Medical Helminthology. Trematodes (Flukes)

Medical helminthology is concerned with the study of helminthes or parasitic
worms.

Helminthes are trophoblastic metazoa (multi-cellular organisms).

Helminthes are among the common parasitic causes of human suffering. They are the cause of high morbidity and mortality of people worldwide.

They cause different diseases in humans, but few helminthic infections cause life- threatening diseases.

They cause anemia and malnutrition. In children they cause a reduction in academic performance.

Helminthes also cause economic loss as a result of infections of domestic animals.

There is age dependent distribution of infections from geo-helminthes and schistosomes.

As a result of predisposing behavioral and immunological status, children disproportionately carry the burden of schistosomes and geo-helminthes

The sources of the parasites are different. Exposure of humans to the parasites may occur in one of the following ways:

1. Contaminated soil (Geo-helminthes), water (cercariae of blood flukes) and food (Taenia in raw meat).
2. Blood sucking insects or arthropods (as in filarial worms).
3. Domestic or wild animals harboring the parasite (as in echinococcus in dogs).
4. Person to person (as in *Enterobius vermicularis, Hymenolopis nana).*
5. Oneself (auto-infection) as in *Enterobius vermicularis.*

They enter the body through different routes including: mouth, skin and the respiratory tract by means of inhalation of airborne eggs.

The helminthes are classified into three major groups. These are:

1. Trematodes (Flukes)
2. Cestodes (Tape worms)
3. Nematodes (Round worms)

The Trematodes and Cestodes are groups of flat worms.

The major objective of this lecture note is to provide good understanding of the most common helminthes prevalent in the tropics in general and in Ukraine in particular.

MEDICALLY IMPORTANT TREMATODES (FLUKES)

Trematodes belong to the phylum platyhelminthes. They are found in a wide range of habitats. The great majority inhabit the alimentary canal, liver, bile duct,ureter and bladder of vertebrate animals.

According to the sites they inhabit, there are four groups of flukes. These are:
Blood flukes, Intestinal flukes, Liver flukes, and Lung flukes

BLOOD FLUKES

These are flukes that reside mainly in the blood vessels of various organs and the schistosomes are the prototype.

SCHISTOSOMIASIS

It is estimated that about 600 million people in 79 countries suffer from schistosomiasis (Bilharziasis). The schistosomes cause intestinal, hepatosplenic, pulmonary, urogenital, cerebral and other forms of schistosomiasis.
Schistosome is the only fluke with separate sexes. The female worm lies in the gynecophoral canal of the male. This condition is important for transportation.

There are five medically important species:

1. *Schistosoma mansoni:* causes intestinal schistosomiasis.
2. *Schistosoma haematobium:* causes vesical (urinary) schistosomiasis.
3. *Schistosoma japonicum:* causes intestinal schistosomiasis.
4. *Schistosoma intercalatum:* causes intestinal schistosomiasis.
5. *Schistosoma mekongi:* causes intestinal schistosomiasis. This seems to cause milder disease in man. It causes disease in other vertebrate hosts.

SCHISTOSOMA MANSONI

Habitat - This species lives in the veins of the intestine.

Geographical distribution: It is found in Africa, South America, Middle East (some Arab countries) etc. Stream and lake-based transmission is common.

The snail hosts that harbor *S. mansoni* are the genera: Biomphalaria *(B. glabrata)* and Trobicorbis. These have oval shells.

Morphology

Male: The male ranges in size from 1-1.4 cm in length and the body is covered by coarse tubercles. It has 6-9 testes

Female:The female is 1.5-2.0 cm in length. The ovary is present in the anterior third and Vitelline glands occupy the posterior two-thirds. It lays about 100-300 eggs daily. The uterus is short containing few ova.

URINARY SCISTOSOMIASIS

Etiology - *Schistosoma haematobium*

Habitat - The worm lives in the veins of the bladder of humans.

The peak prevalence is the 10-14 year age group. The snail hosts that harbor S.*haematobium* are the genera Bulinus (Bulinus africanus, B. truncatus) and Physopsis.

Male: The male ranges in size from 1-1.5 cm in length. The body is covered by fine tubercles. It has 4-5 testes.

Female: The female ranges in size from 2-2.5 cm in length. The ovary is present in the posterior third. Vitelline glands occupy the posterior thirds. Uterus is long containing many ova. It lays about 20-200 eggs daily. **Distribution:** In Africa S. haematobium is found in the Lower Awash Valley in the east and in Benshangul-Gumuz (Assossa) regional state in the west in low altitudes below 1000 meters above sea level and other regions and countries.

SCHISTOSOMA JAPONICUM

The female adult worm lays about 500-3500 eggs daily. The eggs are ovoid, bearing only a minute lateral spine or a small knob postero-laterally. It is found in Japan, China, and Philippines, etc.

SCHISTOSOMA INTERCALATUM

This is the rarest and least pathogenic schistosome that matures in man. It is found in Western and Central Africa. The daily egg output is about 300. The eggs have a terminal spine.

Male adult worm :

	S. haematobium	S. mansoni	S. japonicum
Length	**10 – 15 mm**	**6 – 10 mm**	**12 – 20 mm**
Integument	**finely tuberculated**	**coarsely tuberculated**	**smooth**
No of testes	**3 – 5 (4)**	**6 – 9 (7) in (cluster)**	**7 – 9 (7) (in column)**
Ceca	**reunite late**	**reunite early**	**reunite very late**
Female adult worm :			
Length	**15 – 20 mm**	**10 – 14 mm**	**15 – 30 mm**
Position of the ovary	**posterior half**	**anterior half**	**middle**
Length of the uterus	**long**	**short**	**long**
No. of ova in the uterus	**20 – 50**	**1 – 4**	**50 – 300**
Ova			
Spine (rudimentary)	**terminal spine**	**lateral spine**	**short lateral spine**
Present	**in urine, less, frequently in stool**	**rarely in urine**	**in stool**

Habitat in human :

Body	**vesicle plexus of urinary bladder**	**in interior mesenteric vein, less frequently superior**	**superior mesenteric vein, less frequently interior**

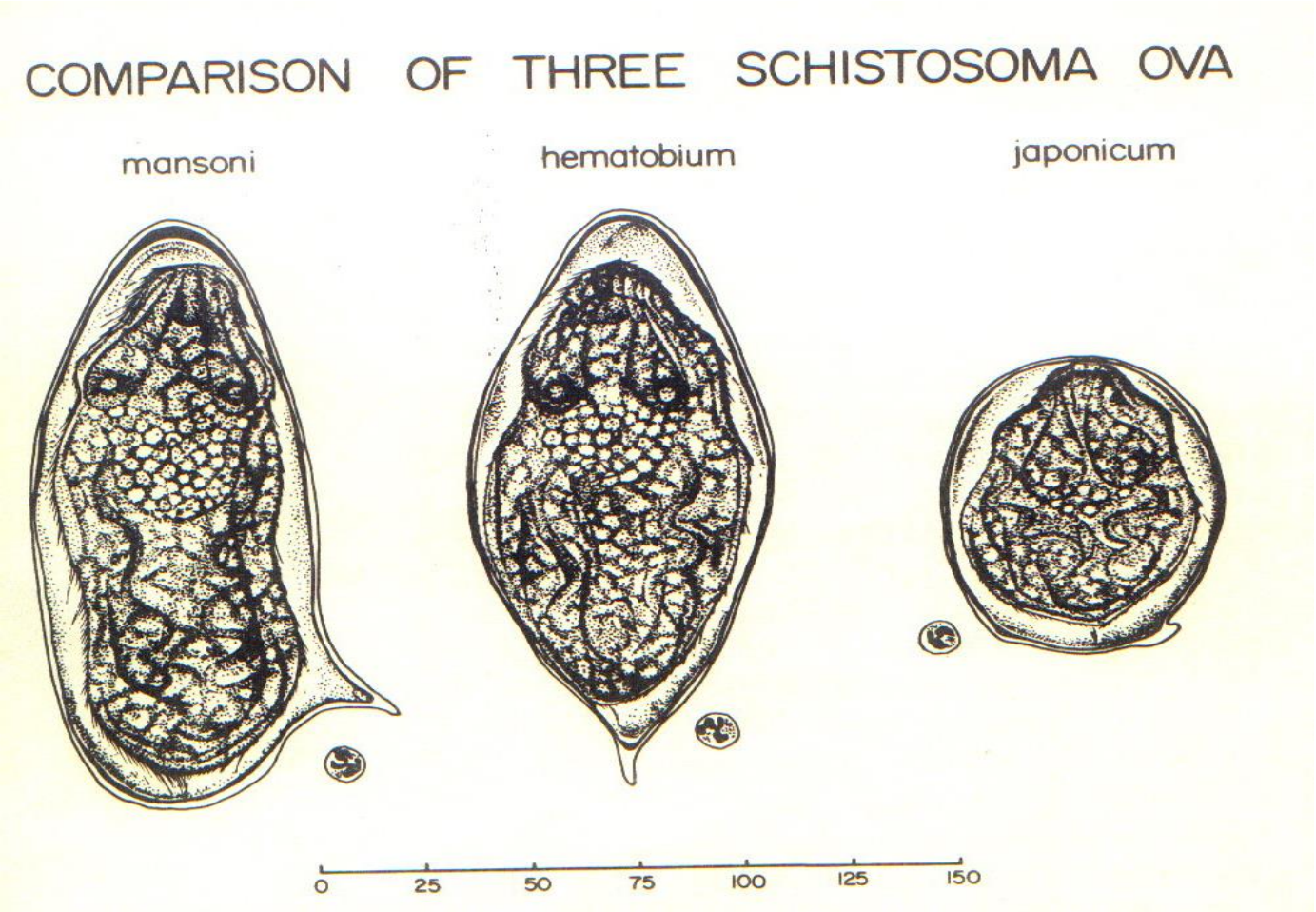
Snails :

(**intermediate host)**	**Bulinus truncatus**	**Biomphalaria spp.**	**Oncomelani spp.**

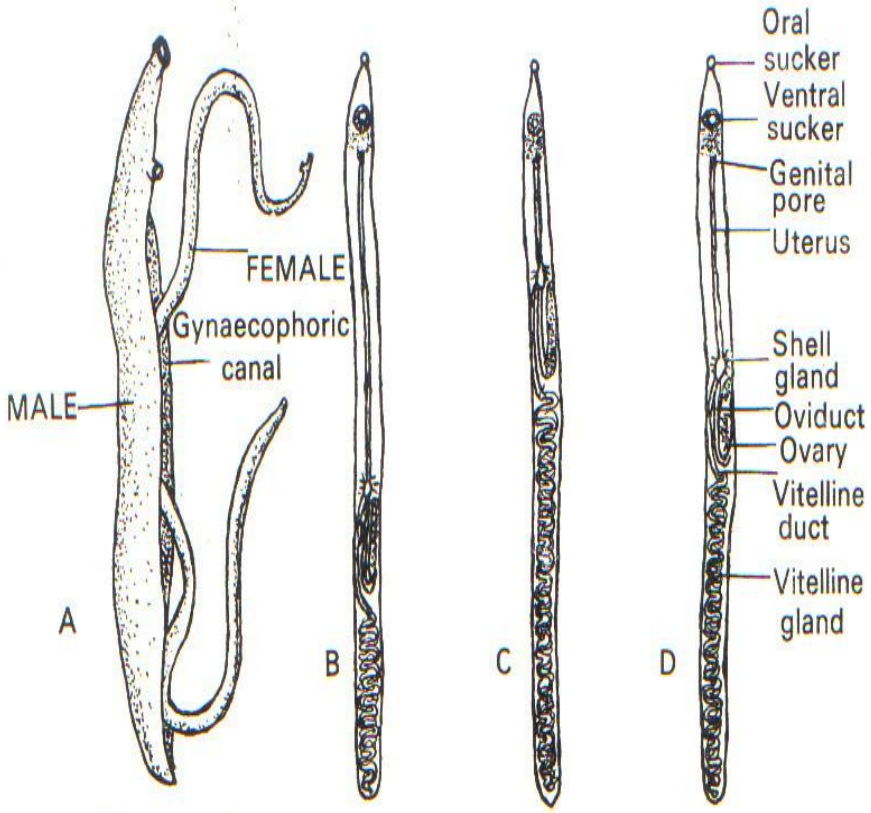
S. haematobium Egg
In Urine

S. mansoni Egg
In Stool

Schistosoma japonicum Egg



Ova of *Schistosoma* spp.



Diagrammatic representation of the species differences of the parasitic schistosomes of man. A = male and female worms *in situ*; B = female *S. haematobium*; C = female *S. mansoni*; D = female *S. japonicum*. *Source:* Blacklock and Southwell (1954) *A Guide to Human Parasitology for Medical Practitioners*, rev. Davey, T. H. (1966), H. K. Lewis & Co., London.

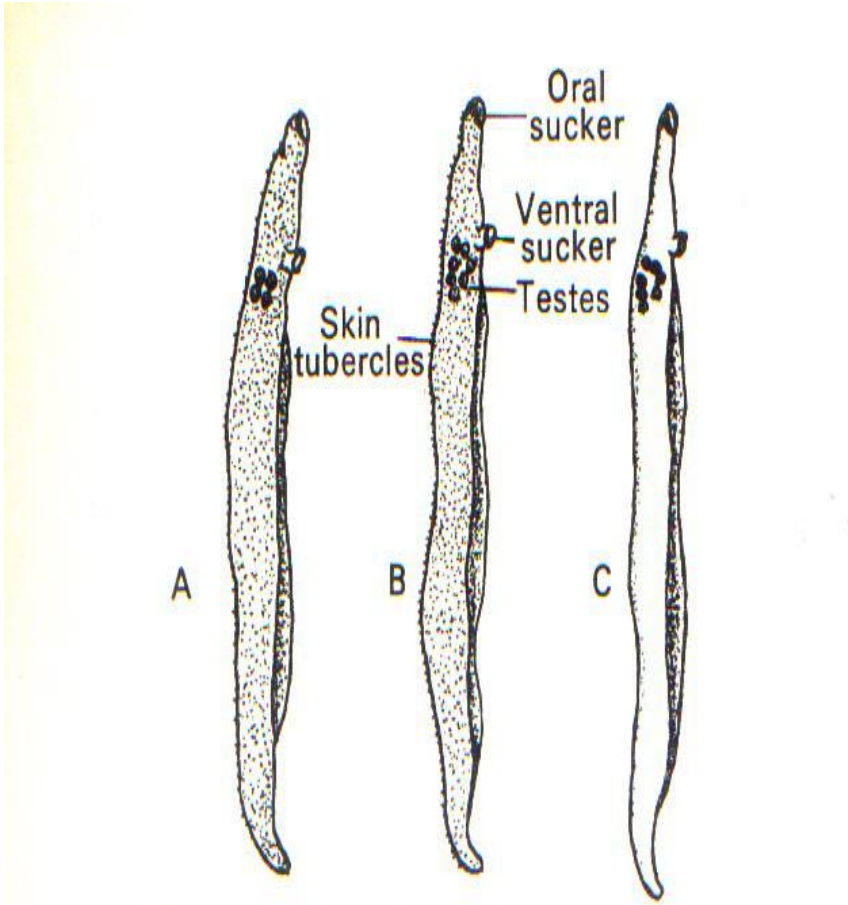
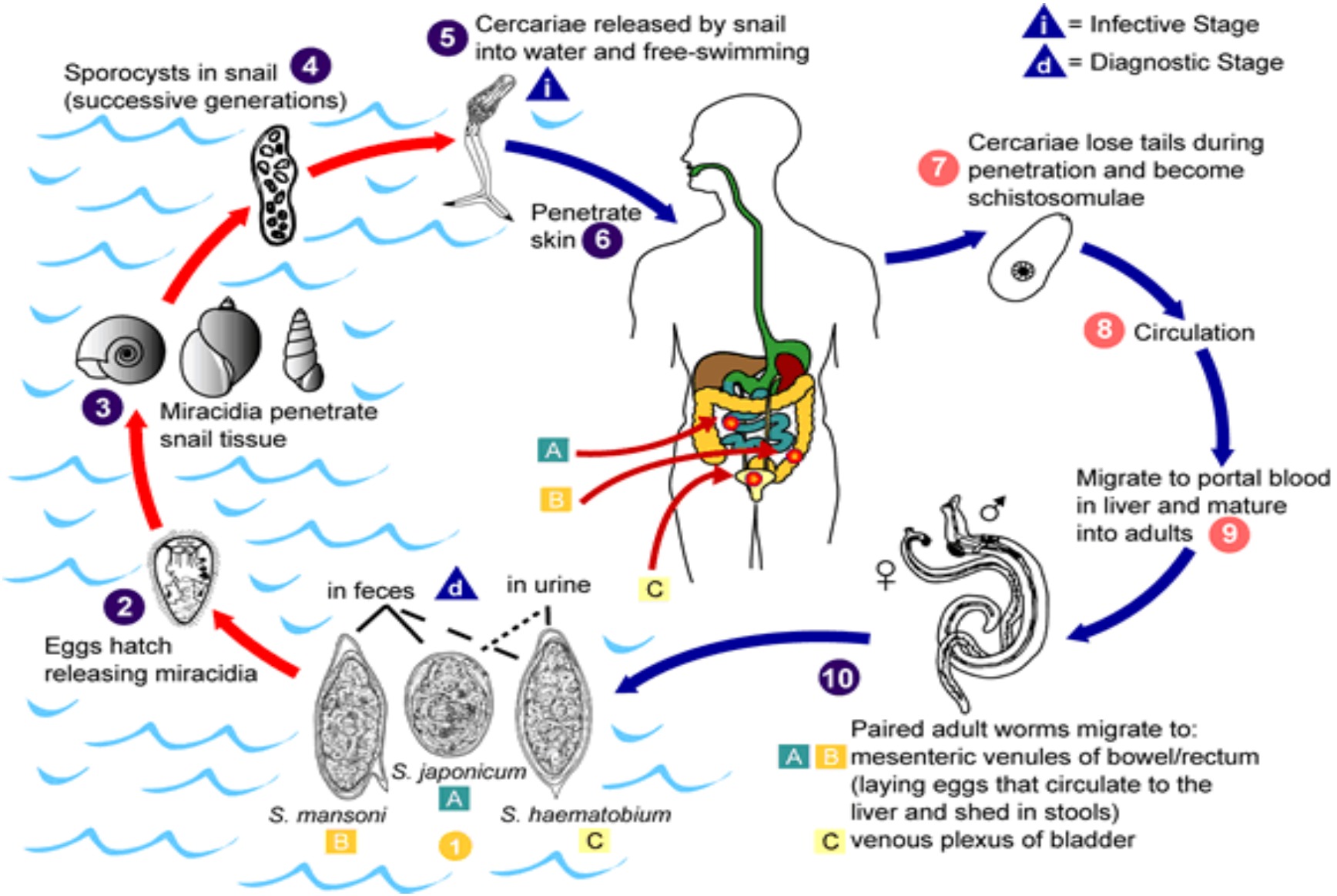


Diagram of the males of the three species of schistosomes which parasitize man, showing their differential characters. A = *S. haematobium*; B = *S. mansoni*; C = *S. japonicum*.

Differential Features of *Schistosoma* spp.

- **LIFE CYCLE OF SCHISTOSOMES**
- Adult worms reside in pairs: the female lying in the gynecophoral canal,After fertilization, eggs are passed into the venules. A larval form – the miracidium - develops within the egg. Its lytic enzymes and the contraction of the venule rupture the wall of the venule liberating the egg into the perivascular tissues of the intestine (*S. mansoni) or urinary bladder (S. haematobium). The* eggs pass into the lumens and organs and are evacuated in the feces (*S.mansoni) or the urine (S. haematobium). On contact with fresh water the* miracidia hatch from the eggs and swim about until they find the appropriate snail, which they penetrate. After two generations of sporocyst development and multiplication within the snail, the fork-tailed cercariae emerge. Infection to man takes place during bathing. The cercariae penetrate the skin, are carried into the systemic circulation and pass through to the portal vessels.Within the intrahepatic portion of the portal system, the worms feed and grow to maturity.



life cycle of *Schistosoma* spp.

Symptoms and complications

Patients infected with *S. haematobium* suffer from terminal haematuria and painful micturition. There is inflammation of the urinary bladder (cystitis), and enlargement of spleen and liver.

Patients infected with *S. mansoni* suffer from cercarial dermatitis (swimmers itch) and dysentery (mucus and blood in stool with tenesmus) as well as enlargements of the spleen and liver.

S. haematobium causes squamous cell carcinoma in the bladder.

Pathology

Penetration of the skin by cercariae (1)
Skin penetration may not be apparent. Human and some non-human *Schistosoma* species cause cercarial dermatitis (swimmer's itch). This manifests with papules, macules, vesicles and intense itching.

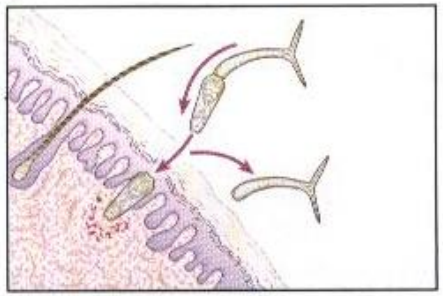
Migration and maturation of immature worms (2)
There are general toxic and allergic symptoms including urticaria with eosinophilia, fever, abdominal pain and tender hepatosplenomegaly. This is known as Katayama or snail fever.

Damage by eggs in tissue (3)
Resulting damage depends on the severity of the parasite load. An inflammatory granuloma forms with epithelial, giant, plasma and eosinophil cells and fibroblasts (Hoeppli reaction). There is subsequent fibrosis and calcification. Such damage may be local and/or ectopic.

Urinary schistosomiasis (4)
Caused by *S. haematobium*. Initial toxic and allergic symptoms are not marked, but the bladder and ureter are typically involved with hyperaemia, terminal haematuria, dysuria and frequency of micturition, papules, papillomata and ulceration. Hypertrophy of the bladder can lead to later contraction. There may be cystitis and calculus formation, with calcification and squamous cell carcinoma. Fistulae may develop. There can also be hydroureter and hydronephrosis. Ectopic lesions are less severe than in other species. Genital schistosomiasis may lead to lumpy semen, haematospermia or wart-like lesions on the vulva.

General

1



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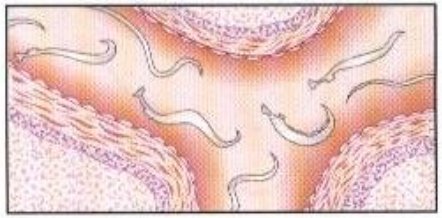

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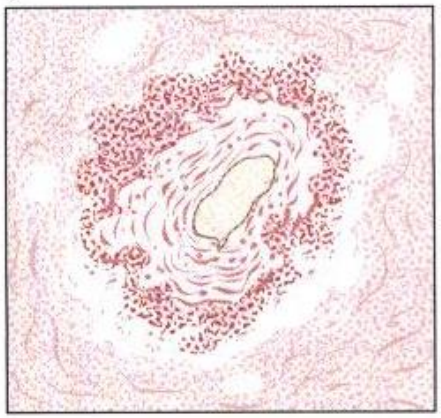
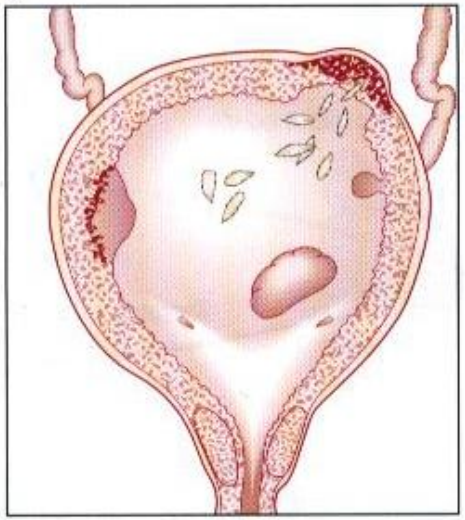


Particular

4



Intestinal schistosomiasis (5)

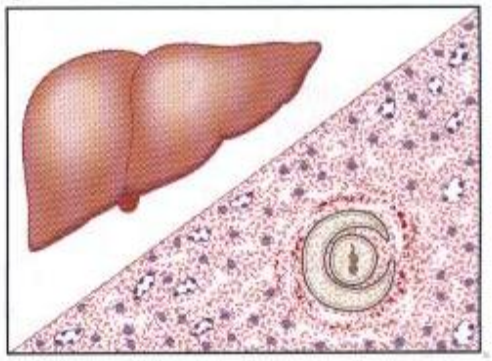
Caused by *S. mansoni*. There are marked initial toxic and allergic symptoms. The large intestine and rectum are typically involved with polyposis, papules, abscesses, ulcers, papillomata, fistulae and ova in faeces. The bladder is sometimes involved, with pathology as for urinary schistosomiasis as above. There can be ectopic lesions; the liver is frequently involved (receiving eggs via the portal vein with inflammatory reaction and fibrosis leading to periportal ('pipe-stem') fibrosis with portal hypertension, oesophageal varices, splenomegaly and ascites; there can also be lesions in the brain, spinal cord and lungs.

5

Oriental schistosomiasis (6)

Caused by *S. japonicum*. Initial toxic and allergic symptoms are marked and can lead to myocarditis and death. Intestinal lesions are similar to those with *S. mansoni* infection, and the small intestine is often involved. The liver is infected as in *S. mansoni*. Hepatic involvement occurs as for *S. mansoni*. The brain may also become involved.

6



Laboratory Diagnosis

S. mansoni

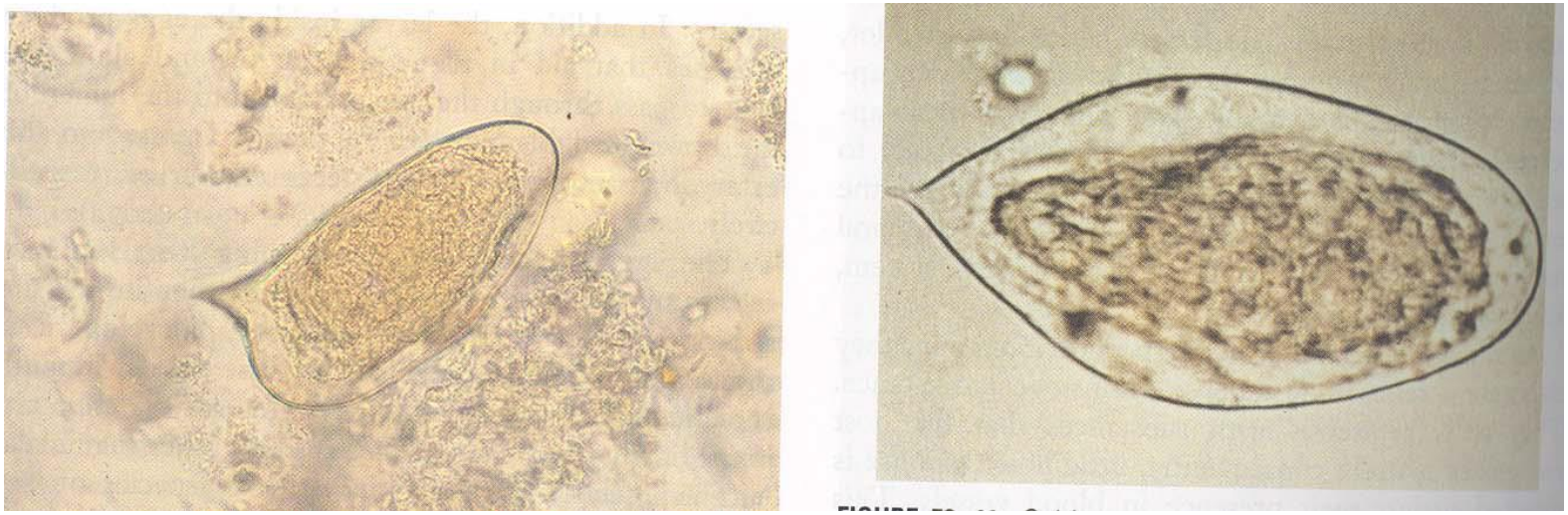
♦ Microscopic examination of the stool for eggs after concentration by sedimentation method. The egg has characteristic lateral spine.

♦ Rectal snip

S. haematobium:

♦ Examination of the urine after allowing it to sediment in a conical urinalysis glass. A drop from the sediment is taken and examined for eggs. Egg has terminal spine.

♦ Biopsy from bladder



Eggs of *S. mansoni* *and* *S. haematobium*

Treatment:

Praziquantel: single oral dose of 40 mg/kg divided into two doses.

Prevention:

1. Health education:

A. On use of clean latrines and safe water supply

B. Avoid urination and defecation in canals, avoid contact with canal water

2. Snail control:

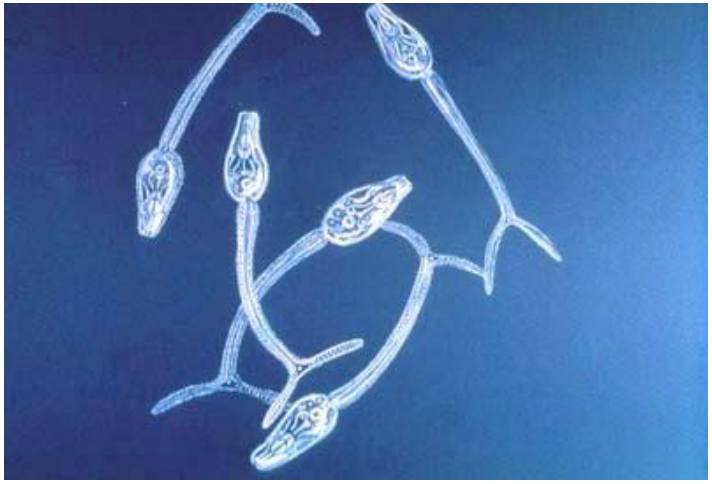
A. Physical methods:

i. Periodic clearance of canals from vegetations.

ii. Manual removal of snails and their destruction.

B. Biological methods: Use of natural enemies to the snails such as Marisa.

C. Chemical methods: Molluscides are applied in the canals to kill the snails. e.g. Endod



Schistosoma Spp- Cercaria

Schistosoma Spp- Miracidium

stages from the life cycle of the *Schistosoma* spp.

Biomphalaria

Oncomelania

The intermediate hosts of *Schistosoma* spp.

Distended Abdomen

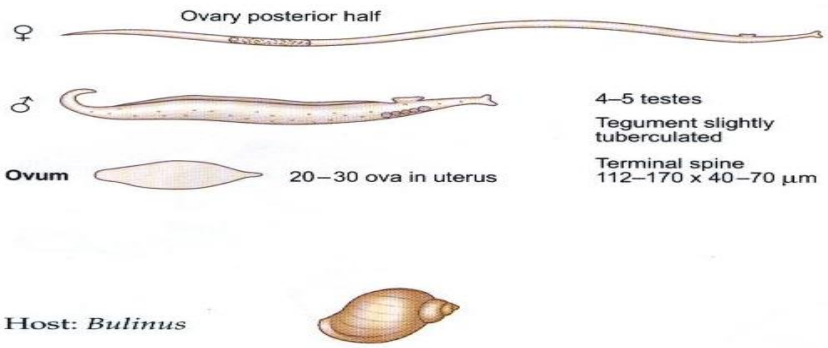
Dilatation of superficial abdominal blood vessels

some clinical sign of schistosomiasis

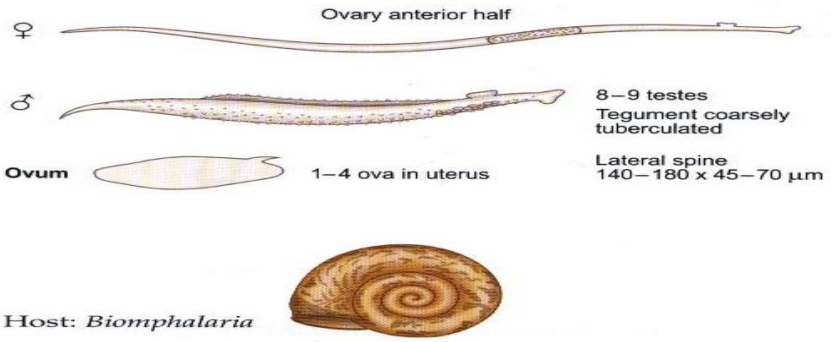
Schistosoma species (blood flukes) (Continued)

Morphology

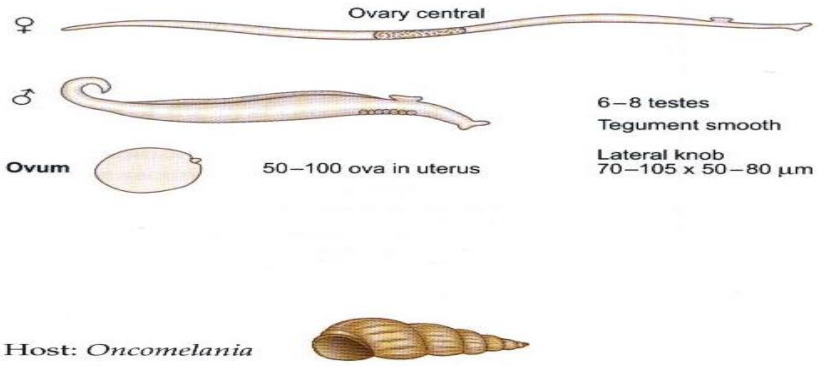
S. haematobium



S. mansoni

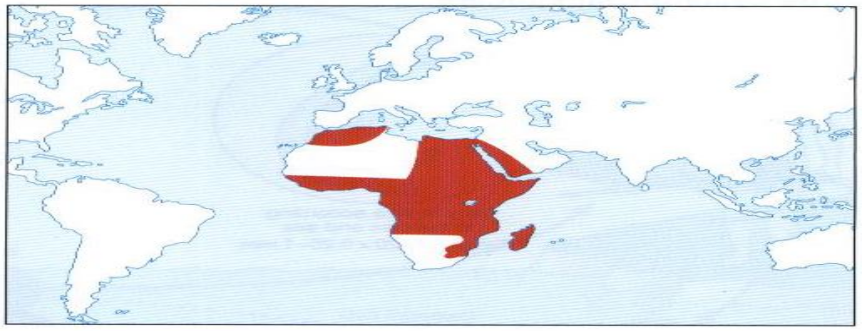


S. japonicum

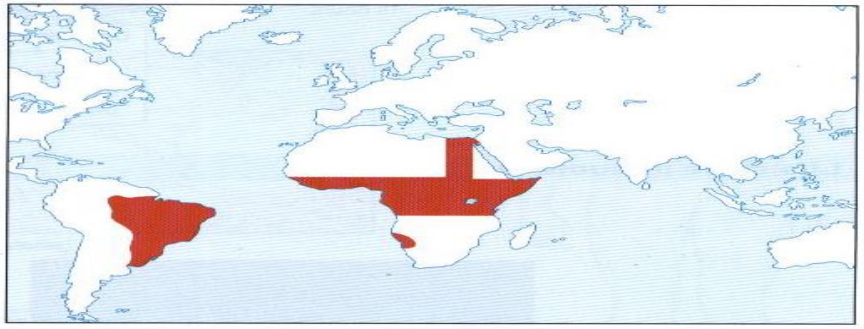


Distribution

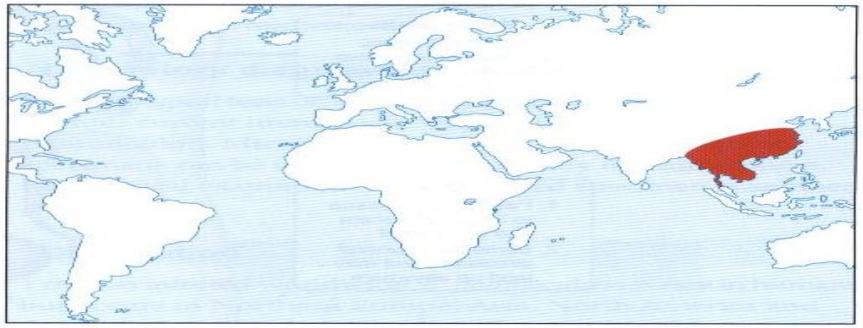
S. haematobium: 78 million



S. mansoni: 57 million



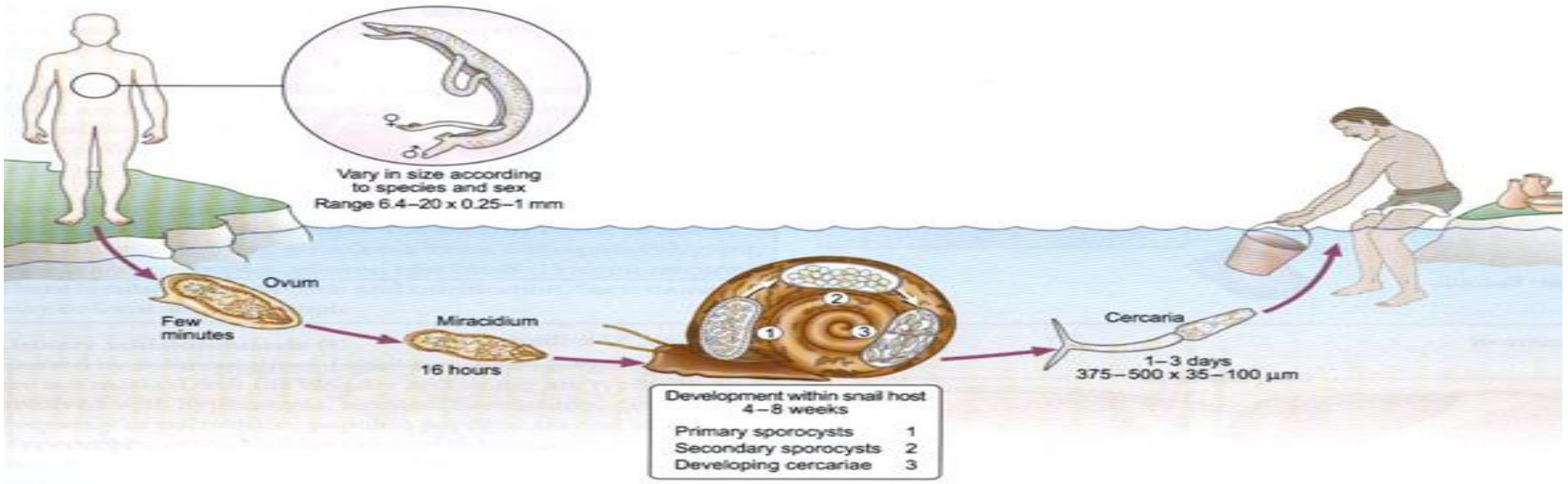
S. japonicum: 69 million



Trematode (flat) worms

Schistosoma species (blood flukes)

Life cycle for all species



Life cycle in humans