The Executive Board at its fifty-fifth session adopted resolution EB55.R22 requesting the Director-General to initiate a study of the problem with a view to drawing up a strategic framework on a global basis for the prevention and control of the disease.

Schistosomiasis is one of the most widespread parasitic infections of man. It is second only to malaria in public health and socioeconomic significance. Over 600 million people are thought to be exposed to infection and over 200 million are infected. Four main species of schistosome are prevalent together with their various intermediate snail hosts in no less than, in total, 71 countries.

The report which follows outlines the main epidemiological characteristics of the disease and attempts to identify the main problems related to, and the techniques and methods for, its control. The basic importance of improvement of the environment and the spread of schistosomiasis in association with agricultural development schemes and artificial water impoundments are stressed.

Current activities, including those of the Organization, concerning research into and control of schistosomiasis are described. Attention is drawn to the need for further penetrating studies on various aspects of schistosomiasis, particularly on its impact on the health of infected communities and on its socioeconomic importance.

It is the Director-General's hope that, in line with the concern expressed by the Executive Board, the World Health Assembly will provide him with a policy guidance which will enable the Organization to stimulate an international programme against the disease and collaborate in its implementation.


Introduction

Schistosomiasis, one of the commonest of the parasitic infections of man, is widely distributed in many tropical and subtropical regions of the world where sanitation facilities and/or domestic water supplies are inadequate. The four major species affecting man are endemic in 71 countries as shown in the attached maps but geographical differences in species prevalence exist and parallel the presence of the intermediate snail host.

Schistosoma japonicum, transmitted by amphibious snails of the genus Oncomelania, has a restricted distribution in Eastern Asia. In China there are infected regions in the southern half of the country and along the middle and lower sections of the Yangtze river. In the province of Taiwan, man is not infected with S. japonicum despite its presence in domestic animals.

Schistosomiasis exists in Japan on the main island of Honshu and also on Kyushu.
Six islands of the Philippines are endemic zones and in Indonesia, a long standing focus is known in the Lake Lindte region of the Celebes. Small areas of endemicity have been found in Thailand and on Khong Island in the Mekong River Basin.

*S. mansoni*, transmitted by aquatic Biomphalaria snails, is found in both the Eastern and Western Hemisphere. It is focally present in the Arabian Peninsula and is hyperendemic in lower Egypt and the Nile delta. In the sub-Saharan zone of Africa down to the Cape Province of South Africa it is widely distributed in the majority of countries.

Areas of transmission are also found in South America and in the Caribbean. Brazil, Surinam and Venezuela are all endemic areas yet curiously Guyana remains free from infection. The parasite occurs in some Caribbean islands but not all, e.g. Dominican Republic, Puerto Rico, Guadeloupe, Martinique and St Lucia.

Urinary schistosomiasis, caused by *S. haematobium*, which is transmitted by aquatic snails of the genus Bulinus, is endemic in Africa over large areas south of the Sahara and in North Africa exists in Egypt, Libya, Tunisia, Algeria and Morocco. Foci are recognized in Saudi Arabia, Yemen, Aden, Syria, Iran and Iraq. In the Indian Ocean, some of the islands are endemic zones, i.e. Mauritius, Zanzibar and Pemba, as well as the Malagasy Republic (in which *S. mansoni* is also present).

Small foci which previously existed in Israel, Turkey and Cyprus do not now constitute public health problems and may in fact be extinct.

Although an isolated focus of a schistosome infection characterized by a terminal-spined egg was reported from the Ratnagiri district of Bombay State in India, it is the only currently known endemic area in the subtropical and the exact status of the parasite is uncertain.

The distribution of a fourth species, *S. intercalatum*, is known to have extended in West Africa in recent years.

It is estimated that over 600 million people live in areas where man is exposed to the risk of infection and, according to recent estimates based on prevalence survey rates, about 200 million people are actually infected. This figure cannot be equated with the prevalence of serious pathology which occurs only in a minority of persons passing eggs in the excreta.

There have been many attempts in the past to control this disease. In most instances these attempts have been limited in scale, partly because the tools available were not considered efficient enough for larger scale application, partly because of the limited financial resources available to countries with endemic schistosomiasis and partly because schistosomiasis was given low priority for action when compared with other major acute communicable and parasitic diseases.

1. **Problems related to control of the disease**

   During the last 25 years there has been an intensification of research effort by individual scientists, institutions, and national, regional and international organizations into the ecology, biology, parasitology, epidemiology and chemotherapy of human schistosomiasis. Numerous scientific disciplines have been involved and the World Health Organization has played a role in the collection and exchange of data, by its own surveys through consultants or field teams, by convening advisory groups, expert technical committees or scientific groups and by periodic reviews of progress.

   Advances in technical development have been applied successfully in many research fields and consequently the knowledge of the geographical distribution and overall epidemiology of schistosomiasis has considerably increased as has the knowledge of the biology of snails. Further development of chemotherapeutic agents and chemicals for the control of snails has taken place and research is being carried out on possibilities of biological control of intermediate hosts. However, there are still a number of problems which make scientists and governmental authorities hesitant to embark upon schistosomiasis control on a larger scale. These problems are:
(a) Public health importance of schistosomiasis

Although the figures on schistosomiasis prevalence in various parts of the world are very impressive it is not yet known to what extent the disease is responsible for temporary or permanent disability. Many studies have been carried out in relation to the clinicopathological aspects of the disease, yet further development of the methodologies needed to measure the impact of the disease on the community in endemic areas is necessary. At present the intensity of infection is measured by counting the egg output in faeces or urine which is used to judge the severity of the infection. This single measurement cannot provide a solid ground for evaluation of the public health importance of the disease and there is a great need for further screening techniques which are both of predictive value and acceptable to a community. Observations made on clinical material indicate the extent of the pathological involvement of different organs and tissues but this approach probably gives a bias to a more severe picture of the disease than that usually found in endemic areas by epidemiological evaluation. There have been several attempts to estimate the degree of disability caused by schistosomiasis using community screening approaches with standardized parasitologic, radiologic and clinical methods and also by measuring the effects of the infection on work output and earnings.

Methodological deficiencies have rendered generalization of the findings impossible. Many schistosomiasis infections are light and virtually symptom free. While there exist impressions that the course of illness, particularly in *S. mansoni* infections, is more severe when malnutrition coexists, there is little hard data to support this and experimental observations have not confirmed the concept.

(b) Problems related to chemotherapy

Several groups of drugs have been developed for use against this disease. In general no drug is 100% effective nor are all drugs effective against every species of schistosome. There is an urgent need for further development of new drugs although it should be realized that the drugs available could contribute much to a significant reduction of the disease if properly applied. In fact, in certain areas of the world the prevalence and the intensity of infection could be significantly reduced with the chemotherapeutic agents available. In other areas, however, particularly Africa and some parts of South America, a combination of chemotherapy and mollusciciding would be required to obtain appreciable and lasting results.

In addition to the problems concerning the efficiency of the chemotherapeutic agents available, there exists also the problem of the toxicity of these compounds. All schistosomicides may produce a number of minor side effects during treatment. Fortunately these are usually relatively infrequent. Some drugs may however be associated with severe toxic effects which diminish their utility in mass treatment campaigns.

Antimonial preparations are known for their curative efficiency in all types of human schistosomiasis but the associated side effects necessitate their administration under medical or paramedical supervision and thus restrict their value.

Infrequently, niridazole may produce adverse neuropsychiatric effects and hycanthone may be associated rarely with acute hepatic necrosis. The concern induced on the possible hazards of hycanthone usage in man led to periodic reviews of available evidence on mutagenicity, teratogenicity and carcinogenicity by expert consultative groups convened by the Organization which allayed anxiety. Clearly however, this field requires constant monitoring and because of the uncertain predictive value to man of some of the test systems used, all schistosomicides of recent introduction are undergoing further mutagenicity and/or carcinogenicity screening procedures.

The organophosphorus compound metrifonate produces a temporary inhibition of cholinesterases in both the erythrocytes and in the plasma. However, recent experience in Ghana has shown that, even in patients in whom glucose-6-phosphate dehydrogenase deficiency or a haemoglobinopathy coexists with *S. haematobium* infection, metrifonate could be used successfully if administered under medical supervision.

Lucanthone hydrochloride usage has tended to be restricted because of the frequency of gastro-intestinal side effects but a notable exception is in Venezuela where the drug has been employed with success on a large scale for many years.
Since most of research in drug development is undertaken by the parasitologically
orientated sections of the pharmaceutical industry, the decreasing amount of effort in the
screening of new schistosomicides in these sections must be regarded with concern and new
approaches conceived to retain this essential activity.

(c) Problems related to molluscicides

A number of synthetic chemical molluscicides are available at present and others are
being tested. Niclosamide and n-tritylmorpholine are considered as outstanding molluscicides
and are commercially available. In addition, good results have been obtained, particularly
against Oncomelania in Japan, with Yurimin. These three molluscicides have a future in the
control of schistosomiasis while sodium pentachlorophenate and copper sulphate are still in
limited use.

Many plants possess varying degrees of molluscicidal activity and further studies of
some of them are currently under way.

Problems in the chemical screening of compounds for molluscicidal activity resemble those
seen in the search for new drugs and a viable commercial market is regarded by the chemical
industry as necessary to ensure continuation of screening activities.

Successful and efficient mollusciciding requires a detailed knowledge of the epidemiolog-
ical pattern of transmission in a given area. Whenever molluscicide usage is planned in
control, adjustment of the strategic approach may vary with different epidemiological findings.

All chemical molluscicides may affect certain fauna in the water, although the toxicity
of the three molluscicides mentioned is very low and the compounds can therefore be considered
as safe to man when used at normal dosage. However, due consideration should be given to the
possible toxicity to non-target organisms and to plants and crops when larger-scale application
of molluscicides is planned. Advances in formulations such as slow release preparations may
be of advantage in this respect provided that human toxicological monitoring data are
satisfactory.

(d) Biological control of snails

As with all living organisms, snail vectors of any one species of schistosome have their
natural enemies. In addition to possible insect or fish predators, a number of microbial
agents are known to affect the life cycle of snails. Species competition between different
genera of snails is also a possibility for reducing or even eliminating snail intermediate
hosts.

All these potential aids to control require further detailed study and it will be some
time before a practical solution can be found for large-scale application. Although over 50
possible biological control agents have been tabulated, their scientific status does not yet
extend in the majority of cases beyond carefully monitored laboratory experiments.

(e) Immunization against schistosomiasis

The immune response of individuals infected with schistosomiasis in relation to partial
protection against reinfection has been observed some time ago. Tests for serological
evaluation of infection have also been used more or less successfully for many years. However,
it should be recognized that the immune response of the host against schistosomal infections
is not as yet clearly understood. The idea that adult schistosomes acquire antigens common to
human antigens has been suggested by recent experiments. This mechanism would facilitate
the survival of adult schistosomes in the human body. This particular type of immune
response is called "concomitant immunity". It is also known that schistosomal exo-antigens
are very complex in nature and that in the course of infection antigen-antibody complexes can
be formed which may produce "immune-complex lesions" such as glomerulonephritis.
The first attempts to develop an immunizing agent against schistosomiasis took place in the early thirties, utilizing a saline solution of the total parasite. These attempts did not get very far. Further efforts, using irradiated material seemed to offer better prospects but much remains to be done in this field. With the development of our knowledge on general immunology and techniques for handling antigens, efforts should be continued and expanded.

(f) Environment

The intensity of the endemicity of schistosomiasis is in direct relation to the contact between man and polluted water. With the development of artificial water impoundments, such as man-made lakes for the generation of electricity or irrigation purposes, schistosomiasis is spreading in areas where this type of development is taking place, as recent experiences in Africa have shown. The obvious solution to the problem is to prevent human excreta from reaching water; in theory such sanitary measures would stop transmission. However, experience has shown that in few cases would environmental sanitation alone be sufficient to interrupt transmission. Together with a community water supply, health education, adequate engineering safeguards in constructing artificial lakes and irrigation schemes, and water management of such schemes, it would contribute greatly to the control of the disease, particularly when medical measures, in the form of chemotherapy, are also applied. In this connexion the experience of Japan should be mentioned, where irrigation canals were lined with concrete thus greatly hampering the development and multiplication of the snails. While these measures necessitate initially a large investment, the long-range cost/benefit ratio is favourable considering also the other vector-borne diseases that may spread with newly established irrigation schemes.

When such investment is not possible, alternative control approaches against the snail intermediate hosts may be practicable depending on the biological habits of the mollusc and the local epidemiology of the disease. The technique used in China of attacking oncomelania snails by modification of design of ditches is a particularly good example.

WHO has collaborated with FAO, participated in some of their projects for irrigation and water resources development, and provided technical inputs designed to make such projects safe from a public health viewpoint. The prevention of schistosomiasis was an important objective in this collaboration in areas where endemic infection exists or where the infection might be introduced following water development projects.

Similarly, many field activities in environmental sanitation, carried out with the assistance of sanitary engineers, sanitarians, and health educators, contribute to the prevention or reduction of schistosomiasis in countries where the infection is endemic. Of particular importance in this respect is the improvement of sanitary conditions in the rural areas as part of general development programmes.

2. Current activities in schistosomiasis

For the last 20 years or more, WHO has taken an active part in stimulating research or in arranging pilot projects for the control of schistosomiasis. Many technical meetings have taken place dealing with the distribution of the disease, the biology and identification of snails and their ecology, molluscicides, chemotherapy, epidemiology and the control of the disease. Reports issued from the three technical meetings, one scientific group, one study group and four expert committees, provide a valuable guide for the organization of schistosomiasis control.1

The Organization, through its grants, supports research in all aspects of schistosomiasis; 20 laboratories or research units are recipients of such grants. Expansion of research support and further direct participation can be anticipated since schistosomiasis will be a major subject of study in the new WHO Special Programme for Research and Training Tropical Diseases.

As far as field research is concerned, for many years the Organization has assisted governments in undertaking special studies or by providing advice for organizing control activities.

An interregional team has in recent years, made significant investigations into the spread of schistosomiasis in man-made lakes and has visited many of the new sites of water development schemes in Africa.

At WHO headquarters, a section has been established with the special task of studying the implications of natural or artificial large-scale water impoundments. While the prevention of the spread of schistosomiasis is a main area of application, other parasitic diseases, associated directly, or indirectly through a vector, with water, are not neglected. At present attempts are being made with the aid of consultants, to formulate a generalized methodology for the prevention of parasitic disease spread in water impoundments, and the evaluation of the impact of parasitic disease and its alleviation if present.

Another major undertaking is the study of *Schistosoma haematobium* in the Volta Lake area, Ghana, which covers all technical aspects, including the ecology of the vector; epidemiological characteristics, possibilities for its control by different means, special studies on chemotherapy, and the importance of social patterns of behaviour in maintaining transmission of the disease.

Interest in the control of schistosomiasis is not confined to one health group and control activities are supported by international agencies, bilateral agencies, regional or national organizations and private foundations.

The project centred on Lake Volta, Ghana, entitled "Research on the Epidemiology and Methodology of Control of Schistosomiasis in Man-made Lakes" is financed by the United Nations Development Programme with added inputs for specific areas from the Edna McConnell Clark Foundation. WHO is the executing agency for this project.

Collaboration between the World Health Organization and other international agencies exists with the Food and Agriculture Organization in the South Chad Irrigation Feasibility Study, with the advice and briefing given to the International Bank for Reconstruction and Development on schistosomiasis, and by the provision of consultants to assess the control of schistosomiasis in the Philippines by agro-engineering methods, a project supported by the World Food Programme.

Cooperation between the United Nations Environment Programme and WHO has been established and the two agencies are combining with other co-sponsors in promoting an international conference on schistosomiasis to be held in Cairo, Egypt, in 1975.

For some years WHO has had working relations with, for example, the United States Agency of International Development, the Medical Research Council, United Kingdom, the Danish International Development Agency, and other bilateral health agencies. From the Swedish International Development Agency has come support for research in tropical medicine.

The Edna McConnell Clark Foundation, of New York, has in recent years, concentrated on schistosomiasis. In becoming a major funding body for research, it supports, through its schistosomiasis programme, a variety of projects, both in endemic areas and in laboratories in non-endemic areas. A successful symposium on research priorities was held in 1975 by the foundation.

In St Lucia, West Indies, the Rockefeller Foundation funds a major schistosomiasis research and control programme against *Schistosoma mansoni*. Additional support is given by the Government of St Lucia and the Medical Research Council, United Kingdom.

In 1974, the Institut de la Vie, Paris, in cooperation with WHO, convened a meeting in Versailles to review the shortages of drugs against parasitic diseases and to make recommendations for future action.
Control activities proceed in the various regions and examples are seen in Tunisia where progress has been steady and successful, in the Yemen where malacological surveys are conducted, in the African Region where, following the conclusion of a successful project on control at Misungwi, Tanzania, consultant epidemiological services are available at Brazzaville. In South-East Asia the protocols for schistosomiasis control in Central Sulawesi, Indonesia have been discussed and preliminary surveys have commenced.

In addition to these various projects, research and control schemes are undertaken by many national governments and Brazil, Egypt and Iran may be cited as having progressive examples of schistosomiasis control plans.

The activities of WHO in the control of schistosomiasis, although significant, have not so far been proportionate to the magnitude of the problem. What is required is a global plan including different approaches, which would underline the strategy countries should follow in their efforts to control schistosomiasis. Undoubtedly, elaboration of the strategy with different tactical variants requires additional field studies, further support by basic research, plus the development of new control tools. Furthermore, to make possible the implementation of larger-scale control programmes, important training efforts will have to be developed, beyond those WHO has already made.

The problem of schistosomiasis has remained in most instances in the hands of the scientists. Thanks to research and technical developments, knowledge of the epidemiology and other aspects of the disease has greatly increased. The time has come for administrators and socioeconomic development planners to be involved.

Only by concerted action, on a broad multidisciplinary basis and with adequate emphasis on managerial as well as on technical aspects of the programmes, shall we be able to overcome one of the most serious challenges facing the world community in the control of communicable diseases of social and economic importance.
DETAILED REVIEW OF THE PROGRAMME BUDGET FOR THE FINANCIAL YEARS 1976 AND 1977

SCHISTOSOMIASIS

For inclusion of two maps as mentioned in the first paragraph of the Introduction on page 1 of document A28/6.