Schistosoma, blood fluke

Schistosoma species are causative agents of a tropical disease **schistosomiasis** or **bilharzia**. Schistosomiasis (also known as snail fever or bilharzia). More than 200 million people are infected worldwide. Mostly in freshwaters where there are many snails which are the intermediate host. There are five main species infecting humans: *Schistosoma mansoni*, *S. haematobium*, *S. japonicum* and two geographically localized species *S. intercalatum* and *S. mekongi*. They are different in the following ways:

1- they have two rather than three hosts

2- they are **dioecious** (having female and male reproductive organs in separate individuals)

3- they infect their hosts by directly penetrating the body surface, rather than being eaten

4- they are **intravascular** parasites (live inside blood vessels)

Life cycle of *Schistosoma*

1-female discharges up to 300 eggs per day singly into mesenteric venule of definitive host (human); the eggs eventually obstruct blood flow in the venule causing a partial necrosis in the intestinal wall; hence, the eggs are dropped of into the lumen of the intestine, and passed to feces.

2- a free-swimming larva; once the egg is released into environment, miracidium hatches immediately and starts swimming; if it happened to swim into a snail, it enters the snail and starts its first life as a parasite. miracidium transforms into sporocyst, second generation of sporocyst, and cercaria.

3- The cercaria emerge from the snail during daylight and they propel themselves in water with the aid of their bifurcated tail, actively seeking out their final host. When they recognise human skin, they penetrate it within a very short time. This occurs in three stages, an initial attachment to the skin, followed by the cercaria creeping over the skin searching for a suitable penetration site, often a hair follicle, and finally penetration of the skin into the epidermis using proteolytic secretions from the cercarial post-acetabular, then pre-acetabular glands. On penetration, the head of the cercaria transforms into an endoparasitic larva, the schistosomule.

Each schistosomule spends a few days in the skin and then enters the circulation-4 starting at the dermal lymphatics and venules. Here they feed on blood, regurgitating the haem as hemozoin. The schistosomule migrates to the lungs (5–7 days post-penetration) and then moves via circulation through eithor the left side of the heart within the blood flow or the right side of the heart agenist the blood flow to the hepatoportal circulation (>15 days) where, if it meets a partner of the opposite sex, it .develops into a sexually mature adult and the pair migrate to the mesenteric veins

Male schistosomes undergo normal maturation and morphological development -5 in the presence or absence of a female. On the other hand, female schistosomes do not mature without a male. Females schistosomes from single-sex infections are .underdeveloped and exhibit an immature reproductive system

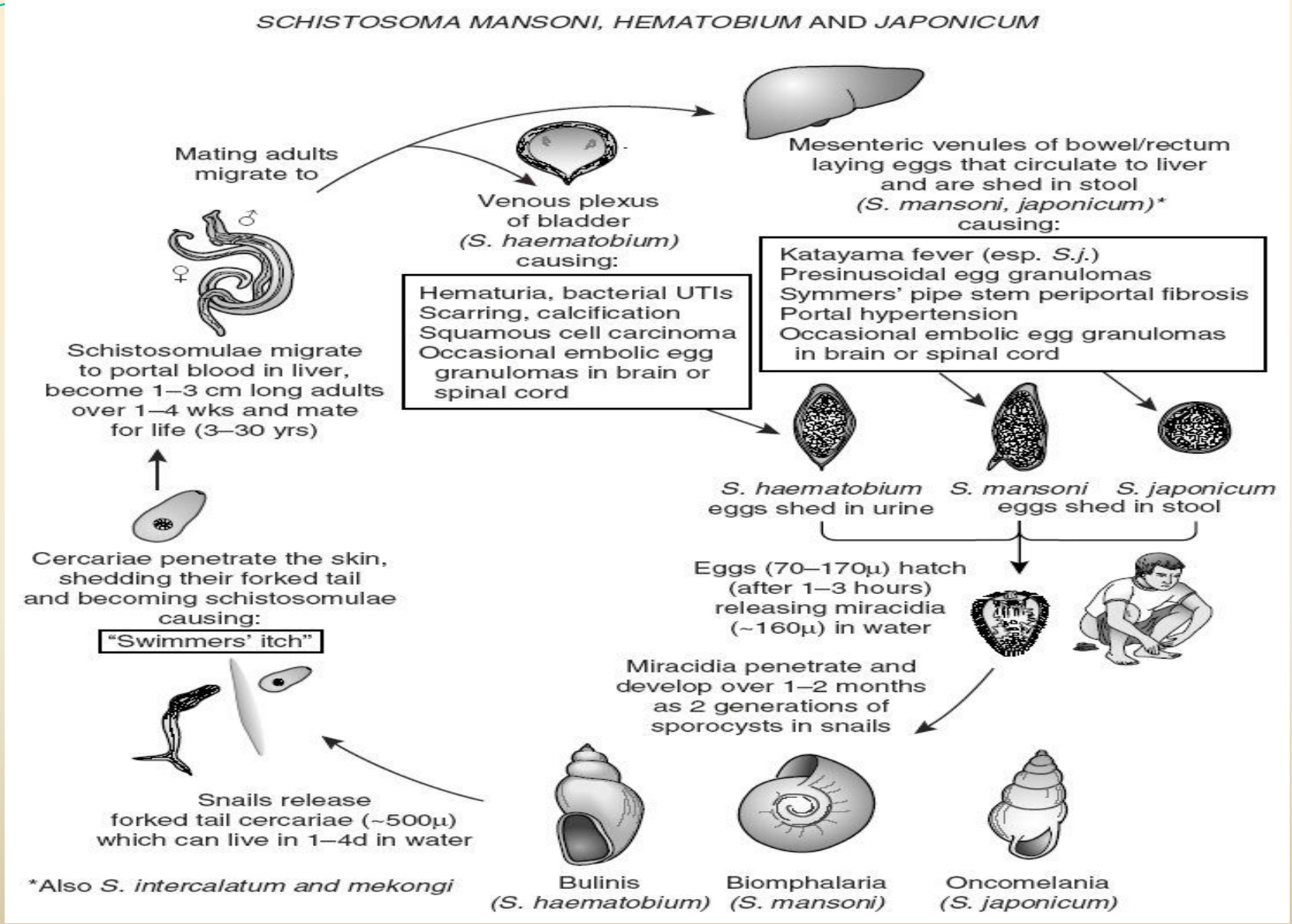
The adult female worm resides within the adult male worm's gynaecophoric -6 canal, which is a modification of the ventral surface of the male forming a groove. The way of paired worms move against the flow of blood to their niche in the mesenteric circulation where they begin eggs production (>32 days) which are deposited on the endothelial lining of the venous capillary walls. The eggs move into the lumen of the host's intestines and are released into the environment with the .faeces

Distribution is critically dependent on the availability of .suitable intermediate snail hosts, *i.e*

a) *Bulinis spp. for Schistosoma haematobium*

b) *Biomphalaria spp. for Schistosoma mansoni*

c) Oncomelania spp. for Schistosoma japonicum


SCHISTOSOMA MANSONI, HEMATOBIUM AND JAPONICUM
Mating adults migrate to
Venous plexus of bladder (S. haematobium) causing:
Hematuria, bacterial UTIs
Scarring, calcification
Squamous cell carcinoma
Occasional embolic egg granulomas in brain or spinal cord
Mesenteric venules of bowel/rectum laying eggs that circulate to liver and are shed in stool (S. mansoni, japonicum)* causing:
Katayama fever (esp. S.j.)
Presinusoidal egg granulomas
Symmers' pipe stem periportal fibrosis
Portal hypertension
Occasional embolic egg granulomas in brain or spinal cord
♂
♀
Schistosomulae migrate to portal blood in liver, become 1–3 cm long adults over 1–4 wks and mate for life (3–30 yrs)
S. haematobium eggs shed in urine
S. mansoni eggs shed in stool
S. japonicum
Eggs (70–170μ) hatch (after 1–3 hours) releasing miracidia (~160μ) in water
Cercariae penetrate the skin, shedding their forked tail and becoming schistosomulae causing:
"Swimmers' itch"
Miracidia penetrate and develop over 1–2 months as 2 generations of sporocysts in snails
Snails release forked tail cercariae (~500μ) which can live in 1–4d in water
*Also S. intercalatum and mekongi
Bulinis (S. haematobium)
Biomphalaria (S. mansoni)
Oncomelania (S. japonicum)

- *Schistosoma haematobium* prefers the venous plexus of the bladder,
- *Schistosoma mansoni* prefers the inferior mesenteric veins, and *Schistosoma japonicum* prefers the superior mesenteric veins as habitats.

:Clinical sign

Eggs pass downstream, but lodge in capillaries, provoking an immune .response

a) With *Schistosoma haematobium* this tends to produce hematuria, bacterial urinary tract infections, scarring and calcification of the bladder, and squamous cell carcinoma of the bladder (the International Agency for Research on Cancer has classified Schistosoma haematobium as a human .carcinogen)

.The eggs escape through hematuria (1)

Fatal renal failure can develop (2)

- Urinary blood flukes. In the urinary form of the disease, the patient may have the signs/symptoms of urethral and renal damage ending in fatal uremia. The infected human might die of bladder carcinoma many years after .being infected

- B)With *Schistosoma mansoni* and *japonicum* this tends to plug up the circulation of the liver, producing portal hypertension, abdominal edema, .and hemorrhoids

.When the hemorrhoids burst and bleed, the eggs escape (1)

- .The patient can bleed to death (2)
- Intestinal blood flukes. Early symptoms are diarrhea, dysentery, and
- abdominal pain. Symptoms of later stages include anorexia, weight loss, may be intestinal tumors. Signs of portal hypertension and hepatic insufficiency are also inevidence

Pathologies

1- Acute pathology

- **Cercarial dermatitis**, "swimmer's itch", skin rash that can be accomanied by lesions and can persist for days, occurs upon massive penetration of skin by cercariae.
- **Katayama fever** is a systemic hypersensitivity reaction against the migrating schistosomulae. The disease (fever, fatigue, myalgia, etc.) starts suddenly in a few weeks or even months after a primary infection. Most patients recover spontaneously after 2-10 weeks. This type of illness is not common in individuals who live in areas that are endemic for schistosomiasis. It occurs instead in those people who have no previous history of exposure.

2-Chronic pathology

- Urinary schistosomiasis (*S. haematobium*)
- Intestinal schistosomiasis(*S. japonicum*)
- Hepatic schistosomiasis and hepatosplenic schistosomiasis (*S. mansoni*)
- Ectopic ("displaced") schistosomiasis

a) Genital schistosomiasis (*S. mansoni*, *S. haematobium*)

b) Pulmonary schistosomiasis (*S. mansoni*)

c) Neuroschistosomiasis (*S. japonicum*, *S. haematobium*)

Pathology

The ova are initially deposited in the muscularis propria which leads to ulceration of the overlaying tissue. Infections are characterized by pronounced acute inflammation, squamous metaplasia, blood and reactive epithelial changes. Granulomas and multinucleated giant cells may be seen

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Some of the deposited eggs reach the outside environment by passing through the wall of the intestine; the rest are swept into the circulation and are filtered out in the periportal tracts of the liver resulting in periportal .fibrosis

- Onset of egg laying in humans is sometimes associated with an onset of fever (Katayama fever). This "acute schistosomiasis" is not, however, as .important as the chronic forms of the disease
- **Granuloma formation is initiated** by antigens secreted by the miracidium through microscopic pores within the rigid egg shell. The granulomas formed around the eggs impair blood flow in the liver and consequently .induce **portal hypertension**
- With time, **collateral circulation** is formed and the eggs disseminate into the lungs, where they cause more granulomas, pulmonary arteritis and, later, **. cor pulmonale (Primary Right Heart Failure)**

- **The hepatic schistosomiasis** is the most important, eggs become lodged in the liver, leading to high blood pressure through the liver, the buildup of fluid in the abdomen, enlarged spleen granulomas here giving rise to .fibrosis of the liver and hepatosplenomegaly in severe cases
- **The intestinal schistosomiasis,** eggs become lodged in the intestinal wall and cause an immune system reaction called a granulomatous reaction. This immune response can lead to obstruction of the colon and blood loss , and potentially life-threatening dilations or swollen areas in the esophagus or gastrointestinal tract that can tear and bleed profusely (esophageal varices) .
- **The nervous form,** Rarely, the central nervous system is affected. Individuals with chronic active schistosomiasis may not complain of typical symptoms
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- A contributory factor to portal hypertension is **Symmers' fibrosis**, which develops around branches of the portal veins a characteristic pipe-shaped fibrosis formed around hepatic portal veins in some cases of long-continued heavy infection with *Schistosoma mansoni*; thought to be induced by the presence of large numbers of schistosome eggs in the hepatic tissues. This fibrosis occur only many years after the infection and apparently is caused in part by soluble egg antigens and various immune cells which react to them .

- Diagnosis of infection is confirmed by:
- The identification of eggs in stools. Eggs of *S. mansoni* are approximately 140 by 60 µm in size, and have a lateral spine.
- The diagnosis is improved by the use of the Kato-Katz technique (a semi-quantitative stool examination technique).
- Enzyme linked immunosorbent assay (ELISA), circumoval precipitation test (COPT) and alkaline phosphatase immunoassay (APIA).
- Recent research has shown that granuloma size is consistent with levels of IL-13, which plays a prominent role in granuloma formation and granuloma size. IL-13 receptor α 2 (IL-13Rα2) binds IL-13 with high affinity and blocks the effects of IL-13. Thus, this receptor is essential in preventing the progression of schistosomiasis from the acute to the chronic (and deadly) stage of disease. Synthetic IL-13Rα2 given to mice has resulted in significant decreases in granuloma size, implicating IL-13Rα2 as an important target in schistosomiasis.

Treatment

.A. Praziquantel (Biltricide®) is the drug of choice

.Cure rates are equal to or better than 85% .1

.Infection intensity is reduced in 99% of patients .2

B. Less expensive metrifonate works well on *Schistosoma .haematobium*

C. Less expensive oxamniquine works well on *Schistosoma .mansoni*

.D. Nothing else works very well on *Schistosoma japonicum*

Prevention

A. Treatment of cases to reduce egg loads may be the .cheapest solution

B. Reduction or elimination of snail intermediate hosts

C. Elimination of snail habitats

D. Sanitation measures