Preface

MANY IMPORTANT infectious diseases are associated with human excreta. The most common association is that the pathogens causing the disease leave an infected person by way of the feces or urine. Excreta are thus the direct source of these infections. Less commonly and directly, excreta may be associated with the breeding of insects that are vectors of disease. The hygienic management and disposal of human excreta is thus of central importance in the control of these associated diseases. This is true in both poor and rich countries and across all climatic zones.

Most people in the developing countries do not have adequate disposal systems for human wastes. A survey of developing countries by the World Health Organization (WHO) in 1975 indicated that 75 percent of urban dwellers did not have sewerage (that is, sewers for disposal of excreta) and that 25 percent had no disposal system of any kind. In rural areas, 85 percent lacked any adequate excreta disposal facility. Major national and international initiatives are clearly required if any substantial improvement in sanitation systems in the developing world is to be made in the next few decades.

In the more wealthy and industrialized countries, most people have adequate excreta disposal arrangements in their homes and places of work. The treatment and disposal of human wastes, however, pose enormous problems for the responsible agencies. Large cities produce such volumes of sewage and such quantities of sludge that the infrastructure for the safe disposal of these wastes may be stretched to the limit. It is in this context that decisions about pathogen destruction in sewage and sludge and about the risks to public health of various treatment and disposal options become of the utmost importance.

In all countries, public health is of central importance in the design and implementation of excreta disposal projects, and better health is the main social and economic benefit that planners and economists hope to gain by investing in excreta disposal systems. To achieve this gain as much information as possible is needed about the interactions between excreta and health—information not only about broad epidemiological issues of disease prevention through improved excreta disposal, but also about the effect of particular excreta disposal and reuse technologies on the survival and dissemination of particular pathogens.

Scope and Organization

This book sets out to provide such information for a broad readership. It is intended for the wide spectrum of professionals concerned with sanitation and public health: those who control—such as health planners, economists, and public health administrators; those who implement—such as environmental hygienists, sanitary engineers, public health workers, and health educators; and those who study and advise—especially epidemiologists, microbiologists, and parasitologists. The book has been written with a minimum of technical jargon so that it can be readily absorbed by people from different professional backgrounds; technical terms are defined when they are used, and acronyms and abbreviations are listed on page 22.

The book has two parts. Part One, entitled "The Health Hazards of Excreta: Theory and Control," presents a distillation of available knowledge about excreta, night soil, and sewage and their effects on health. The emphasis is on presenting the complex, and sometimes contradictory, evidence as clearly and concisely as possible. The source for Part One is largely, but not entirely, the literature. On occasion, we have gone beyond the literature to state what we anticipate to be the case; this theoretical content is based on a fundamental understanding of the particular disease or pathogen. Inevitably, the need for

clarity and the demands of limited space have necessitated some oversimplification.

Part Two, entitled "Environmental Biology and Epidemiology of Specific Excreted Pathogens," contains twenty eight chapters, each describing the environmental properties of a specific excreted pathogen or group of excreted pathogens and the epidemiology and control of the infections these pathogens cause. Emphasis is placed on the occurrence and survival of the pathogen in the environment and on the efficacy of various waste treatment processes in reducing or eliminating the pathogen. For ease of reference, the chapters of Part Two are grouped by biological class of pathogen in five sections—the excreted viruses, bacteria, protozoa, and helminths, and the excreta-related insect vectors of disease. As in Part One, the material in Part Two is derived from the literature. Where documentation is ambiguous or contradictory, we have attempted to give a conservative opinion—overestimating, for example, the ability of a pathogen to survive hostile environmental conditions.

Each chapter in Parts One and Two has its own list of literature cited. The several hundred papers and publications cited were selected from among a total collection of several thousand items assembled during the writing of this book. The literature searches for the various chapters were ended between late 1980 and mid-1981. The literature throughout has been selected from international sources (a considerable number of Czech, French, German, Japanese, Korean, Russian, Spanish, and other non-English language publications have been used).

Despite its division into two parts, the book is meant to be used as a unit. Readers desiring elaboration or support of statements made in Part One must refer to Part Two.

Origins and Related Publications

This book arises out of a World Bank research project in appropriate technology for waste disposal that was initiated in 1976 by the Bank's chief water and wastes adviser, Mr. John M. Kalbermatten. The results of this research are published in three books, under the series title "World Bank Studies in Water Supply and Sanitation." Numbers 1 and 2 of this series were published in 1982 by the Johns Hopkins University Press and are entitled *Appropriate Sanitation Alternatives: A Technical and Economic Appraisal* (by J. M. Kalbermatten, D. S. Julius, and C. G. Gunnerson) and *Appropriate Sanitation Alternatives: A Planning and Design Manual* (by J. M. Kalbermatten, D. S. Julius, C. G. Gunnerson, and D. D. Mara). In addition, the Transportation and Water Department of the World Bank issues a series of reports—under the main title *Appropriate Technology for Water Supply and Sanitation*—available from the Bank's Publication Unit (for information on obtaining these and related World Bank publications, see the last page of this book). Twelve reports have been published in this series so far.

Contributors

The book has been pepared by the Ross Institute of Tropical Hygiene from the work of a group of bacteriologists, engineers, entomologists, epidemiologists, parasitologists, and virologists from the London School of Hygiene and Tropical Medicine and elsewhere. Contributing specialists, their affiliations, and the chapters to which they contributed are:

	Chapter
Dr. J. Coghlan *Leptospirosis Reference Laboratory, London*	14
Dr. C. F. Curtis *Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine*	36
Dr. D. M. E. Curtis *Institute of Local Government Studies, University of Birmingham*	8
Dr. W. A. M. Cutting *Department of Child Life and Health, University of Edinburgh (formerly of Ross Institute, London School of Hygiene and Tropical Medicine)*	11
Dr. B. S. Drasar *Department of Medical Microbiology, London School of Hygiene and Tropical Medicine*	12, 13, 16
Dr. B. Lloyd *Department of Microbiology, University of Surrey*	15, 17, 18
Professor W. W. Macdonald *Department of Entomology, Liverpool School of Tropical Medicine (formerly Department of Entomology, London School of Hygiene and Tropical Medicine)*	36
Dr. D. M. Mackay* *Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine*	17

Dr. R. L. Muller *Commonwealth Institute of Helminthology, St. Albans (formerly Department of Medical Helminthology, London School of Hygiene and Tropical Medicine)*	24, 25, 26, 27, 28, 29, 30, 31, 33, 34
Dr. J. S. Slade *Thames Water Authority, London*	9
Dr. B. A. Southgate *Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine*	22
Dr. D. C. Warhurst *Department of Medical Protozoology, London School of Hygiène and Tropical Medicine*	19, 20, 21
Professor A. J. Zuckerman *Department of Medical Microbiology, London School of Hygiene and Tropical Medicine*	10

* Sadly, Dr. Donald Mackay died while this book was going to press. He made a substantial contribution to it, and we trust that he would have been pleased by the final result.

The book evolved, the group of contributors was convened, and the chapters on specific diseases initially each comprised a short general account followed by abstracted references. Following the review of this draft, Dr. Feachem rewrote these chapters, incorporating additional material, to form a continuous account. The chapters in their final form were then reviewed by their original authors.

Acknowledgments

This review of sanitation and disease was originally commissioned by The World Bank, and the Bank covered a proportion of the costs involved in the preparation of the manuscript. We are indebted to the Bank's staff for their support and encouragement. We particularly acknowledge the assistance of Mr. John Kalbermatten, Mr. Charles Gunnerson, Dr. DeAnne Julius, and Mr. Richard Middleton. The Publications Department of The World Bank was instrumental in guiding this book from its first manuscript in 1978 to its final manuscript in 1981, and so to the printed book in 1983. We are especially indebted to Mr. James McEuen for his major contribution to the structure and content of the book. Jamie Cameron, Ian McIntosh, Lyn Udall and their colleagues at John Wiley & Sons, UK, ensured the rapid and efficient publication of the final manuscript.

We thank the reviewers of earlier manuscripts for their thoughtful and constructive suggestions: Dr. F. A. Butrico, Dr. V. J. Cabelli, Dr. W. Crewe, Dr. B. Cvjetanović, Dr. R. H. Gilman, Dr. J. M. Hughes, Dr. B. R. Laurence, Dr. J. C. Leighty, Mr. W. L. Reyes, Dr. H. I. Shuval, Dr. B. B. Sundaresan, Professor A. Wolman, and Professor A. M. Wright.

Many others have assisted in various ways, and we especially acknowledge Dr. F. I. C. Apted, Ms. Angela Batten, Ms. Pauline Berrington, Dr. M. Blaser, Ms. Elizabeth Burge, Ms. Margaret Carroll, Mr. P. Hawkins, Professor K. Ives, Dr. B. Karlin, Ms. Jane Lillywhite, Dr. M. McGarry, Dr. G. Groenen, Mr. C. Miller, and Dr. M. B. Skirrow.

Dr. A. J. Duggan and Ms. Sheila Aspinall of the Wellcome Museum of Medical Science, London, were of great assistance in collecting the photographic illustrations for Part Two. A considerable number of the references cited were translated from the originals, and we acknowledge the valuable work of Sandy Cairncross (Portuguese), Mario Campa (Italian), Agnès Candler (French), Zuzana Feachem (Czech, Slovak, and Russian), and Rieko Fukano (Japanese). Bibliographic, editorial, and secretarial assistance was ably provided by Mary-Grace Browning, Agnès Candler, Jackie Channon, Margaret Dawson, Alison Davies, Lynne Davies, Dianne Fishman, and Jill Tatham.

RICHARD G. FEACHEM
DAVID J. BRADLEY
HEMDA GARELICK
D. DUNCAN MARA

London
June 1982