

PRINCIPLES
OF SOIL
MICROBIOLOGY

WAKSMAN

SECOND EDITION

PRINCIPLES OF SOIL MICROBIOLOGY

BY

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PREFACE TO THE FIRST EDITION

Although the biochemical processes in the soil as well as the nature of the microorganisms present there have received considerable attention from various points of view and although an extensive literature has accumulated, not only dealing with soil processes in general but even with certain specific activities of the organisms, our present knowledge of the soil microflora and microfauna and of the numerous transformations that they bring about has not advanced beyond a mere beginning of a systematic study. The isolation of numerous microorganisms from the soil, their identification and cultivation upon artificial media is very important but such data do not tell what rôle they play in the soil. A knowledge of the activities of certain organisms isolated from the soil is certainly necessary, but that is not a knowledge of the extent to which these processes take place in the soil itself. A book on soil microbiology should include a study of the occurrence of microorganisms in the soil, their activities and their rôle in soil processes. It is this last phase which has been studied least and where the information available is far from satisfactory in explaining what is taking place in the soil. This is due largely to the limitations of the subject which depends for its advance on botany, zoology, bacteriology, chemistry, including biological and physical, and especially upon the advance of our understanding of the physical and chemical conditions of the soil.

There are various kinds of audiences to which a book on soil microbiology may appeal. There is the scientific farmer who may search for a better understanding of the processes taking place in the soil, those processes which control the growth of his crops and indirectly influence the growth of his animals. There is the agronomist, who is interested in the fundamental reactions controlling soil fertility by reason of the need of directing such processes towards a greater utilization of the nutrients added to the soil or stored away in the soil organic matter. There is the investigator, the soil chemist or the soil microbiologist, who, in attacking problems dealing with the occurrence of microorganisms in the soil, their activities, and especially with the relation of these activities to the physical and chemical soil conditions, seeks for specific or general information. These investigators may deal with organisms or

processes which could be better understood when correlated with the other soil organisms and the numerous other processes. An attempt has been made to compile a book which will be of service not only to the investigators in soil science, but also to workers in allied sciences, especially botany, plant physiology, plant pathology and bacteriology, as well as to the general student in agriculture.

This book is a collection of known facts concerning microorganisms found in the soil and their activities; it is a study of the literature dealing with the science in question; it is an interpretation of the facts already presented; it indicates the various lines of investigation and notes where further information is especially wanted. Soil microbiology is a science which is at the very base of our understanding of agricultural processes and the practice of agriculture; it comprises a number of sciences. The book may, therefore, be looked upon more as an introduction to further research rather than as an ordinary text-book; as of help to those working in the allied sciences, who are desirous of obtaining some information concerning the soil population and its activities.

If this volume will help to disclose to the reader some of the numerous interrelated processes in the soil, if it will present in a clearer light to the chemist, the physiologist, the botanist, the bacteriologist and the zoologist the nature of the many scientific and practical problems awaiting the investigator, if it contributes in a small measure toward making soil science an exact science, the author will feel that he has been amply rewarded.

The author is greatly indebted to his various colleagues for reading and criticizing the different chapters of the book and for many helpful suggestions generously offered, especially to Dr. J. Blom, Mr. A. Bonazzi, Dr. B. M. Bristol-Roach, Dr. R. Burri, Dr. N. Cobb, Dr. H. J. Conn, Mr. D. W. Cutler, Dr. E. B. Fred, Dr. W. M. Gibbs, Dr. I. C. Hall, Dr. A. T. Henrici, Prof. D. R. Hoagland, Dr. L. R. Jones, Dr. W. P. Kelley, Dr. C. A. Kofoed, Dr. L. T. Leonard, Dr. J. G. Lipman, Dr. O. Meyerhof, Dr. G. T. Moore, Dr. T. B. Osborne, Dr. M. C. Rayner, Dr. H. Sandon, Dr. R. L. Starkey, Dr. J. Steiner, Dr. Ch. Thom and Dr. A. T. Whiting, as well as to all those who have generously allowed the use and reproduction of the various illustrations in the text.

SELMAN A. WAKSMAN.

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New Brunswick, N. J., U. S. A.

PREFACE TO THE SECOND EDITION

Within the brief period of four years, since the appearance of the First Edition of this book, the numerous contributions to our knowledge of the rapidly growing subject of microorganisms and their activities in the soil necessitate a number of changes in the new Edition. The book has been brought to date by the incorporation of the additional information. A number of chapters have been entirely rewritten, especially those dealing with the mycorrhiza fungi and the soil as a medium for plant and animal parasites. A number of new chapters have been added, dealing with the rôle of microorganisms in the decomposition of organic matter in green manures and stable manures, in the formation and decomposition of peat and forest soils, and with the relation between plant growth and the activities of microorganisms in soil. To avoid any considerable increase in the actual size of the book, a certain amount of condensation became necessary so as to balance the added material. This was accomplished by leaving out some of the text which did not bear directly upon the subject under consideration. Several chapters have been combined so as to avoid unnecessary duplication.

As in the previous Edition, the interdependence between the activities of microorganisms and the chemical transformations in the soil has been particularly emphasized. The added chapters tend to stress further the influence of the soil as a medium upon the nature and activities of the microorganisms in the soil.

The author availed himself of the criticisms which have been so freely given in the various reviews of the first edition of this book that have appeared in English and in other languages; also of the numerous suggestions offered by various colleagues through correspondence. Opportunity is hereby taken by the author to express his gratitude to all his friends and colleagues in the various fields of microbiology and soil science for the generous assistance thus rendered.

In view of the rapidly growing bibliography of the subject of microbiology and its relation to soil processes, it seemed more desirable to leave out the titles of the papers rather than to have to sacrifice some of the older or even some of the more recent references to the literature.

SELMAN A. WAKSMAN.

March 1, 1931.

New Brunswick, N. J.

A CLASSIFIED LIST OF BOOKS FOR REFERENCE IN SOIL MICROBIOLOGY

CLASSIFICATION OF ORGANISMS

Bacteria

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TREATISES IN GENERAL SCIENCES

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