distinguished by initial capital letters.

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Schistosomiasis is estimated to affect two hundred million people in the world. In view of its prevalence, its wide distribution over three continents and the extent of the morbidity it causes, schistosomiasis ranks among the most important public health problems of the tropics and subtropics, coming next to malaria as a parasitic disease. If the necessary preventive measures are not taken, it is bound to become an even greater problem in many developing countries where the harnessing of water resources for irrigation and motive power production as well as large population movements have created ideal conditions for the propagation of schistosomiasis. There are known examples to testify to the reality of such ecological boomerang effects. Interest of investigators which, for a long time, was concentrated mainly on clinical, pathological and parasitological aspects of schistosomiasis, has shifted in the last three decades more and more to ways of attacking the disease at its sources and to its epidemiology, the indispensable basis of any control
work. While in former times field workers were satisfied to establish the existence and prevalence of schistosome infection in population groups, it was soon realized that other quantitative data, obtained by reliable techniques, were needed to assess the public health importance of the disease and investigate a given epidemiological situation.

When a young investigator first devotes himself to field work on schistosomiasis, he is confronted with a maze of practical, administrative and scientific hurdles. The required literature, scattered in numerous single articles published in various journals or reports, is not readily available to him. Neither do existing textbooks nor academic courses help him to overcome his difficulties. The manual on the Epidemiology and Control of Schistosomiasis is intended to fill this gap by providing the reader with both the basic scientific knowledge and understanding of its practical application in field work. It is an excellent guide for correct planning of projects and evaluation of results.

The manual was prepared under the sponsorship of the World Health Organization which, since its inception, has accorded a high priority to schistosomiasis in its programme of work. By calling upon experts from all over the world to assist governments in the planning and implementation of surveys and control projects, to recommend the most promising approaches for research and field activities and to participate in collaborative laboratory and operational programmes, the World Health Organization has gathered considerable information and experience which have been condensed in this publication.

Dr. N. Ansari, Chief of the Parasitic Diseases unit in WHO and Editor of the present manual, has long felt the need for such a comprehensive guide. It is to his credit that he not only conceived this work but also brought it to completion, and special recognition is, therefore, due to him and to his collaborators.

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Preface

The purpose of this manual on the epidemiology and control of schistosomiasis
is to provide broad practical guidance in the planning and conduct of epidemiological surveys and operations designed to control schistosomiasis. To avoid any ambiguity, let it be said that several degrees of control may be achieved by a wide range of measures. The objective may be the simple containment of the spread of infection, a reduction in the morbidity, or a significant reduction in transmission resulting in decreased morbidity, severity and prevalence. In optimum circumstances, total interruption of transmission may be feasible and eradication attempted.

If epidemiology and control are given equal prominence in this publication, this is by a deliberate choice. Experience has shown the absolute necessity of correctly carrying out epidemiological investigations not only in order to assess the infection and the disease in a given community or area but also to identify the local and regional epidemiological patterns, select the most appropriate control methods and evaluate their results on the basis of well-defined parameters. In the past, the lack of uniform methods in schistosomiasis has often prevented the proper assessment of operational programmes, with the result of needlessly discouraging both public and official support. It is hoped that the present manual will in part at least meet this deficiency.

It is realized that, in schistosomiasis, the methodology for epidemiological assessment and control has not yet reached such a stage of sophistication as to allow a simple solution to be offered to meet the needs of every situation. In fact, were guidance of this type attempted, it would probably impede the exercise of independent judgement and the development of new methods. On the other hand, the valuable experience gained in schistosomiasis control over the past decades suggests that certain guide-lines may constructively channel efforts in directions that give indications of being most fruitful. This experience has been acquired through national programmes and through WHO-assisted pilot projects in different parts of the world. Much information and inspiration has also emanated from the deliberations and recommendations of various conferences, scientific groups and expert committees sponsored by WHO since 1949.

For whom then is the present manual intended? In the lesser industrialized countries where resources for public health activities may be particularly scarce, a reasonable choice must be made between alternatives among health programmes. Such a choice must be based upon both knowledge of past successes and failures and an accurate assessment of the existing situation. Responsible officials in organizations or government agencies interested in initiating schistosomiasis control will, therefore, find useful the comparative
information contained in this book for establishing national and local priorities in control of schistosomiasis.

By providing broad guidelines in epidemiology and control of schistosomiasis, the intention has also been to assist the 'worker in the field' who has little access to the specialized literature and no time to waste on learning by trial and error. Within this frame of reference are included the investigating epidemiologist, the aquatic biologist, the parasitologist and the irrigation engineer, as well as other field personnel and the associated laboratory technicians who should be in a position to share in and profit from the experiences of past efforts.

Further progress in the epidemiology and control of schistosomiasis will depend on advances made in the many fields of tropical medicine and of related research - epidemiology, biology, chemotherapy, immunology, clinical medicine, preventive medicine, molluscicides, sanitary engineering, etc. To people already engaged or interested in such fields, the manual gives an opportunity to acquire a greater familiarity with concrete problems raised in the current practice of the epidemiology and control of schistosomiasis.

By incorporating accepted and recommended methods for the epidemiological assessment of schistosomiasis the present manual considerably enlarges upon a previous WHO monograph which was limited to snail control. Most of the information contained in the latter has been revised in the light of knowledge gained in the intervening period and integrated into the present manual.

1 Snail control in the prevention of bilharziasis. World Health Organization Monograph Series No. 50 (Geneva 1965).

Preface XXI

This manual would not have been possible were it not for the voluntary co-operation of prominent specialists who, depending on the subject covered, undertook singly or with the assistance of other experts, to summarize and assess the data and experience acquired over the last two decades by numerous individual scientists and laboratories as well as information collected in national and WHO-supported research and control programmes, or by survey teams and consultants. Special acknowledgement is, therefore, due to the principal authors of the fourteen chapters of the manual for this arduous task.

In a brief historical introduction, Dr. M. Farooq chose to review past events that led to the present knowledge of epidemiology and control of schistosomiasis, thereby paying tribute to the insight and effort of many predecessors.
Of the schistosome species causing disease in man, Dr. M. A. Stirewalt describes those features in their life-cycle that are of importance for their identification and for evaluation of their role in epidemiological assessments. Dr. W. H. Wright’s review of the geographical distribution of schistosomes and their intermediate hosts attempts to condense current knowledge of the subject into one and the same report. To facilitate its use according to needs, the information is presented on three scales: first on a world basis, then area by area, and finally for each area country by country. For further details, numerous reference lists have been appended. The same chapter also includes a discussion of the schistosome-intermediate host complex in Africa, Southwest Asia, the Orient and the Americas, which deals with the relative susceptibilities to the human schistosome species of proved or potential molluscan intermediate hosts, and of their significance in the transmission of the disease. Factors having an influence in gradually limiting or increasing its spread are considered in the concluding section on future trends of the disease.

In the preparation of certain parts of this chapter, Dr. Wright was able to enlist the co-operation of a number of specialists possessing authoritative knowledge of a particular area or problem, namely: Dr. N. Ayad, Prof. J. Fraga de Azevedo, Dr. F. S. Barbosa, Dr. V. de V. Clarke, Dr. M. Farooq, Dr. J. H. S. Gear, Dr. J. Gillet, Dr. H. F. Hsü, Dr. P. Jordan, Prof. Y. Komiya, Dr. F. S. McCullough, Prof. G. S. Nelson, Dr. W. L. Paraense, Dr. R. J. Pitchford and Dr. G. Webbe. Their individual contributions, which have been integrated into the text and will be easily recognized by the expert, are herewith gratefully acknowledged, and so is Mrs. J. Bernard-Kirukhine’s help in the tracing and checking of source material.

Preface XXII

The mere knowledge of the factors and the chain of events leading to transmission of schistosomiasis in a given area is not sufficient to permit the development of a sound plan for the control of the disease. A quantitative approach is needed to effect such measurements as will assist in the selection of appropriate control methods and in monitoring their results during and after control proper. In the chapter on the dynamics of transmission Prof. N. G. Hairston describes how such quantitative studies are carried out, the problems that are encountered and the ways in which results may be interpreted. This chapter also demonstrates the usefulness of descriptive models of schistosomiasis transmission such as the one developed by Prof. Hairston, which provides a logical frame of reference to epidemiological research. Apart from the question of availability of funds and staff, any decision to initiate schistosomiasis control must be based on a reliable assessment of the
public health importance of this disease. The relevant problems are taken up in the chapter by Prof. G. Macdonald and Dr. M. Farooq. They also describe the organization and types of investigation required for such an assessment. Although estimation of the economic effects of parasitic diseases in conditions obtaining in developing countries is still hampered by the lack of an accepted methodology, suggestions and examples are given which may prove useful in broadly evaluating the cost of schistosomiasis as compared to the cost of its control.

Few investigations have been carried out to ascertain the severity of schistosomiasis but where this has been done the results revealed that schistosomiasis is a far greater cause of morbidity than was suspected. Such studies need to be encouraged. The interested investigator will find in Prof. Macdonald's résumé of the report of two WHO scientific groups (one convened under his chairmanship) a description of the essential pathological and clinical manifestations of the three main forms of human schistosomiasis wherein those features lending themselves to quantitative analysis are singled out. Procedures and working criteria for comparative studies are also presented.

The three following chapters by Dr. M. Farooq provide information on the various approaches followed and the results achieved in past and current national control programmes, on the considerations upon which to base a decision to initiate control, and on the planning and organization of a control programme which can attain the chosen objective.

It is now generally accepted that control of schistosomiasis is best achieved by the use of a combination of control measures. However, specialists have generally agreed that snail destruction is still the most effective single control measure. Dr. L. S. Ritchie, with the collaboration of Prof. E. Paulini, Mr. W. R. Jobin, Dr. V. de Y. Clarke and Mr. A. E. H. Higgins, presents an up-to-date review on the chemical control of snails which includes descriptions of laboratory and field methods used for screening and evaluating promising molluscicides; a summary of the properties of available and candidate molluscicides; and practical guidance on the choice of a molluscicide as well as on the strategy, planning and equipment for molluscicide application.

The two other ways to control the snail intermediate hosts are ‘biological control’ using the harmful effects to snails of predators, parasites and competitors, and ‘environmental control’ aimed at rendering habitats unsuitable to the snails. These are dealt with in a chapter prepared by Dr. D. B. McMullen with the collaboration of Mr. Z. Buzo, Prof. E. Chernin and Dr. F.F. Ferguson. While biological control has distinct limitations, a wide
range of engineering measures are known to be very effective when applied to
such widely varying habitats as streams, ponds, marshes, drains and irrigation
schemes. The difficulties encountered in the use of these control measures
and the methods to be used in overcoming them, are discussed in this chapter.
Mass administration of drugs for the purpose of reducing transmission
of schistosomiasis should not be attempted without a clear appreciation of
its precise indications, careful scientific planning and strict working criteria.
The reasons, both technical and pharmacological, are explained by Dr.
A. Davis in the chapter on chemotherapy in control which also contains
general information related to drugs presently used or showing promise in the
control of schistosomiasis.
Whatever the methods chosen to control schistosomiasis, it is essential
that their efficacy be evaluated during the attack phase of the control programme
to allow operational mistakes to be corrected and to allow judgement
of the results achieved on the basis of reliable data. In discussing this subject,
Dr. L. J. Olivier examines the various parameters and procedures that can be
used to obtain direct or indirect evidence of the efficacy of control work.
The last chapter, prepared by Dr. L. J. Olivier and Mr. K. Uemura, is
entirely devoted to descriptions of techniques, statistical methods and recording
forms used for schistosomiasis surveys and for control operations.
They are illustrated by examples and figures from field epidemiological and
control programmes or laboratory work.
Many other specialists, by participating in the work of WHO expert and
scientific meetings, by offering advice and comments, have contributed,
although indirectly, to the preparation of the present manual. Their names

Preface XXIV

have been mentioned in the special acknowledgements that close this book, as
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Dr. W.H. Wright, Prof. P.C. Beaver, Dr. B.A. Southgate and Mrs
J. Sotiroff have read and edited the manuscript in part or in toto. Appreciation
for their invaluable guidance and assistance is due to each of them.
Finally, we wish to thank Karger S. A. for agreeing to publish this work
which, it is hoped, will stimulate interest in the epidemiology and control of
schistosomiasis, a disease that impairs the health of millions of people and is a
heavy burden in the economic struggle of many developing countries.

N. Ansari

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