthworm Biology, Ecology, Behavior, and Physiology; IV. Influence of Earthworms on Soil Organic Matter Dynamics, Nutrient Dynamics, and Microbial Ecology; V. Effects of Earthworms on Soil Physical Properties and Function; VI. Interactions of Earthworms with Microorganisms, Invertebrates, and Plants; VII. Earthworms in Agroecosystems; VIII. Earthworms and Environmental Pollution; and IX. Earthworms in Waste Management.

The four new chapters in *Earthworm Ecology* provide new perspectives and insights into different aspects of earthworm ecology. For Part I, Edwards has written an introductory chapter that touches on important aspects of the history of scientific inquiry into earthworms, their taxonomy and ecology, their role in soil fertility, function as indicators of soil quality, use in pollution abatement, problems associated with earthworm immigration, and effects of agriculture on earthworms, as well as research need. The chapter provides an overview of the topics covered in the rest of the book.

Also in Part I, "How Earthworms Affect Plant Growth: Burrowing into the Mechanisms" by

George Brown, Clive Edwards, and Lijbert Brussaard is a particularly welcome addition to the second edition of *Earthworm Ecology*. It addresses the gap in information between the observed responses of plants to earthworm activities (mostly positive, sometimes negative, rarely neutral), and the mechanistic underpinnings of such responses. Brown et al. describe seven main mechanisms by which earthworms affect plants, from production of plant growth-regulating/influencing substances to changes in the spatial and temporal distribution of nutrient availability. Each mechanism is described in detail, and both supporting and contradictory evidence from the literature is presented. Furthermore, they examine the pros and practical limitations of the micro- and mesoscale, reductionist approach to experimental evaluation of mechanisms, advocating for field experiments because of the practical context in which the information is gathered and the associated utility to practitioners.

Another timely addition to this edition is a chapter by Samuel James and Paul Hendrix, "Invasion of Exotic Earthworms into North America and Other Regions". Exotic invasive species in general are a topic of great interest to environmental managers and scientists alike, and earthworms in this category are of particular interest because of their role as keystone species. James and Hendrix list the criteria used to classify earthworms as exotic, describe the characteristics that make them invasive, and discuss the mechanisms by which invasions take place. Of particular interests are the sections on how invasive species interact with native earthworms and with other organisms, and on the effects of invasive earthworms on ecosystem processes. The chapter ends with a discussion on what can be done about exotic earthworm invasions based on what is known about the science and management of earthworm populations.

The final new chapter in *Earthworm Ecology*, by Jorge Dominguez, addresses both the science and technology of vermicomposting. It considers the suitability of different earthworm species, their autoecology, and provides a case study in which the various processes (e.g., nu-

trient and C transformations, humification, pathogen destruction) associated with vermicomposting are examined. Dominguez also identifies gaps in information in vermicomposting science and technology.

The 16 revised chapters in the second edition of *Earthworm Ecology* offer up-to-date information and hypotheses on a wide variety of topics, from taxonomy to long-term, landscape scale effects on nutrient dynamics, to impacts on forest biota, to their uses in ecotoxicology. The chapters in Part II offer a wide variety of perspectives on taxonomy, diversity and biogeography of earthworms. In addition to the chapter on invasive exotics discussed earlier, Part II includes a chapter by Samuel James that gives a planetary-scale view of the how geologic processes affect the distribution and ecology of earthworms and what earthworms can tell us about geologic events. There is also a report, authored by John Reynolds, on the current status of earthworm biogeography, diversity, and taxonomy in North America and a discussion of research trends and needs in these areas.

Part III addresses the biology, ecology, behavior, and physiology of earthworms. It begins with a chapter by James Curry that discusses the factors affecting the abundance of earthworms, including climate, soil properties, food, competition, predation, parasitism and disease, and a wide range of land management practices. There is also a very thorough study by Pop and Pop on the taxonomy and ecology of earthworms in the genus *Octodrilus* from the Carpathian Mountains in Eastern Europe, which includes information on everything from the molecular taxonomy and phylogeny of species in this genus, to the structure of earthworm communities, to their role in the development of vermic soils.

The influence of earthworms on the dynamics of soil organic matter and nutrients, and on microbial ecology are discussed in Part IV. Lavelle et al. take a long-term, broad-scale look at organic matter and nutrient dynamics, with emphasis on tropical savannahs and agroecosystems. Bohlen et al. consider a number of conceptual models for integration of the effects of earthworms on nutrient cycling across spatial and temporal scales. They describe a hierarchical approach that integrates the results of studies from the single organism scale on to the population, community, ecosystem, and landscape scales to understand how earthworms impact biogeochemical cycles.

In Part V, the subject is the effects of earthworms on soil physical properties and function. Shipitalo and Le Bayon describe the effects of earthworms on soil aggregation and porosity, considering both the conceptual mechanisms and determination of processes involved, and the advantages and limitations of the methods necessary to assess the practical effects on stability, erosion, and water quality. Kretzschmar takes up the question of cause and effect between the activities of earthworms and changes in the physical properties and functions of soil. Also addressed are methodological constraints in the study of earthworm-soil interactions.

Brown and Doube cover the interactions between earthworms, microorganisms, organic matter, and plants in the first chapter of Part VI. The emphasis is on cropped soils, and interactions between earthworms and soil biota are considered at scales ranging from the gut of the earthworm to the fields within which earthworms are found. Also in Part VI, Parkinson et al. discuss the impacts of earthworms on soil biota in forest soils. They focus on cool temperate montane forests, with particular attention to earthworm invasions of North American forests by European earthworm species and their effect on soil microorganisms, fauna, and plant communities.

Part VII considers earthworms in the context of agroecosystems. Baker concerns himself with the management of earthworms as a resource in Australian pastures. This chapter considers a wide range of topics, from the earthworm fauna of Australia, to the effects of agricultural management practices on earthworms, to the intentional introduction of exotic earthworm species as a management tool. Hendrix and Edwards deliver a review of the status of research on earthworms in an agricultural context, and identify priorities for research on the influence of earthworms on agricultural soils and crop production.

The role of earthworms in environmental pollution is addressed in Part VIII. Reinecke and Reinecke review the use of earthworms as test organisms in ecotoxicological assessments. They examine their use in acute and chronic toxicity testing, as indicators and monitors of exposure and bioavailability of chemicals, and in field toxicity testing. The chapter by Eijsackers examines the mechanisms of contaminant uptake, elimination, and bioaccumulation by earthworms. The use of appropriate toxicological endpoints is discussed, as well as the use of earthworms in field studies to evaluate pesticide and heavy metal tox-

icity, to rejuvenate contaminated soils, and to assess the transfer of toxicants at the level of food-webs and ecosystems.

Part IX concerns the use of earthworms in waste management. In addition to the chapter by Domínguez, discussed earlier, a chapter by Edwards and Arancon describes the use of earthworms in breaking down organic wastes to produce vermicomposts and animal feed protein. Considered within this chapter are the breakdown of a wide variety of wastes (from sewage sludge to urban organic industrial wastes) by earthworms, the suitability of particular species of earthworms for processing of organic wastes, the effects of vermicomposts on plants and soils, the value of earthworms as a source of protein in feed in animal production, and a variety of methods used to process organic wastes with earthworms. The chapter by Kale addresses the use of earthworms in utilization of organic wastes in Asia, with emphasis on the practices carried out in India.

In the second edition of *Earthworm Ecology*, Professor Edwards has brought together an impressive list of experts in the field. The book offers a well-edited, superb synopsis of the growing body of information on the ecology of these keystone organisms. Its contents are not only relevant to the serious student of earthworm ecology, but impinge on a wide range of research areas, from soil genesis and morphology to microbial ecology, to sustainable agriculture and waste management. Its 20 chapters are very informative, offering well-written syntheses of contemporary issues in earthworm ecology. Last, but not least, the second edition of *Earthworm Ecology* is priced reasonably.

José A. Amador

University of Rhode Island

Amazonian Dark Earths

2004. J. Lehmann, D.C. Kern, B. Glaser & W.I. Woods, eds.

Kluwer Academic Pub., P.O. Box 989, 3300 AZ Dordrecht, The Netherlands. 523 pp., \$149 (US), €135, ISBN: 1-4020-1839-8.

This book resulted from presentations at the First International Workshop on Terra Preta de Indio (Indian Black Earth) held in Manaus, Brazil, July 10–19, 2002. Amazon Dark Earths (ADE) are dark-colored (dark brown to black), high organic, and generally enriched in nutrients such as P. These soils are in such contrast to other

soils of the humid tropical lowlands that they were of keen interest in the 1870s and interest continues today. According to the editors, this publication provides the first comprehensive review of Amazonian Dark Earths. These unique soils are thought to have resulted from past human activity and, thus, they have been of interest to a wide spectrum of scientists, especially in archaeology, history, anthropology, ecology, geography, and soil science.

The book is divided into four sections: I. Discovering Amazonian Dark Earths, II. Properties of Amazonian Dark Earths, III. Methods for Characterization of Amazonian Dark Earths, and IV. Amazonian Dark Earth Management. The book has a total of 23 chapters with nearly equal numbers of chapters for the four sections. Over 50 authors contributed to the writing of the book.

Section I has chapters on development of Anthrosol research, historical perspective, historical and sociocultural origins of ADE, distribution of ADE, and classification of ADE. These soils occur along major rivers in all regions and landscapes in Amazonia; they are in nonfloodable land and in well-drained positions. The ADEs are found on a variety of soil types; however, Ferralsols and Acrisols are the most common. Although this book concentrates on ADEs in the Brazilian Amazon, they also occur in other Latin American countries. The introduction of the archaeo-anthropogenic horizon and the Archaeo-Pedological Classification Legend in the classification chapter was interesting and may provide application to classifying soils at archaeological sites in other regions.

The chapters in the section on Properties of Amazonian Dark Earths include chapters on soil fertility and production potential, ADEs as carbon stores and sinks, soil organic matter stability, agrobiodiversity, and ethnoscientific understanding of ADEs. The discussion on soil organic matter stability in ADEs was very interesting and informative.

Methods for studying ADEs include archaeobotanical, organic chemistry, micromorphology, nutrient bioavailability, soil physical characterization, biological measurements, and pedo-geochemical and mineralogical analyses. The background information on the methods described provides a good understanding of their application to archaeological studies.

The last section of the book on Amazonian Dark Earth Management provides information on specific studies relating to land use practices,

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