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Report of a WHO Expert Committee

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Geneva, 12-17 December 1966

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EPIDEMIOLOGY AND CONTROL OF SCHISTOSOMIASIS

Report of a WHO Expert Committee

A WHO Expert Commitee on Schistosomiasis met in Geneva from 12 to 17 December 1966. Professor T. H. Weller was elected Chairman, Dr F. Rizk Vice-Chairman, and Dr D. B. McMullen Rapporteur. Dr P. Dorolle, Deputy Director-General, opened the meeting on behalf of the Director-General.

INTRODUCTION

In the two years that have elapsed since the meeting of the previous committee, much progress has been made in the knowledge of schistosomiasis, as the outcome of intensive research carried out over the past decade. New techniques have been developed for conducting epidemiological surveys indispensable to determining the importance of the disease in endemic areas and to investigating the many factors that contribute to its transmission. A number of control methods have been tested in the field and have proved successful, and continuing evaluation of chemotherapeutic agents and dosages is establishing their advantages and limitations in combating schistosomiasis. While laboratory and operational research continues on control methods, better knowledge is being gained of the pathogenesis and pathology of schistosome infections through parasitological, immunological, clinical, radiological, and post-mortem studies.

As is the case with other parasitic diseases, it has become evident that while research on schistosomiasis has received a tremendous impetus from fast-progressing technology, application in the field—i.e., control of the disease—is proceeding at practically the same pace as before. Knowledge is accumulating but there is no opportunity for it to be tested sufficiently. In order to improve present control techniques, they must be put to field use, their results evaluated under different epidemiological conditions, and their defects recognized. This creates a need for standardized techniques and procedures, so that valid conclusions can be drawn from the various data received.

The gap is widening between research workers and those who are actually faced with the task of fighting schistosomiasis, and it appears that WHO may be of particular assistance by publishing reports on tech-

niques that have been proved effective, as was the case with the monograph *Snail Control in the Prevention of Bilharziasis*.[1]

This report briefly summarizes present knowledge of a number of subjects related to the epidemiology and control of schistosomiasis, and draws attention to recent work deserving of special mention. In addition, recommendations concerning research and the future course of control programmes are made.

1. PARASITOLOGY

Since the meeting in 1964 of a WHO Expert Committee on Bilharziasis [2] there have been a number of outstanding developments in knowledge of the schistosomes and of relationships between the parasites and their hosts.

1.1 Morphology and physiology

1.1.1 *Miracidia*

The miracidium has been found to have a well-developed "scanning" ability and this may compensate in part for the adverse effects of various factors which tend to jeopardize continuation of the cycle. Recent studies have shown that free-swimming miracidia are stimulated by and attracted to various compounds, and that they make both purposive and non-purposive movements in response to certain chemical stimuli.

Further study of methods of detecting and estimating the numbers of miracidia in natural habitats is desirable.

Penetration probably is achieved by a combination of muscular effort and lytic substances, but the precise mechanism involved is unknown. Recent work has indicated that only a small proportion of miracidia that enter even a susceptible molluscan host actually develop into mature mother sporocysts. Successful establishment of infection is thwarted if the parasite migrates into resistant compact tissues of the snail or is confronted with miracidial-immobilizing substances.

Research with *Schistosoma mansoni* has demonstrated the extensive migration of daughter sporocysts through snail host tissues. Descriptions have been given of the histological and pathological changes accompanying the development of *S. mansoni* in *Biomphalaria glabrata*.

Infection reduces the egg-laying ability of the snail. High mortality among infected molluscs coincides with heavy emergence of cercariae and with the appearance of a severe generalized proliferative tissue reac-

[1] *World Health Organization: Monograph Series*, No. 50 (1965).

[2] *Wld Hlth Org. techn. Rep. Ser.*, 1965, **299**.

tion, caused by cercariae trapped and dying in the loose vascular tissues of the host.

1.1.2 *Cercariae*

Continued studies of the cercarial stage have resulted in additional basic information. Experimental work in East Africa and Puerto Rico has indicated that for infection to occur, there is an optimum speed of flow of the water to which a host is exposed. Other investigations have shown that there are marked seasonal differences in the production of cercariae by snails and that these differences are more pronounced with *S. mansoni* than with *S. mattheei*. Transmission is dependent upon a number of biological factors in the habitat but it now seems that seasonal variations in transmission, at least in South Africa, may be more marked than was previously supposed.

Accurate techniques for demonstrating cercariae in their aquatic habitat are important in epidemiological studies. Continued efforts in Puerto Rico have provided and evaluated new methods for the detection of *S. mansoni* cercariae. As a result of extended studies it has been suggested that for detection of free-swimming cercariae, a combination of the paper filtration technique and the exposure of rodents to suspected waters may be the method of choice at this time.

1.1.3 *Schistosomula*

Studies of schistosomula have continued, with emphasis on their biology in the early phase of migration within the definitive host. Upon removal from the host, schistosomula can survive for limited periods in special maintenance media composed mainly of saline and serum; they are, however, unable to survive in water and can no longer produce pericercarial envelopes when placed in antiserum.

There is some evidence that in experimental animals some of the migrating schistosomes pass from the lungs through the diaphragm to the portal vein.

1.2 Taxonomy of the schistosomes

Proper classification of schistosomes at the species level continues to be a perplexing problem to investigators concerned with the epidemiological and zoonotic aspects of schistosomiasis.

It has been known for several years that geographical strains of *Schistosoma japonicum* differ markedly in their infectivity to both their intermediate and definitive hosts, the extreme example being the Taiwan strain which is zoophilic and non-infective to man. With *S. mansoni* such a marked divergence has not been recorded, but comparison of strains from Africa and Puerto Rico has shown that they differ in morphology,

in infectivity to the intermediate snail host, and in infectivity and pathogenicity in animals. Morphological differences in the eggs and variation in infectivity to the snail hosts have been well documented for geographical strains of *S. haematobium*, but there are as yet no data on differences in the behaviour of the worm in the definitive host. Hybrids may occur between *S. haematobium* and related species such as *S. mattheei*.

This whole subject requires much further study; it is particularly important to determine if variations in the biological characteristics of schistosomes account for differences in their pathogenicity and epidemiological characteristics as observed in different areas.

1.3 Snail/parasite relationship

A new strain of *Oncomelania formosana*, *O. f. chiui* (syn. *Tricula chiui*), from a new focus in northern Taiwan, has been experimentally infected with four of the strains of *S. japonicum* that infect humans, and a strain of *O. formosana* from the Ilan area in Taiwan has been similarly infected with two such strains of this parasite. These findings are of epidemiological interest because of population movements to the island from areas where human schistosomiasis is endemic.

1.4 Animal hosts of schistosomes

The significance of lower animals in the transmission of *S. japonicum* is well established and is of concern in areas where control schemes are in operation. Only very few animals have been found naturally infected with *S. haematobium*; they include rodents, the domestic pig, monkeys, and the chimpanzee. In all cases, however, these have been isolated discoveries and there is no evidence that the animals are true maintenance hosts of the parasite. With S. *mansoni*, much higher infection rates have been recorded in animals, especially rodents and baboons, but usually only in areas where the infection is endemic in man. There is, as yet, no evidence to suggest that *S. mansoni* can be maintained in an animal community, and the extent to which animals enhance transmission to man is not known. In most regions *S. mansoni* is maintained by interhuman transmission. It is recommended that further studies be carried out to assess the significance of animal reservoirs in the more remote rural areas.

Many other species of schistosomes occur in wild and domestic animals. Some, like *S. mattheei*, are of significance because they often infect man. Others, like *Orientobilharzia harinasutai* and *S. margrebowiei*, cause confusion because their eggs closely resemble those of *S. mansoni* and *S. japonicum*, respectively; still others, like *S. spindale*, are important because they cause cercarial dermatitis.

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