

THE UNCONQUERED PLAGUE

Schistosomiasis is the greatest unconquered parasitic disease now afflicting men and animals. It is a "man-made" disease, resulting from people's own unsanitary practices; tragically, it is growing in seriousness in just those developing nations which are struggling to improve agricultural practices essential to progress.

Schistosomiasis is almost universally prevalent throughout the countries of the Far East, Africa, the Middle East, Eastern South America, and in Puerto Rico and the Leeward and Windward Islands of the Caribbean. It is an ancient disease (eggs have been found in Egyptian mummies circa 1000 B. C.), which spreads with vigor (almost 100 percent of a given population can be infected) and has so far proven invulnerable (although individual cases can be cured, no largescale method of prevention or cure has yet been found).

Cause and Effect

Schistosomiasis is caused by a parasitic worm, or schistosome. What happens to people who get it? The eggs of the worm flow freely through the blood stream, invading the lungs, liver, kidneys, heart, and on occasion, the brain and central nervous system. As many as 100,000 eggs have been recovered from the lungs alone of individuals with chronic infections. A single worm can continue to deposit eggs in vital body tissues for a minimum of five and a maximum of twenty years. Each succeeding infection adds to the burden; tissues of the bladder, intestinal tract, kidneys, lungs, and liver are progressively destroyed and fibrous tissue reactions interfere with their normal functions. Thus the direct threat to the individual becomes apparent only after years of infection. Frequently the disabling phase of the disease appears in individuals at the time of life when normal degeneration of organs, caused by aging, might be expected. Consequently the basic cause of the degenerative lesions is frequently overlooked.

For years the physicians of Egypt had recognized the devastating effects of schistosomiasis but since the overwhelming infection in Egypt was considered by some public health authorities to be unique, the tendency in other areas was to assume that schistosomiasis infections were mild and unimportant. The error in this view became apparent in recent years as the result of broadened research: as surveys were extended to more areas in Africa, Latin America, and the Middle and Far East, it became clear that the extent of the infection in most of these countries was as grave as that in Egypt.

1. This background survey is based on a report to the Trustees of the Rockefeller Foundation prepared by John M. Weir, M. D., Ph. D., Director, Medical and Natural Sciences, The Rockefeller Foundation.

Prior to World War II few Americans, even physicians, had heard of schistosomiasis. An episode in which thousands of servicemen contracted the disease during operations in the Philippines jarred American complacency and raised the threat that the disease might be transplanted to this country. A quick survey showed, however, that of 72 North American snails, only one was a possible host. The high level of sanitation in most parts of this country further precluded any widespread outbreak.

200 Million Cases

The roles of the snail and of people's sanitary habits are understood once the life cycle of the parasite is grasped. The cycle is complicated but its essence is that a parasite, living in water, enters a human or animal through the skin. The parasite's eggs are eventually discharged with body wastes, and if they enter water, the eggs hatch and the emerging miracidia take up occupancy in the body of a snail. In its final, larval form the parasite leaves the snail and seeks a human or appropriate animal in the water.

As surveys are extended into rural populations in infested areas, it becomes increasingly clear that any individual old enough to walk to the village watering spot will become infected. (In Egypt, for example, it is likely that 100 percent of the rural population over two years old carries the disease). Since these impoverished people have no central water supply or means of waste disposal, they must of necessity turn to local streams, lakes, or canals for bathing, laundering, or swimming. In a misguided desire to dispose of waste outside their villages, they often use these water areas for excretion, and wherever the snail is present infection must spread to most of the population as long as a single case is present in the village. In 1948 the World Health Organization estimated on the basis of information then available that at least 150 million cases of schistosomiasis existed in the world. Subsequent surveys, particularly in Africa and Brazil, have made it clear that there are this many cases in Africa alone and that the total burden of infection must affect at least 200 million or more people. It is now evident that this disease, with its wide distribution and its high levels of infection in rural populations, is second only to malaria in global importance. Since malaria is waning under constant attack throughout the world, schistosomiasis remains the major parasitic disease for which we have no solution.

Threat to Development

The disease is growing in seriousness in just those underdeveloped countries where man is struggling most valiantly to raise his level of well-being through agricultural improvement. The association of snails and irrigation canals accounts for the increase of schistosomiasis in tropical and subtropical rural regions; snails thrive in the warm, moist, shady edges of irrigation ditches. Vast irrigation projects bringing water to huge new farming areas bring also schistosomiasis to regions where it was unknown. So serious is the result that one \$10 million irrigation project in Southern Rhodesia had to be abandoned only 10 years after it was started. Schistosomiasis thus stands as a barrier against increased food production.

In underdeveloped countries the government authorities are overwhelmed by the need for funds to control many acute and chronic diseases and are faced with severe economic problems. Consequently the simple demonstration that a crippling and lethal disease exists in the community does not necessarily result in community efforts to curb it. Apathy to schistosomiasis is the more understandable since no realistic method for measuring its economic importance has been devised and the disease itself has little drama to stimulate action. Nonetheless, when superficial attempts have been made to define the economic loss due to schistosomiasis the results have been impressive. A survey by the World Health Organization in Leyte, the Philippines, showed that 125,000 adults lost \$1.3 million in wages while under treatment or in hospitals. The total direct economic medical care costs for 100,000 of these people was \$5.3 million. In Japan, in a 90 square-mile area, the economic loss in wages plus the costs to the community for treatment was calculated to be \$3 million per year. In Egypt direct cost of treatment and control centers —which function with only limited success —is several millions of pounds annually.

Possibilities of Control: Sanitation

The ultimate and clearly the ideal solution to the schistosomiasis problem is the provision of a protected water supply to the individual home. Universal facilities for water and for sewage disposal have been developed, however, in only the most advanced countries. Apart from economics, a basic problem is unawareness in uneducated rural communities of the inherent dangers of poor sanitation. This latter factor is of extreme importance. In its public health work, The Rockefeller Foundation has played a major role in attempting to provide a solution for sanitation problems in rural communities, but even in regions where it has been economically feasible to provide primitive but fairly efficient covered wells, and sanitary latrines, the cycle of schistosomiasis has in no way been affected. The reason is that in rural communities it requires far-reaching changes in social habits and customs, affecting family life and the working day in the fields, before protection can be assured.

Individual Treatment

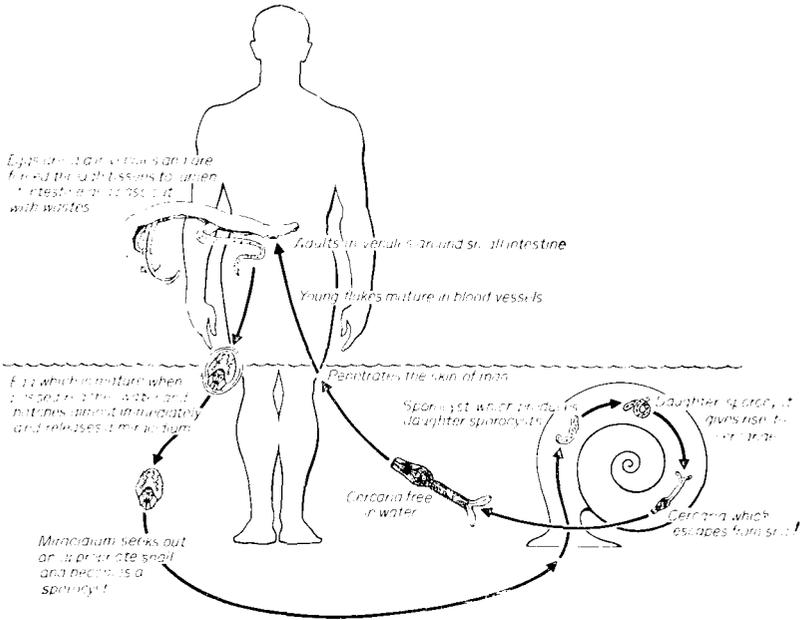
If sanitation is not practical, why then do we not mount massive programs to eradicate the worm in infected people and thus interrupt the cycle? Intensive research has been devoted to this facet of the problem. At the present time three types of chemicals are available which will kill the parasite in human beings or other animals. These compounds are derived from antimony, arsenic, and aniline dye bases. None of them is effective for mass treatment: use of the aniline dye Miracil D, for example, requires hospitalization of the patient, while the arsenic and antimony compounds produce very unpleasant reactions in the patient, and even when given in an intensive form they require a minimum of 12 visits to a treatment center in as many days.

Eradication of Snails

If effective sanitation and mass treatment are not yet possible, then the best step clearly is to kill the snails so that no intermediate host exists to continue the cycle. In the late 1920's The Rockefeller Foundation combined forces with Dr. Khalil Abdel Khalig, of the Egyptian Ministry of Health,

to test the efficacy of copper sulphate, which Dr. Khalig had shown to be effective against snails under laboratory conditions. It was shown that copper sulphate could indeed kill about 95 percent of the snails in an irrigation canal, but there were considerable practical difficulties in its application. An additional drawback was that snail eggs were not killed, so that new generations rapidly appeared. However, the partial success of this method has led to intensive research to find other chemicals that are more effective. Thousands of chemicals have been screened by the United States Public Health Service, naval research units, university departments and by commercial companies, and at the present time at least a dozen molluscicides (snail killers) are undergoing field trials. The most promising at the moment is sodium pentachlorophenate; this kills snails and eggs, and in Egyptian field trials has kept canals free for extended periods at a reasonable cost. If snail eradication teams can be properly organized to cover several thousand miles of canal annually, then this chemical may prove the answer to the problem in Egypt.

Unfortunately, sodium pentachlorophenate cannot be used where fish production is important or where the snail reservoir is in running streams or shallow pools exposed to intensive sunlight. It therefore is not useful in most of Africa, South America, or the Far East. Other chemicals give promise of even more dramatic results but so far all reveal essentially similar defects when practical control measures are undertaken.



SCHISTOSOMA LIFE CYCLE

A Variety of Hosts

Experience in Egypt led the early workers to believe that only two kinds of snail host were involved and that any chemical which would attack these two types would automatically prove useful in other areas of Africa, and indeed in the other continents. Unhappily, surveys now completed in most of Africa indicate that a great variety of snails can serve as hosts. These varieties seem to differ in their biological response to chemicals and to their environment. Each type of snail survives under particular conditions of temperature, water flow, turbidity, salinity, and so on. Consequently there is little likelihood of establishing a uniform system of control even if an adequate chemical is found, and clearly, more information about the ecology and biology of the snail vectors is needed before large-scale control can be established with any chemical.

Search for a Vaccine

The remaining avenue of approach to the schistosomiasis problem is the possibility of developing a vaccine. Making human beings immune through a vaccine is the classical method of controlling many infectious diseases; at the present time immunizing procedure for parasitic diseases have not been developed and, indeed, the immune reactions to parasites are not well understood. It is within the bounds of possibility, however, that some way of increasing human resistance to the parasite's invasion will yet be found.

An Inconspicuous Disease

Why has schistosomiasis received so little attention in most public health campaigns in the past? There are various reasons for this seemingly inexplicable neglect. First, it is not a dramatic disease; normally it neither kills nor totally incapacitates. The direct threat to the individual sufferer becomes apparent only after years of infection. In the main, however, schistosomiasis has been neglected because it is rural disease, a poor man's disease. For endemic diseases, such as malaria, which threaten urban as well as rural populations, the government worker and the peasant, the rich and the poor, it is far less difficult to obtain comparatively large funds for their control.

Early Efforts

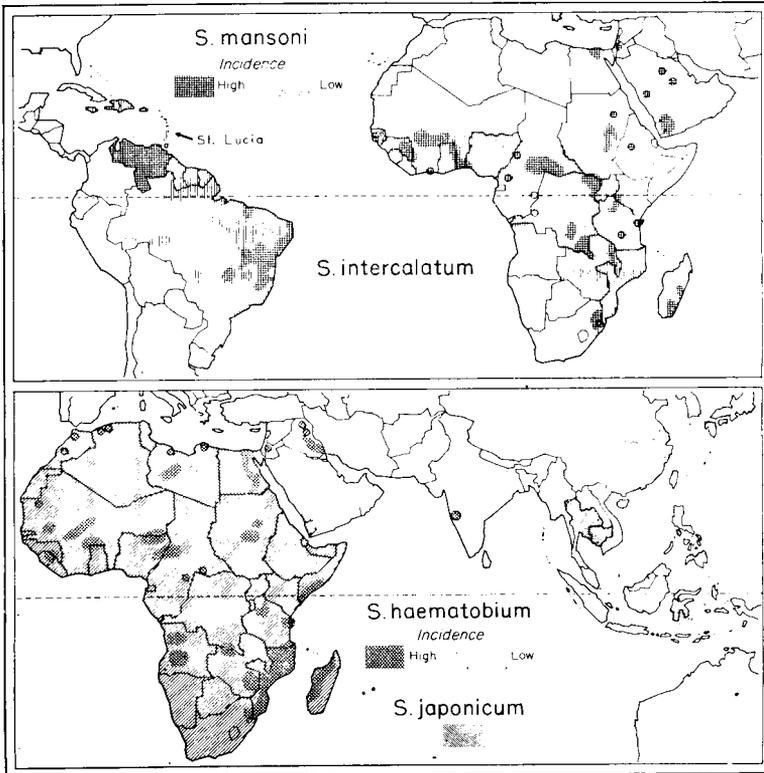
In April of 1960 a group of leading field and laboratory scientists met in Mozambique under the auspices of the World Health Organization to review the problem of schistosomiasis, with particular reference to Africa.

It became apparent in reviewing current research that some of the failure to make progress resulted from the dispersion of the studies in widely separated laboratories and from the lack of continuity in attacking the problem as a whole. No well-organized program had been attempted in which all possible methods of control were combined in a single attack on the disease in a population or a community, along with simultaneous studies of the factors affecting transmission of the disease. As a result there was no information as to whether a critical level of snail vectors existed at which transmission would cease if human cases could be temporarily decreased through intensive

treatment. These views were endorsed later by the WHO expert committee on schistosomiasis, and once the international committee had stated its conviction that a coordinated research program was essential, it was relatively easy to organize the first step in this direction.

This first step was the decision of Professor George Macdonald, director of the Ross Institute of the London School of Hygiene and Tropical Medicine, to leave his research work on malaria and to concentrate his talents on the resolution of the many biological and human problems of schistosomiasis. It was decided the team would use the University of East Africa's Makerere Medical School, Kampala, Uganda, as its clinical base and the epidemiological and biological personnel of the East African Medical Research Council for the field staff, and to study the disease in Africans around the area of Lake Victoria. The team would relate the course of the disease to the biology of the local snail in an attempt to define the natural history of the disease, emphasize the damaging effects to the human being, and simultaneously develop techniques for meeting the varied conditions necessary for control of the snail in the area. A grant in 1961 of \$142,500 from The Rockefeller Foundation, whose interest in the disease goes back some 40 years, still supports the work of Dr. Macdonald's group.

WORLD DISTRIBUTION OF SCHISTOSOMIASIS



The St. Lucia Project

In addition to research and experimentation now being carried on, what is needed is a pilot project where current knowledge and techniques can be applied in a coordinated manner to demonstrate control. Ideally, the area selected for such a program should contain heavily infested populations of humans and cattle on a land mass sufficiently isolated so that reinfection can be minimized as control progresses. The area should also be sufficiently limited in population and in acreage so that the economic, agricultural, health, and demographic effects of the control effort can be measured. These basic conditions exist on the island of St. Lucia in the Caribbean.

St. Lucia is a British colonial possession, one of the Windward Islands, situated 20 miles south of Martinique. It is small: 28 miles long and 14 miles wide, with a precipitous terrain. It has relatively heavy rainfall, ranging from 60 inches per year along the north and south coasts to 160 inches in the interior. Rainwater runs off into numerous small rivers, ponds, and swamps, all of which may serve as breeding places for the snail host of *Schistosoma mansoni*. The population is approximately 100,000; about half lives in or near seven small towns, and the rest lives on or near plantations. Except for a minority, which remains continuously in an urbanized environment the population is presumably exposed almost daily to infection with schistosomiasis through contact with water while at work.

The principal source of income in St. Lucia has always been agricultural production; today, in excess of 90 percent of income is from the production of bananas sold in the United Kingdom. Approximately 4.5 million stems are produced annually, with a value of about \$3.7 million. Of a total of some 150,000 acres in the island, about half are available for agriculture, and more than half of this acreage is held by small landowners. Banana fields have numerous primary and secondary drainage ditches. These ditches, unless cleaned at frequent intervals, become filled with vegetation and serve as ideal places for the propagation of snails, as do also the margins of the numerous small streams into which the drainage ditches empty. Since there are almost no sanitary facilities in the rural areas, fecal matter containing *S. mansoni* eggs finds its way into drainage ditches and streams with the result that the snails become infected. Workers are in almost constant contact with water, and water from streams is used for washing clothes, bathing, and drinking. The epidemiology of schistosomiasis in St. Lucia, therefore, is intimately associated with agriculture and with the normal life of the inhabitants.

The initial proposal presented by the Government of St. Lucia calls for the establishment of a special studies and control unit within the Ministry of Education, Health and Social Affairs, the work of which would be financed jointly by the Foundation and the Government. On its part the Government would provide some professional personnel, most elements of the subprofessional staff, all labor forces for control work, and housing for laboratories and hospital facilities. The Foundation will provide a number of public health specialists who will be named as consultants to the Ministry, as well as funds for laboratory equipment and field investigations.