THE HELPFUL DATEBOOK

It was clear to him that this young woman must have spent some time in Africa or the Middle East where this type of worm is prevalent. When interviewed she confirmed that she had been in Africa, participating in one of the excursions organized by the club.

The young woman did not have cancer at all, but had contracted schistosomiasis while swimming in the oasis pond. When investigators began to fear that other members of her group might also be infected, her date book came to their aid. Many of her companions had exchanged addresses with this attractive young lady, and eventually all members of the group were contacted and examined. The toll was heavy – out of 28 persons, nine were added to the long list of travellers infected at El Mamoun.1

THE LIFE OF THE FLATWORM

How did it happen? The swimmers hadn’t noticed among the vegetation at the edge of the pond the presence of minute snails so small that a dozen would easily fit into a teaspoon. In some ponds and rivers as many as 1,000 can be found in a square metre. They are the freshwater snails belonging to the genus Bulinus, which serve as the specific hosts to the larval stages of the Schistosoma haematobium worm.

The Snail – The Creature Nurturing Infection

The eggs of the worm are eliminated via the urine of those infected. When an egg reaches freshwater, it hatches rapidly – see picture of the life cycle of the human schistosomes (1). The ensuing larva (an immature form of life called miracidium) is an oval shaped organism clothed with minute cilia (2) swimming in search of the Bulinus snail.
The **miracidium** [Gr.: _meirákon_ = young form of life] is attracted by the snail’s mucous secretion and burrows into the soft tissue of the mollusc (e). Once inside, the **miracidium** transforms itself into an elongated, thin walled sack called mother **sporocyst** [Gr.: _sporá_ = sowing, seed; _kústis_ = sack] (3), which gives rise to about four hundred daughter **sporocysts** (4). Each one forms within its cavity numerous fork-tailed **cercariae** [Gr.: _kerkos_ = tail], representing the early stages of maturing worms. A single **miracidium** may produce thousands of **cercariae** in only six weeks and this production may carry on in the snail for months.

The water in the pond of El Mamoun was teeming with this kind of microscopic life when our tourists arrived at the oasis. Previous visits to the oasis by Bedouins had left the pond infected, a legacy of the disease for the tourists to contract. Like divers jumping from their boats, the **cercariae**, stimulated by the bright light and the high temperature of the day, abandon the snails. Seen under the microscope they look like miniature tadpoles, with a pear shaped buoy and a long tail ending in a y-shaped fork which acts as a propeller to move the organism through the water (5). They are now swimming in a desperate race against time, searching for a human host to ensure their survival. They will die within 48 hours if the search fails.

Attracted by the oily secretion lubricating the human body, they attach themselves to the skin with their oral suckers. They do not need to find a wound or break in the skin since they secrete an enzyme which splits the ‘cement’ holding the cells of the skin together (6). As soon as the **cercariae** start to penetrate the outer layers, they shed their tails (7) and burrow a tunnel through the epidermis.

### Humans – The Sexual Life of the Worm

The tail-less **cercariae**, now called **schistosomulae**, then reach the lymph vessels which drain into the two major veins, allowing the **schistosomulae** of both sexes to reach first the lungs and then the liver, where they mature and mate.

The worms have a rounded and elongated appearance. In the animal kingdom they are placed under the group **Platyhelminthes** (Gr.: _platús_ = broad; _élmis_ = worm). They are greyish-white in colour and measure between 1/2 and 1 inch (1.2-2.5 cm) in length and have two suction discs for adhesion and feeding. They belong to the family of flukes or **Trematoda** (Gr.: _tre_ – _ma_ = hole) and are commonly called ‘blood flukes’ because they live in the blood vessels of mammals. The name for their genus, **Schistosoma** (Gr.: _schistós_ = cleft, split; _soma_ = body), indicates their difference from all other flukes: They are not hermaphroditic, but have two genders – male and female. When they mate, the edges of the larger male worm fold over to form a groove to hold the slender and longer female close to him (8). Then, tightly embraced, they leave the liver, swimming against the flow of the venous blood, to settle in the blood vessels surrounding the bladder and the adjacent organs in the genito-urinary system.

The reason? Since the only way to ensure the survival of the species is to get the eggs into freshwater, the worms live close to the natural openings of the human body – the bladder or the openings of the reproductive organs – so that the eggs can easily escape to the outside.

The human body doesn’t suspect their presence because the worms disguise themselves with a coating of protein similar to that of the host. This coating fools the human’s defense system,
Schistosoma haematobium

Schistosoma mansoni

Schistosoma mekongi

Schistosoma japonicum

There is no risk in seawater.

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Of the thousands of different species of

THE FLATWORM IN HUMANS

Of the thousands of different species of flatworms living as parasites in practically every kind of vertebrate, only 8 are responsible for the human disease schistosomiasis. Each species has a specific intermediate host a suitable species of freshwater snail, in which the larva undergoes further development:

- *Schistosoma haematobium* lives in the blood vessels of the bladder and genitalia. The eggs, characterized by a terminal spike (d), are passed with urine. The intermediate host snail belongs to the genus Bulinus which has a conical shaped shell, dark grey in colour measuring about 1 cm in length (d1). The infection caused by *S. haematobium* is found in Africa (including Madagascar) and the Middle East. Humans are the only known reservoir of this species, therefore, with improved sanitation and public health initiatives the prospects of eradication are excellent in communities who are infected with *S. haematobium* only.

- *Schistosoma mansoni* lives in the blood vessels surrounding the large bowel. The eggs, which have a lateral spine (c), are passed with the stools. The intermediate host belongs to the genus Biomphalaria, a snail with a flat disc-shaped shell (c1), dusky brown or reddish in colour with a diameter of 7-22mm. The infection caused by *S. mansoni* is endemic in Africa (including Madagascar), the Arabian peninsula, Brazil, Venezuela, and some Caribbean countries. Besides humans, *S. mansoni* also infects rodents and monkeys (baboons) in some endemic areas which contribute to maintaining the transmission cycle and making elimination more difficult.

- *Schistosoma japonicum* lives mainly in the blood vessels of the small intestine. The eggs, which have a rudimentary lateral spine (b) escape into the bowel and are passed with stools. The intermediate host is a small amphibious snail of the genus Oncomelania (b1). It has a turreted (tower-like) shell, dark olive in colour, measuring about 1 cm in length. The infection caused by this worm occurs in China, the Philippines and in limited areas of Central Sulawesi, Indonesia. *S. japonicum* is primarily a zoonotic (animal) infection with multiple reservoir hosts: Rodents, dogs, cattle, water buffalo, pigs, horses, sheep and goats, making elimination efforts challenging and very costly.

- *Schistosoma mekongi* was identified in 1978. It is found along the Mekong River in Cambodia and Laos.

In countries where Schistosomiasis is endemic, avoid contact with fresh water. There will be situations where you will be tempted to disregard this simple advice. There is no risk in seawater.

Be Aware of Schistosomiasis | 2020
A Brief History of Schistosomiasis:
It is believed that both schistosomes and snail hosts have been in contact with humans since our evolutionary origins. From the area of the Great Lakes in East Africa, the infection moved northward along the Nile and later reached the Middle East and West Africa through trade routes.

The movement of East African tribes contributed to spreading the disease to the south. From west Africa the infection was transported to the Americas by the slave trade and it became established in South America and some Caribbean Islands due to the presence of suitable snail hosts. Schistosomiasis was known to the ancient civilizations of Egypt, Mesopotamia, and China.

1500 B.C. The Egyptian Papyrus Ebers mentions remedies “to kill worms in the body causing blood in the urine”. Calcified eggs of S. haematobium, found in two mummies of the XXth dynasty by Sir Marc Armand Ruffer in 1910 substantiate this evidence.

400 B.C. Ge Hong in his classic compendium of traditional Chinese medicine ‘Zhouhou Bei Ji Fang’, describes “water poison attacking man like ‘shegong’ [a poisonous insect], but invisible”.

1851 Theodor Bilharz, a German physician working at the Kasr el Aini Hospital in Cairo discovered trematoda worms in the veins of a patient during an autopsy. He realized they were the cause of Schistosomiasis. In honour of his discovery, the disease is called Bilharzia, a term widely used in Europe.

• Schistosoma malayensis was identified in 1988 as the cause of human infection on peninsular Malaysia and Malaysian Borneo.

• Schistosoma guineensis was identified in 2003. It is found in western Africa, mainly in Cameroon, Equatorial Guinea, Gabon, Sao Tomé and Príncipe, Nigeria, Burkina Faso, and Mali. Mapping of this species is not complete.

• Schistosoma intercalatum is present in the Democratic Republic of the Congo. It is usually the sole transmission agent but can also be found in areas where S. mansoni and S. haematobium are present.

• Schistosoma mattheei is found in southern Africa (South Africa, Swaziland, Zambia) and primarily affects cattle, horses, sheep and antelopes, but can infect humans. It co-exists with S. mansoni and S. haematobium.

THE DISEASE – THE DAMAGE BY THE EGGS

The early signs of the disease caused by the different species of worms are similar. When the cercariae penetrate the skin, they produce itching and a localized rash at the point of entry which disappears within a day or two, followed by a symptomless period of 4 to 6 weeks during which the worms reach maturity. Towards the end of this period, you start to feel weak, suffer loss of appetite, experience night sweating, and have a pronounced rash resembling hives all over the body. A late afternoon fever lasting from 5 to 10 days is known as ‘snail fever’ or Katayama Fever. The French call it ‘fièvre des safaris’ (safari fever).

After a few months, when the infection is well established, the damage produced by the discharge of eggs into the tissues of the various organs will manifest itself in different ways based on the type of worm.

• The passage of blood in urine and frequent and painful urination are consistent symptoms of the disease caused by S. haematobium.

• Bouts of diarrhea with the passage of blood and mucous in the stools are the signs of the infection caused by S. mansoni. In the late stages of the illness, extensive fibrosis of the liver (scarred liver) leads to the accumulation of fluids in the abdomen, producing a clinical picture similar to cirrhosis of the liver.

• The infection caused by S. japonicum follows a course similar to that of S. mansoni, but the disease tends to be more severe due to the large number of eggs produced by this species (an average of 3,000 eggs per female worm a day). Infection with S. mekongi and S. malayensis tend to be milder than S. japonicum.

• The infection by S. guineensis and S. intercalatum runs a rather mild course, sometimes without symptoms.

Schistosomiasis lacks the immediate effects of other tropical diseases. It is a chronic condition produced by the cumulative damage of repeated egg deposits, making you vulnerable to other infections, including HIV, and can be fatal. This silent drama unfolds slowly among populations in rural and agricultural areas. Even the suburbs of some African, Asian, and South American cities are infected. In many areas the disease is so common that it is regarded as a way of life. In fact, in some parts of Africa it is not considered unusual for a person to pass blood with urine. Today, it is estimated that 249 million people throughout the world, mainly in sub-Saharan Africa, are affected by the disease.

A MAJOR CONCERN

The worldwide demand for water requires new irrigation projects and the construction of dams has resulted in the spread of the disease where it previously did not exist.

A case in point is the construction of the Akosombo Dam in Ghana creating Lake Volta in 1965. The project displaced 80,000 people, mostly subsistence farmers and fishermen from 700 villages who were resettled into 52 new communities. In a short period after construction of the dam, the proportion of the population affected by Schistosomiasis jumped to 40% from the previous 5%.

In Egypt, construction of the Aswan Dam altered the balance between the two types of infection present in the country. Ecological changes favouring the spread of Biomphalaria snails, which harbours S. mansoni (affecting the liver and large bowel) increased, while the urinary form caused by S. haematobium decreased. With a successful national Schistosomiasis treatment programme, the proportion of people with clinical disease decreased from 0.4% in 1960 to 0.2% in 1990.
Since 2006, due to educational awareness programs and the yearly distribution of chemotherapy, many endemic countries have experienced a significant decrease in human infections. Some countries no longer report human infections and are awaiting evaluation and confirmation by the WHO that human transmission has been interrupted. See IAMAT’s World Schistosomiasis Risk Chart for country details. However, the majority of endemic countries still require massive help with public health and improved sanitation, this is to say, chemotherapy campaigns must be combined with infrastructure improvements – safe water and sewage disposal – education, and snail control to achieve permanent success.

**CONTROL**

The targets for the interruption of the transmission cycle are public education, improved sanitation and disposal of human waste, elimination of snails, and treatment of infected persons.

**TREATMENT**

The drug of choice for the treatment of Schistosomiasis is praziquantel, a compound effective against all species of schistosomes. The drug is well tolerated and fast acting. Praziquantel paralyzes the worms, making them vulnerable to the body’s defense mechanisms. However, successful treatment will improve but not solve the situation; treated persons can easily become re-infected. Prevention is still preferable to treatment since in the absence of obvious symptoms, irreversible damage may be done before the infection is detected.

The targets for the interruption of the transmission cycle are public education, improved sanitation and disposal of human waste, elimination of snails, and treatment of infected persons.
PERSONAL PREVENTION

No drugs are available to prevent the establishment of the infection although progress has been made in the development of a vaccine for the schistosomes that affect domestic animals. Attempts to develop a vaccine for human schistosomes have not yet been successful.

The Golden Rules to Prevent Schistosomiasis

- In countries where Schistosomiasis is endemic, avoid contact with fresh water. There will be situations where you will be tempted to disregard this simple advice. There is no risk in seawater. See IAMAT’s World Schistosomiasis Risk Chart for country details.

- If you are planning a trip into the jungle or desert, make sure it is a short one, so that you can withstand the heat and are not tempted to cool off in a pond or stream. Make sure you do not run out of purified water.

- If you must pass through streams or swamps, wear high waterproof boots or hip waders.

- Stay away from the banks of streams and rivers; snails abound in shallow water where they feed on organic waste and aquatic vegetation. Snail presence is minimal in the deeper ends of lakes, rivers, and streams where water tends to flow faster.

- Avoid contact with freshwater during peak daylight hours when the cercariae emerge from the snails and are most active.

- If you accidentally come into contact with freshwater, rub your skin immediately with rubbing alcohol and a dry towel to reduce the possibility of infection.

- If you are travelling overland by car, carry a pair of rubber gloves in case you have to dip your hands into a stream or pond to get water for the radiator.

- Water from a river or lake used for bathing and washing should be boiled or chlorinated.

- Water for washing and bathing is relatively safe if it has been stored for 2-3 days (the period generally accepted as the life span of cercariae), provided that the container is free of snails.

- Drinking water should be boiled or treated with chlorine tablets, as the cercariae may burrow through the mucosa of the mouth.

- Make sure vegetables are well cooked and avoid salads since the leaves may have been washed with infected water. For advice on water and food precautions, see www.iamat.org.

Sources: Please contact IAMAT for references.

1978 Marietta Voge, David Bruckner and John I. Bruce confirmed that S. mekongi is a separate species from S. japonicum.

1988 S. malayensis was identified as a separate species from S. japonicum by G. J. Greer, C. K. Ow-Yang, and H. S. Yong.

2003 S. guineensis was identified as a separate species from S. intercalatum by a team of scientists from Cameroon, France, and England.

GUIDELINES FOR SNAIL IDENTIFICATION

It is not always easy, even for a trained person, to distinguish harmful snails from harmless ones. Snail features vary from continent to continent. The following hints will help you identify intermediate snail hosts. Always wear a pair of rubber gloves to hold snails for examination.

Africa

- Look for the dimensions of the snail. Harmful ones will have a shell less than 2 cm (3/4 inch) in length.
- Harmful snails are always in the water, either floating, lying on the bottom or attached to aquatic vegetation. Snails crawling on land are harmless.
- Harmful snails do not have an operculum, a 'door' attached to the foot which closes the opening of the shell when the snail retreats. In Africa, harmless snails have an operculum.

Harmful snails are divided into two major groups:
1) Snails with a flat, round shell like a disc or wheel belong to the genus *Biomphalaria*, which is the intermediate host of *S. mansoni*.
2) Snails with a conical shell ending with a sharp tip belong to the genus *Bulinus*, which transmit *S. haematobium*.

You may identify the harmful *Bulinus* species by holding the shell between your fingers with the opening facing you and the apex pointing upwards. You are dealing with a harmful species if the opening is to the left hand side. Shells with a right hand opening belong to harmless snails.

South America and Some Caribbean Islands

The only harmful species of snail present in the western hemisphere belong to the genus *Biomphalaria*. Except for *B. straminea*, they differ from the African species in that they are larger than 2 cm (3/4 inch) in length. They have a round, flat-shaped shell, dark brown, sometimes reddish in colour.

Southeast Asia

In southeast Asia, the snails transmitting schistosomiasis belong to the genus *Oncomelania*. They have a conical, turreted dark brown shell, usually less than 1 cm (1/2 inch) in length. You may notice that in this dangerous species the opening is to the right and when the snail retreats, the operculum will close the opening. You will find them either floating in water or crawling on land.