Basic Veterinary Parasitology Introduction and Systemic Platyhelminths Third Year Stage 2017-2018

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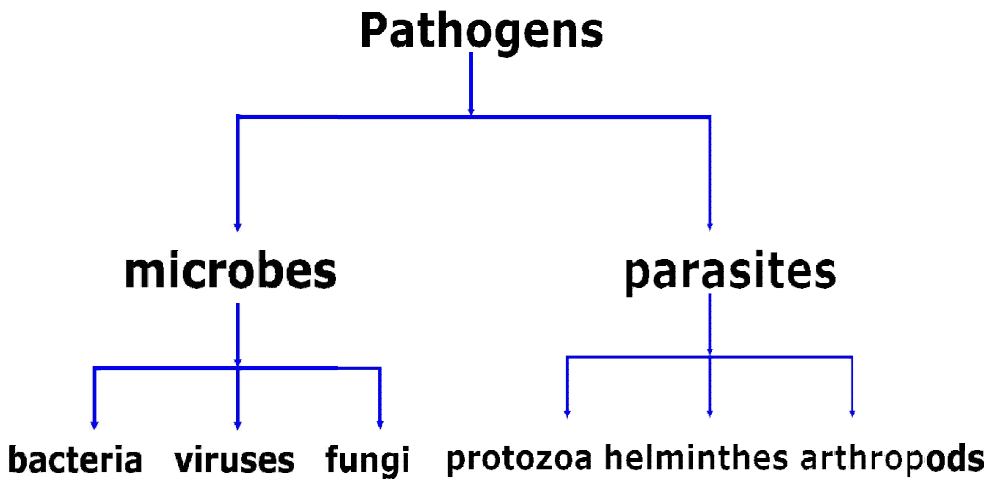
CHAPTER ONE

INTRODUCTION

A SPECIES IS BINOMIAL

Parasitology is the study of parasites, their hosts, and the relationship between them. As a biological discipline, the scope of Parasitology is not determined by the organism or environment in question, but by their way of life. This means it forms a synthesis of other disciplines, and draws on techniques from fields such as cell biology, bioinformatics, biochemistry, molecular
biology, immunology, genetics, evolution and ecology. Before the beginning the fascinating topic of Parasitology, there tend to be one common deficiency that needs immediate remedy. Namely, the basic Linnaeus concept or rule that states that a species is binomial. This is a universal in zoology, botany, Parasitology, and bacteriology, but for some reason many students have failed to grasp this concept. The Swedish scientist Carolus von Linnaeus (1707-1778) developed the binomial system of nomenclature that is still in use today. As an example, let's use the species *Homo sapiens* ("humans" to you molecular biologists). *Homo* is the genus, *sapiens* is the trivial name (*nomentriviale* or specific epithet), and together they make up the species. The epithet *sapiens* is NOT the species, although some very basic texts erroneously say it is. Remember... a species is binomial ("two names").

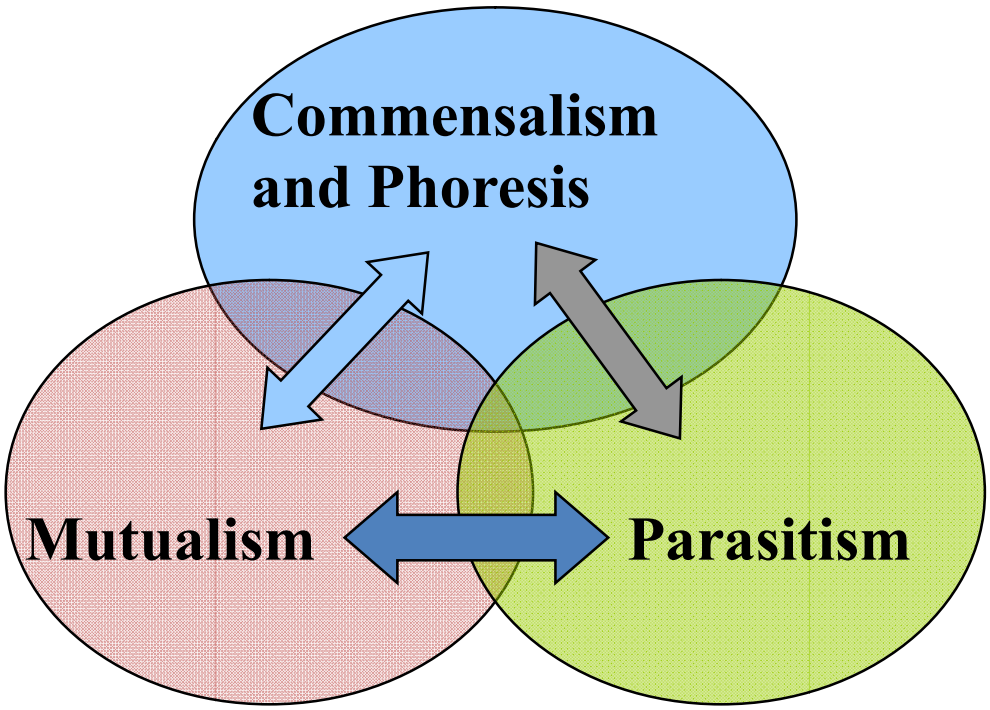
The taxonomically of pathogens classify according to the sachem below:



INTRODUCTION TO THE PARASITOLOGY

Medical parasitology traditionally has included the study of three major groups of animals: parasitic protozoa, parasitic helminthes (worms), and those arthropods that directly cause disease or act as vectors of various pathogens.

The relationship between organisms as in the sachem below:



Parasitology is a type of SYMBIOSIS that living together in the plant, animal, or protest, which is intimately associated with another organism of a different species; each member is termed a SYMBIONT. There are various type of symbiosis:

A. PHORESIS is a traveling together or to carry. A smaller organism is termed a PHORONT that is carried mechanically by a HOST for instance, bacteria, fungus, cysts, or eggs on insect legs or even passively within an arthropod gut.

B. COMMENSALISM means when one symbiont is named a COMMENSAL, benefits and the other animal is neither helped nor harmed True commensalism is difficult to find, and may not even actually exist. Close inspections usually reveal either a mutualistic or parasitic association. Perhaps *Entamoeba gingivalis* in mouth to some degree; some pilot fish and remoras associated with sharks

C. MUTUALISM means each member is named MUTUALIST, depends upon the other; obligatory or facultative in nature for instance, flagellates produce cellulose in gut of termites, ciliates in ruminants, algae and fungus forming a lichen; crocodiles and Egyptian teeth cleaning plovers.

D. PREDATION means where one member is named a PREDATOR, benefits and a smaller organism is called a PREY that is harmed and usually eaten. This association is not usually considered a type of symbiosis, but it technically falls under the definition]. Examples include coyotes and rabbits, cats and mice.

E. PARASITISM means where one member is named a PARASITE, lives in or on another organism that is called a HOST.

However, PARASITOLOGY is the study of the relationship between a parasite and its host. This method of existence is the single most successful way of making

a living, and it has been estimated that no less than 80% of all species of organisms are parasites. Parasitic relationships may be temporary, facultative, or obligatory.

The Basic types of parasitism and terminology

- ECTOPARASITE: lives on surface of the host, appropriate terminology includes the terms "infected" and "infested" [i.e. ticks, lice, fleas].
- ENDOPARASITE: lives within the host, appropriate terminology is "infected;" infested is inappropriate terminology [i.e. roundworms in gut, tapeworms in gut].
- HYPERPARASITE: parasite within a parasite [i.e. malaria in mosquitoes; tapeworm larvae in fleas].
- VECTORS: transmits parasites from host to host, and this is divided into:
    - BIOLOGICAL VECTOR: essential in life-cycle of parasite.
    - MECHANICAL VECTOR: unessential in life-cycle of parasite phonetic.

Class of Parasites

1. Temporary Parasite: Visits it's host for a short period.
2. Permanent Parasite: Leads a parasitic life throughout the whole period of its life.
3. Facultative Parasite: Leaves a parasitic life when opportunity arise.
4. Obligatory Parasite: Cannot exist without a parasitic life.
5. Occasional or Accidental Parasite: Attacks an unusual host.
6. Wandering or Aberrant Parasite: Happens to reach a place where it can't live.

Types of Hosts:

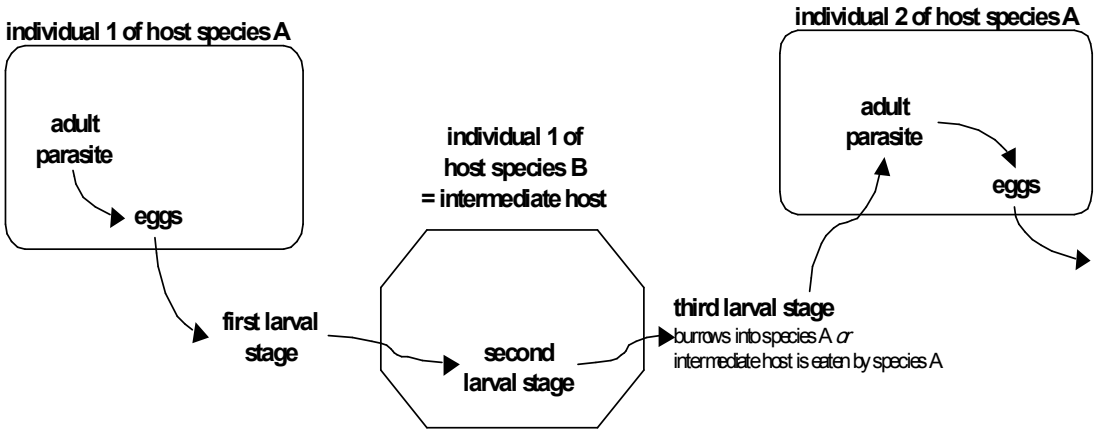
- Definitive or Final Host : Host in which parasite reaches sexual maturity and reproduces.
- Intermediate Host: Some development in host, but does not reach sexual maturity, often asexual stages.
- Paratenic or Transport Host: No parasite development; but parasite continues to live and is infective to next host, for instance and pseudophyllidean tapeworm larvae in fish.
- Reservoir Host: Non-human animals that serve as sources of infection to humans.

Types of Life Cycle:

- Direct Life Cycle: Infective stage is reached in the environment.
- Indirect Life Cycle: Infective stage is reached in an intermediate host.
- INFECTION: Parasites maybe endoparasites especially protozoa that inside cells of the host.
- INFESTATION- Parasites such as worms and ectoparasites that outside cells of the host or on the host.

Scheme of Complex Life Cycle

Two or more host species and parasite exploits food chain relationships of hosts - increases chances of locating hosts and reduces chances of super-infecting host.



Nomenclature of Parasites:

Each parasite possesses two names, a generic and a specific that the former begins with an initial capital and the latter with an initial small letter, after which comes the designator's name followed by punctuation and finally the year. The generic and specific names are in italics but not the designator's name. For example:

The common name of intestinal roundworm of hors is named *Parascaris eqourium*, Linnaeus, 1758. This means that it belongs to the genus *Parascaris* and the name of species *eqourium* was given by Linnaeus in the year 1758. When the name assigned to the parasite is later transferred the correct name is written as usual followed by the original name with the year of parenthesis.

The describing animal parasites certain rules of zoological nomenclature are followed and each phylum may be further subdivided as follows:

SUPERCLASS SUPERFAMILY

PHYLUM SUBPHYLUM CLASS ORDER FAMILY GENUS SPECIES

SUBCLASS SUBORDER SUBFAMILY

IMPORTANT CONCEPTS OF PARASITIC INFECTIONS

- Infection = presence of an agent that has the ability to cause disease
- Disease = the occurrence of dysfunction
- Infectious = capable of causing infection
- Infection --- Disease --- Infectious

EXAMPLE:

A. The dog showed no adverse symptoms to the 2 female *Dirofilaria immitis* in its right ventricle(Infection).
B. 1,000 juvenile *Haemonchus contortus* were causing severe anemia in the lamb(Infection + Disease).
C. Cats suffering from large bowel diarrhea due to *Tritrichomonas foetus* pass active trophs in their feces(Infection+ Disease+ Infectious).
D. The cat passed several active proglottids of the flea tapeworm, *Dipylidium caninum*(Infection).

Parasitic Mode of Transmission

1- Direct transmission

The parasite is passed directly from one animal to another

Examples

A. Animal ingests infected feces or vomit
B. Parasite enters through the skin

C. Mother passes it to the offspring through transplacental or transmammary routes

2. Indirect transmission

The animal ingests a Paratenic host, an animal that can harbor parasites without becoming infects, the parasite remains inactive in the paratenic host until the appropriate host ingests it.

Examples

Rodents, Birds, Rabbits, Flies

SOME TYPICAL CHARACTERISTICS OF PARASITISM

There are different ways or characteristic of parasitism:

1. High reproductive potential, i.e. multiple fission in Apicomplexa; hermaphrodism of trematodes; parthenogenesis in *Strongyloides* spp.; i.e. strobilation of tapeworms for high ova output; and overall high ova/larval output of many worms.
2. Often unique morphological or physiological specializations, loss of structures, like:

    a. loss of digestive tract of tapeworms
    b. loss of wings of fleas and lice
    c. loss of many sensory structures of nematodes

d. development and refinement of a TEGUMENT; a living external layer of digenes, cestodes and acanthocephalan that allows digestion and other functions across body surface
e. development of special holdfast organs, including hooks, suckers, teeth, clamps, cutting plates, spines
f. production of anti-coagulants in leeches and hookworms

3. Often special site specificity.
4. Usually, but not always, non-lethal to host.
5. Generally more numerous than hosts.
6. Generally much smaller than host if larger, then termed a predator.
7. Often have evolved methods of evading host immune system, like:
   a. Antigenic variation of trypanosomes.
   b. Tough tegument of acanthocephalans.
   c. Intracellular habitat of coccidian and *Trichinella* larvae.
   d. Antigen acquisition of Schistosoma.
   e. Suppression eosinophiles or neutrophil migration to the site of the parasite.
   f. Encystment.
   g. Ability to cleave antibodies or consume complement.
   h. Ability to trigger certain arms of the immune response, which may in turn damage host tissue enough to facilitate parasite invasion.

8. Level of pathology due to the parasitism, like:

   a. Physical trauma: Cells-tissue destruction because of the migration of nematodes through tissues, ulceration of intestinal wall and liver by cysteine

proteases of *Entamoeba histolytica*, displacement of tissue or structures by hydatids, protease digestion of epithelial cells by *Trichomonas virginals*, ulceration due to insertion of hooks and spines into intestinal wall.

b. Nutritional diversion: Such as giardiasis results in diarrhea and malabsorption and *Diphylobothrium* absorbs vitamin B12.

c. Toxins/Excretory products/Immune complexes: African trypanosomes slough antigen/Ab complexes that are absorbed by RBC's, complement activated, massive RBC lyses, as a excretory products of some trematodes and cestodes causing anaphylaxis as a fibrosis and inflammation around Schistosoma eggs in the granulomas, fibrosis, edema against adult filarids.

9. Blood loss: hookworms which causing anemia.

TYPICAL WAYS OF PARASITES TRANSMISSION

INGESTION from food or water / inhalation included VECTORS or/ and DIRECT PENETRATION of skin from environment.

10. Some additional terminology to be used in class of Anthroponoses in the human diseases that can be transmitted to animals.

EPIDEMIOLOGICAL TERMS:

-Epidemic is a disease that affects a large number of humans and spreads rapidly.

-Epizootic is a disease that affects a large number of non-human animals and spreads rapidly.

-Epizoic is a living on the surface; a skin parasite.

-Incidence is the number of cases of an infection occurring during a given period of time in relation to the population unit in which they occur.

-Infection is a parasitic invasion resulting in injury and reaction to injury.

-Latent is a non-visible infection.

-Monoxenous is a (single host life cycle.

-Parasitemia is a parasites in blood.

-Pathogenic is a results in disease or morbid symptoms.

-Premunition is a resistance to super infection; depends upon survival of parasites in host and disappears with their elimination.

-Prevalence is a number of organisms in a population infected with a parasite at any one time.

-Virulence is a relative infectiousness of a parasite.

-Zoonosis is an animal diseases that may be transmitted from animals to humans.

GENERALLY:

Many parasites are now being shown to change host behavior. Growing number of scientists believe that many ecological studies need to include Parasitology as component as much animal behavior can be explained by level of parasitism. Especial behavior of some insects harboring larval stages of parasites, bird behavior in response to both ectoparasites and densities of some intestinal worms.

HOST SPECIFICITY

Some parasites have specific host that only infect specific animals, which often sensitive to body temperature or other environmental conditions as well as another might attack any host available such as fleas.

IMMUNOLOGY

The study of immunology, a broad field encompassing both research and clinical applications, deals with antigens, antibodies and cell- mediated host defense functions, especially as they related to immunity disease, hypersensitive biological reactions, allergies and rejection of foreign tissues.

IMMUNITY AGAINST PARASITES

Parasites possess three major characteristics that make them difficult for a host to control immunologically: their size, their elaborate life – cycles and their antigenic complexity. The Protozoa are most have complex life cycles and the various stages of either antigenically distinct, as in the malaria parasites, or variable as in the African trypanosomes. Protozoa inhabit the gut, blood or other tissues, including macrophages and the immune responses elicited are more appropriate to the site of infection than to the nature of the parasites themselves.

In the helminthes infestation, the nature of the surface of the worm, which is the part available for immune stimulation and attack is important. In Digeneans and Cestodes it is the tegument of the worm that is exposed while in nematodes the outer surface is a protective cuticle, the antigenic nature of which may vary during the life cycle. Like protozoa, different Helminthes occupy different sites usually

the gut, but sometimes the blood or other tissues and the immune response is again more appropriate to the site of infection than to the actual parasites.

A further complication in helminthes infections is that during it's life cycle that worm may not only change its form but may also change its site of infection several times. In *Ascaris lumbricoides* infections, larvae pass through various internal organs before maturing in the gut, the net result of these variations in the expression of antigens and frequent changes in site of infection is that the immune responses elicited may be against antigens that are no longer present or in places where the parasites no longer live.

PARASITISM ASPECTS

- Each animal can be a host of many parasites; thus, there are far more parasitic organisms on earth than there are non parasitic organisms.
- It has been estimated that more than 50% of all living plants and animals are parasitic at some stage during their life cycle.

VETERINARY IMPORTANCE OF PARASITES

- A poultry farmer can be wiped out by Coccidia.
- Cattle, pigs, and sheep infected with parasites fail to gain weight and may not reproduce.
- Dogs may become infected with heartworm and die if untreated.
- Cats are infected by many species of protozoans and helminthes.
- In Africa, cattle cannot be raised in an area equal to that of the U.S. due to trypanosomes.

WHY DO WE STUDY PARASITES?

Generally, parasites provide as a unique examples of biological phenomena not found in free-living organisms and distribution in all the world and found even in plants, so, a different importance can be found, like:

- Medical Importance: When infect or infest human and causing severe disease some time leading to the death.
- Veterinary Importance: When infect or infest different animals such as wild, domestic, birds and different mammals and causing economical losses or sever disease or complicated disease like viral, bacterial and rektticial leading to the death.
    - Economic Importance: When infect or infest different animals of domestic and birds that causes economical losses of meat and milk product, egg product, or other products.

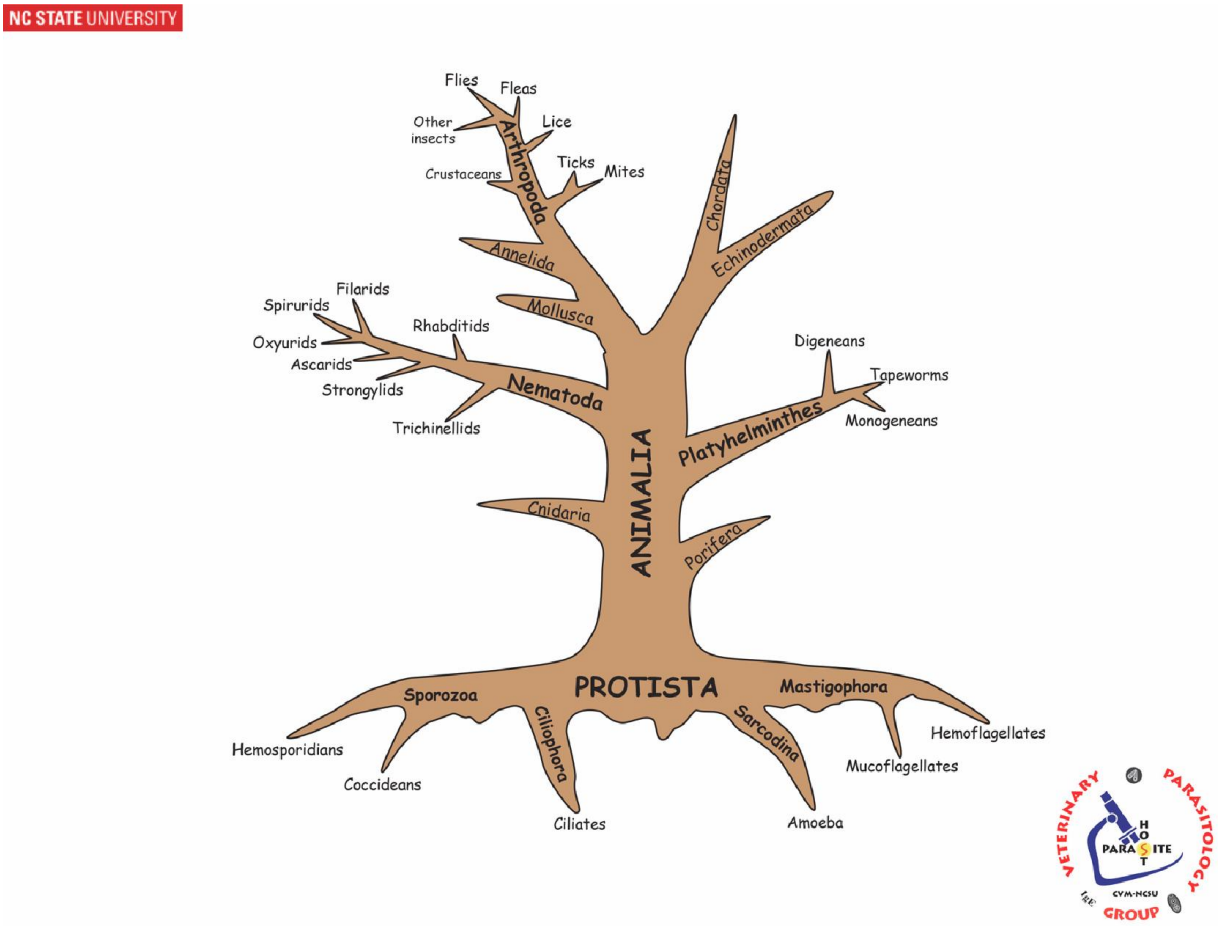
SCHEME FOLLOWED IN PARASITOLOGICAL STUDIES

The study of animals' parasites infecting animals or human and producing manifestation should include the following:

1. History of discover the parasite.
2. Geographical distribution.
3. Habitat inside the host.
4. Morphological and life cycle.
5. Modes of infection, reservoir host, source of infection, portal of entry, vehicle of transmission.
6. effect of the parasite: pathogenic lesions, clinical manifestation.
7. Immunological response.
8. Method for diagnosis.
9. Therapy.

CHAPTER TWO

SYSTEMATIC PLATYHELMINTHES



Characteristics of the Phylum Platyhelminthes:

Platyhelminthes one of the most important phylum with thousands genus at the world, the general characteristics:

1. bilaterally symmetrical; dorso-ventrally flattened
2. A celomate
3. cannot synthesize fatty acids
4. tegument (living external layer)
5. digestive tract incomplete or absent
6. excretory system protonephridia

The phylum Platyhelminthes consists of four classes:

1. CLASS: Turbellaria

mainly free-living flatworms, some as symbionts associated with echinoderms, molluscs, fish, cnidarians, etc. Although the majority are thought to be commensals, some are truly parasitic, few are commensals or parasites of invertebrates, free-living examples include *Planaria* spp. in aquatic environments and the giant terrestrial land planaria in the genus *Bipalium* spp.; commensal/parasitic forms include *Syndesmis* spp. in the intestines of sea urchins, *Bdelloura* spp. on the gills of horseshoe crabs, and *Stylochusfrontalis* in the valves of oysters.

2. CLASS: Monogenoidea (Monogenea)

All parasitic, most species on fish gills or skin; however, some internal in urinary bladder, nasal passages, cloaca, one host life-cycles, evolutionarily, appears to be more closely related to cestodes than trematodes, with two main "traditional" subclasses for this class:

1. **Subclass: Monopisthocotylea**
2. **Subclass: Polyopisthocotylea**

3. CLASS: Trematoda

All parasitic, mainly in digestive tract, most with suckers, most with 2-more host life cycles, with three subclasses:

1. **Subclass: Digenea (typical flukes)**
2. **Subclass: Aspidogastrea**
3. **Subclass: Didymozoidea**

4. CLASS: Cestoidea

All parasitic; tapeworms, most with 2-more host life cycles, no digestive tract, most segmented.

Class: Monogenea

The general characteristics of class Monogenea as below:

1. hermaphrodites
2. normally ectoparasites on aquatic vertebrates

3. generally site specific on host and host specific
4. live a few days - years, depending on species
5. morphologically: Prohaptor (sometime present, anterior end that may bear adhesive or feeding organs). Eyespots sometime present, photoreceptors near two anterior ganglia. The tegument (living external layer).

Alimentary tract consist of:

1. mouth anterior, usually with Prohaptor
2. esophagus with muscular pharynx
3. intestine branches into cecae, often with diverticula
4. Monopisthocotylea feed mainly on epidermis and mucus; Polyopisthocotylea mainly on blood, host cells, and mucus
5. blind-ended gut, regurgitate waste

Protonephridia [excretion] consist of:

1. 2 main lateral ducts, extend posteriorly; then curve and extend anteriorly
2. contractile bladders laterally
3. flame cells drive fluid within ducts

Reproductive systems consist of:

- **Male :** 1-200 testes (1-2 most common), testes - vas efferent - vas deferens - seminal vesicle - cirrus - gonopore; sometimes prostate

- **Female :** 1 ovary, normally anterior to testes, oviduct from ovary – ootype, Mehlis gland lubricates uterus, forms egg shell capsule, genito intestinal canal, only in Polyopisthocotylea; connects oviduct with right intestinal caecum for excess secretions discharge, 0-2 vaginas - sperm transfer; if none, use gonopore, sometimes a seminal receptacle, vitellarial secretions add to egg-shell formation; ducts fuse near oviduct, eggs pass through uterus, out gonopore; sometime a muscular metraterm

Development

- eggs shed, normally with filaments, filaments stick to host
- oncomiracidium ciliated, hooked posteriorly, about a 24 hr life, if eyespots, phototactic, some attracted to fish mucus, grow to adult directly

  Opisthaptor which may be:
- suckers (=suckerlets)
- anchors (large hooks, sometimes called hamuli or central hooks)
- hooklets (left over larval hooks, sometimes called marginal hooks)
- bars (often called accessory sclerites; they support anchors)
- clamps (complex, muscular structures more advanced than suckers).

Figure 14.16

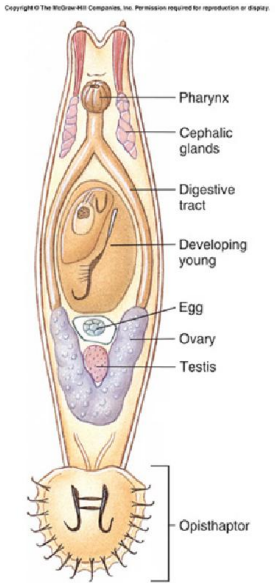


Fig. (1): The Typical structure of Monogenea

Monogenea typically occur at low levels on fish and so do not inflict serious harm. However, in fish farms, infestations may become very heavy and lead to significant mortality.

Class: Digenea

Typically digenia with two suckers usually as an attach organs which was:

A. oral (usually anterior) sucker. Surrounds mouth.

B. acetabulum (ventral sucker).

And two or more hosts in life cycle. All but a few monecious (self or cross fertilize)

Types of adult flukes according to the sucker as name and position:

1- distome (most common; oral sucker and ventral acetabulum).

2- amphistome (oral sucker; posterior sucker, usually posterior to testes).

3-monostome (oral sucker only).

4-gasterostome (mouth in center of oral, ventral sucker)

5-holostome (forebody and hindbody; tribocytic organ posterior to acetabulum).

6-echinostome (collar of spines around anterior sucker).

Tegument consist of two zones:

1. outer cytoplasmic syncytium with microvilli [mitochondria, ER, vacuoles, lipids, etc.] [pinocytosis; spines]
2. inner area of nucleated cell bodies - cytons
3. zones separated by basal lamina
4. also, circular & longitudinal muscle under basal lamina

Numerous chemicals in tegument

- mucopolysaccharides to inhibit host digestive enzymes
- acid & alkaline phosphatases, esterases, and aminopeptidases for digestion

Alimentary tract consist of:

- incomplete gut
- pharynx, when present, masticates food
- esophagus leads to 2 blind cecae
- entire gut secretion by cells along gut; proteases, lipases, etc.
- in cecae, absorption too

different species feed on different things: like: blood, mucus and epithelium cells.

Reproductive system consist of:

Male reproductive system consist of: usually 2 testes; taxonomic importance, vas efferens - vas deferens - cirrus pouch, cirrus pouch encloses seminal vesicle, prostate glands, and cirrus; some with external seminal vesicle outside of pouch, sperm stored in seminal vesicle and prostate secretes fluid to keep sperm alive.

Female reproductive system consist of: usually single ovary, 2ndry oocytes released, through short oviduct, into ootype, 3 organs enter into ootype: Mehlis gland, cluster of unicellular glands, enhance egg tanning by maintaining correct pH. Different cell types in gland, secretions cause release of shell globules from vitelline glands, secretes first membrane around egg into lubricates uterus and activates sperm, which are passed down ootype. Common vitelline duct (passage of vitelline gland secretions for eggshell

formation], Duct from seminal receptacle (absent in some species), Occasionally a fourth duct, vitelline reservoir, as diverticulum of vitelline duct.

Excretory system consist of:

- protonephridia (flame cells)
- excretory bladder in posterior, with excretory pore

Development:

- Egg: usually operculate, lid pops off during hatching (in Schistosomes, no lid; shell splits).
- Miricidium: hatches from egg - penetrates mollusc (rarely annelids), asexual stages from miricidium, with morphologic characteristics: apical stylet, apical papilla [where ducts from glands open; also nerve endings for chemoreception], apical gland [histolytic enzymes], cephalic glands [lytic enzymes], photoreceptors [eyespots], germinal mass [initiate asexual stages], cilia [locomotion], excretory pore, actively swim, chemoreception to snail mucus, attaches to snail with apical papillae; lytic enzymes dissolve tissues. About 30 min for penetration.
- Sporocyst: asexual stage, various shapes, no mouth or digestive system, absorbs nutrients through tegument, may produce rediae, daughter sporocysts, or cercaria.

- Redia: develop directly from miricidium, or from embryos generated from sporocysts, elongate; crawl actively, muscular pharynx, mouth, blind-ended sac caecum, 1-more ambulatory buds for movement often, because ingestion, many species cause extensive damage to host, will form daughter rediae or cercaria
- Cercaria: from redia or sporocyst, free-swimming, leaves snail and seeks host, miniature immature fluke with tail, penetrate skin of definitive host, encyst on vegetation as metacercaria, encyst as metacercaria in intermediate host or eaten by intermediate or definitive host or mesocercaria (unencysted juvenile) in tissues

Types, some systematic based on sucker placement of cercaria

- **monostome**

a. 1 sucker only, anterior
b. 2 eyespots
c. long, simple tails
d. develop from redia
e. give rise to monostome adults

- **amphistome**

f. posterior sucker, often anterior too
g. eyespots
h. develop from redia

i. give rise to amphistome adults

j. all in superfamily: Paramphistomoidea

- **gasterostome**

k. mouth ventral

l. develop into gasterostome adults

m. all in family: Bucephalidae

- **distome**

n. 2 suckers, one oral and one ventral

o. most common type

Another classification, based on cercarial tail shape and other structures:

- pleurolophocercous
- furcocercous
- echinostome
- xiphidiocercariae
- ophthalmocercariae (with eyespots)

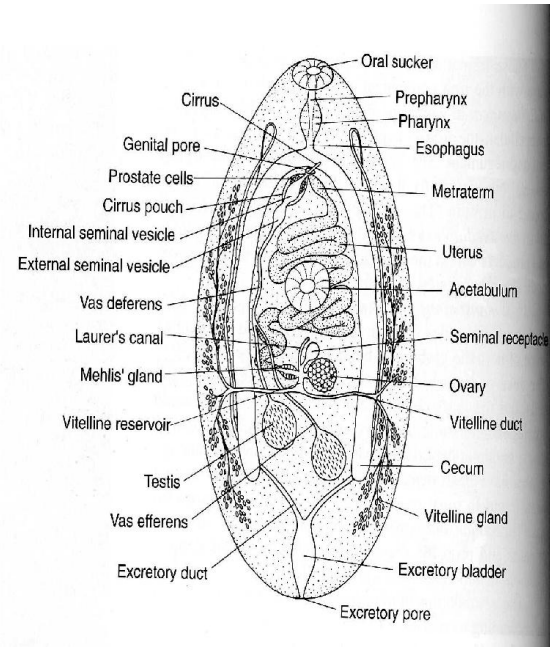


Fig. (2): Typical structure of Digenia

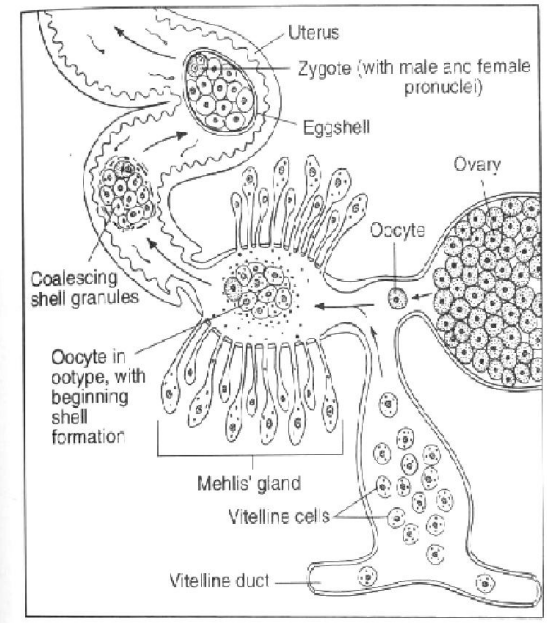


Fig. (3): Typical structure of female reproductive system in Digenia

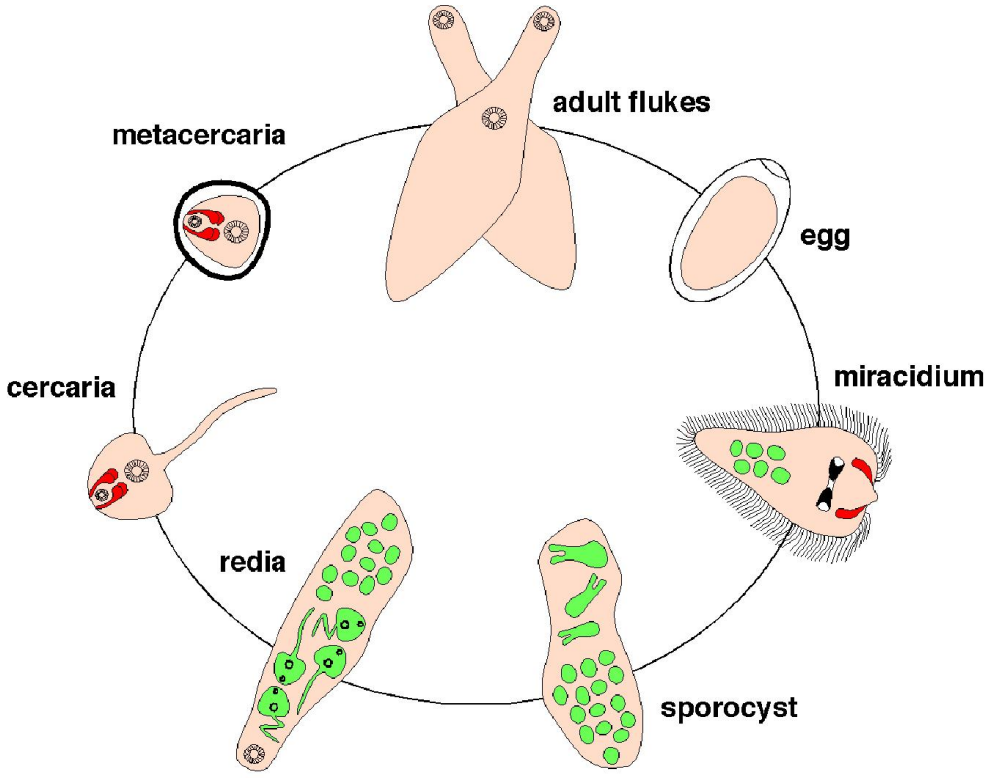


Fig. (4): Typical larval stages and life cycle in Digenia

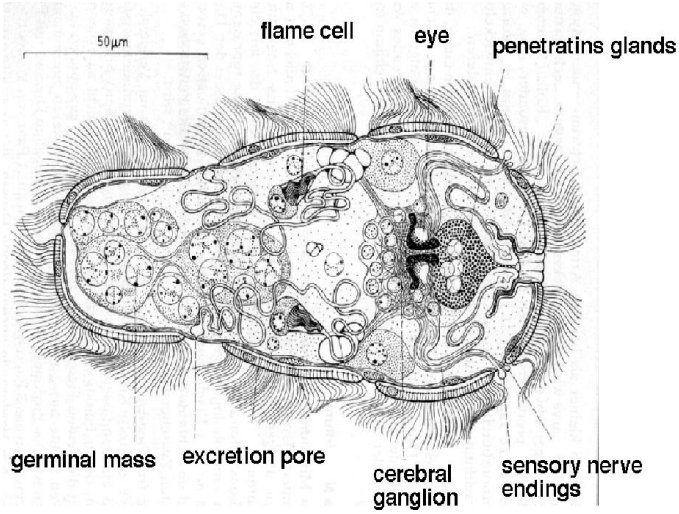


Fig. (5): Typical structure of miracidium in Digenia

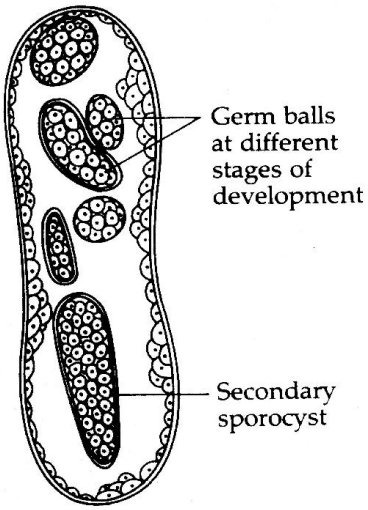


Fig. (6): Typical structure of sporocyst in Digenia

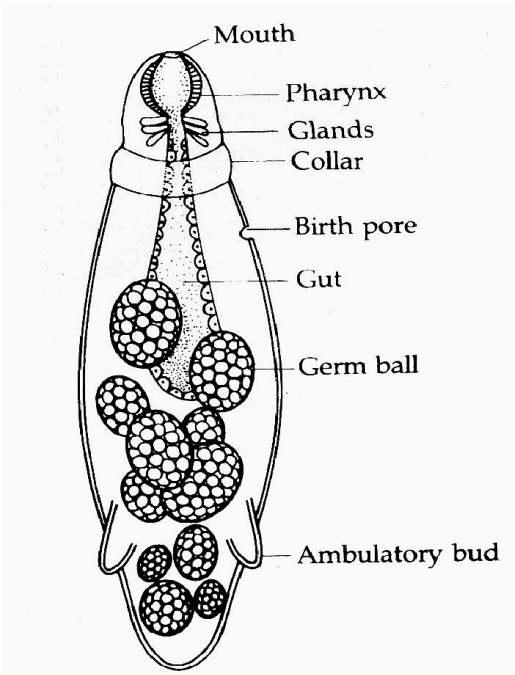


Fig. (7): Typical structure of redia in Digenia

Fig. (8): Metacercaria in Digenia

Trematoda can be divided according to the site of infection in the definitive host to:

1- Liver Flukes

2- Intestine Flukes

3- Lung Flukes

4- Blood Flukes

Liver Flukes:

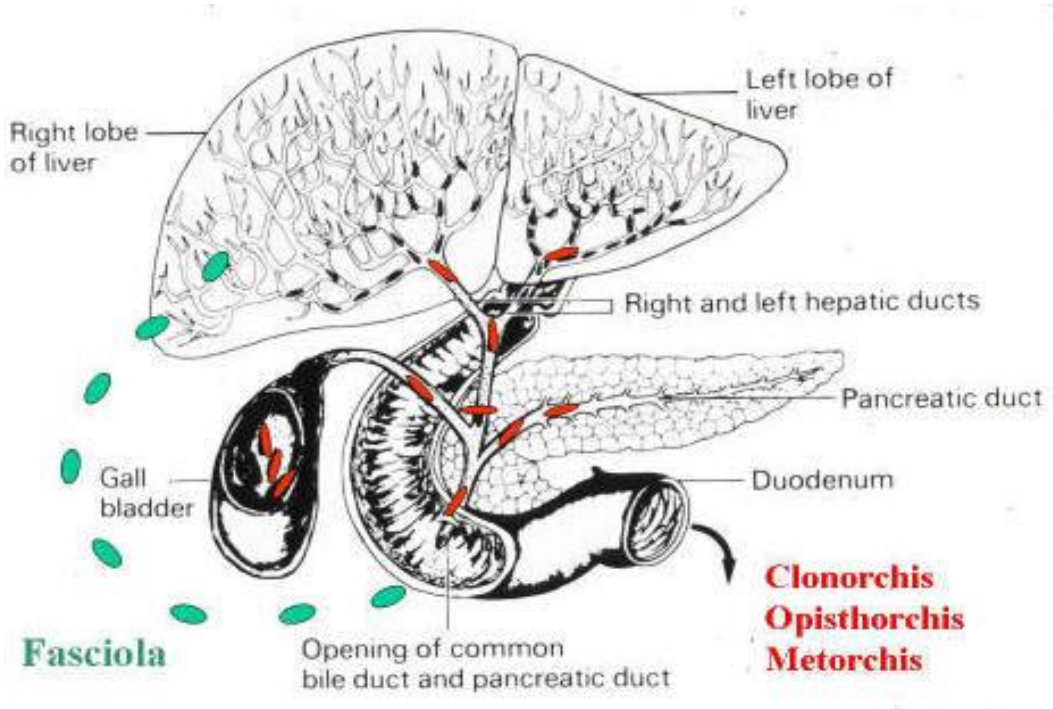


Fig. (9): The pathway of liver flukes

1- Family: Fasciolidae: *Fasciola hepatica, Fasciola gigentica*

Phylum: Platyhelminthes

Class: Trematodes

Subclass: Digenea

Order: Echinostomatiformes

Family: Fasciolidae

Genus: *Fasciola hepatica, Fasciola gigantica*

1. large, leaf-shaped, with cephalic cone
2. mainly in herbivores
3. intestinal cecae, testes, and ovary dendritic

The disease cause Fascioliasis

Intermediate host: fresh water snails

Final host: Cattle

Site of Infection: hepatic and portal vessels

life-cycle

Adults in gall bladder, bile ducts, eggs out with feces, un embryonated, develop in 9-10 days, hatch to miricidia and penetrate several species of snails. Sporocyst; two redial generations, cercaria emerge 5-7 wk post-

infection, encyst as metacercariae on underwater vegetation, ingested; cross gut and penetrate liver (glycocholic acid in bile the stimulus; migration cue), feed in liver for 2 months, then enter bile ducts and after another month, mature and produce eggs.

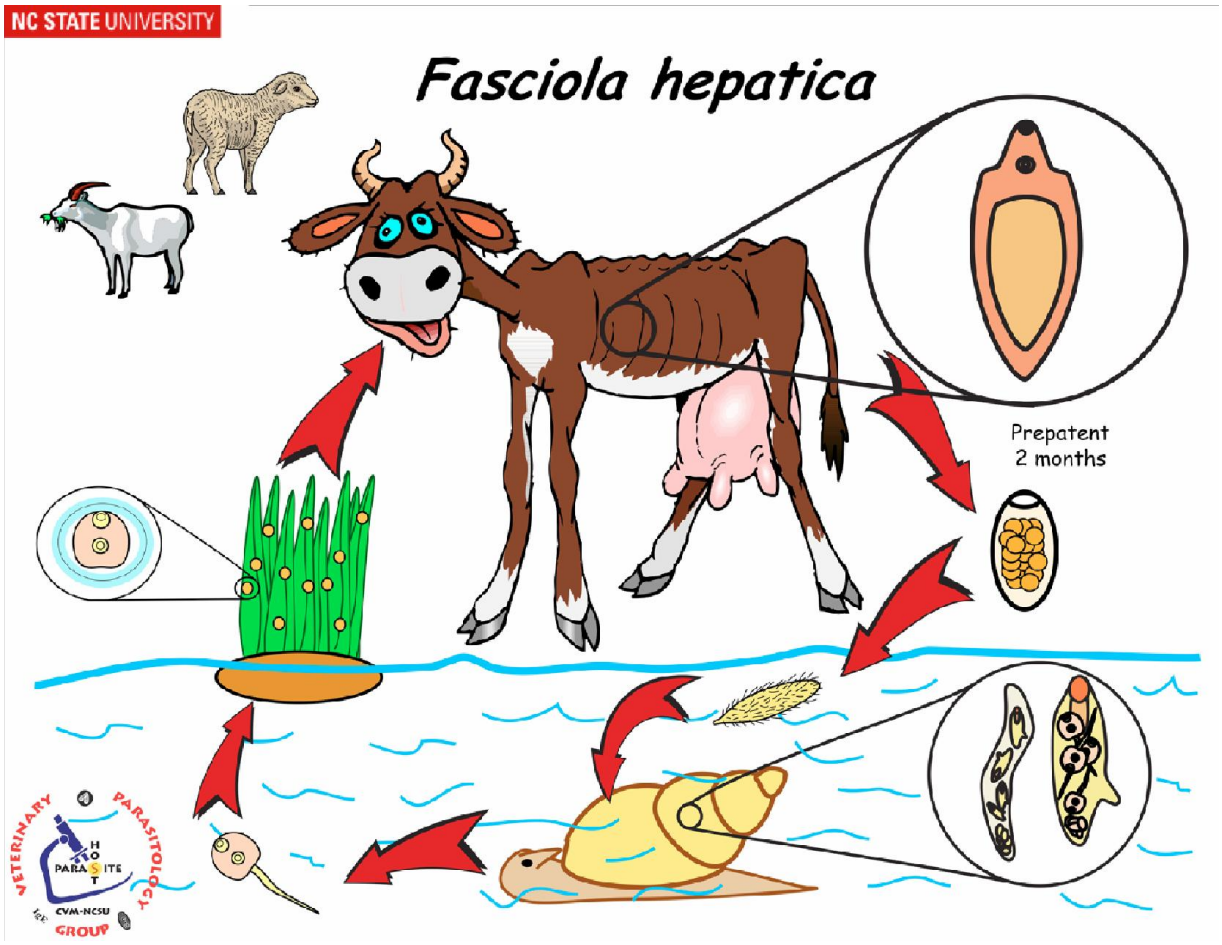


Fig. (10): The life cycle of *Fasciola hepatica*

Pathology

A. inflammation and erosion of bile ducts

B. tissue destruction of liver

C. fibrosis of liver and bile duct walls

D. back pressure in liver, leading to cirrhosis and jaundice

E. blockage of bile ducts

F. abscesses in liver

G. migrating juveniles may cause ectopic abscesses in lungs, brain, skin, eye

H. halzoun - adults attach in nasopharynx after eating raw liver (middle east)

Symptoms:

- **Acute**
  - More common in sheep
  - 10,000+ Metacercariea consumed at one time
  - Dramatic Liver Inflammation, Frequently Resulting in Death
- **Chronic**
  - More Common and Rarely Fatal
  - Nonspecific Symptoms
- **Halzoun**
  - Eating raw, infected liver
  - Infects pharynx

- Causes swelling and obstructs breathing

Related species

Fasciola gigantica (found in a variety of Artiodactylids in Africa, India, portions of Europe, Indonesia, Asia, and Hawaii. The most common infections occur in cattle, sheep, and goats. Patent infections in humans also occur). Hybrids between this species and *Fasciola hepatica* have been reported.

Fasciola jacksoni (nasty pathology in Asian elephants)

Fasciolopsisbuski (swine and humans in Asia).

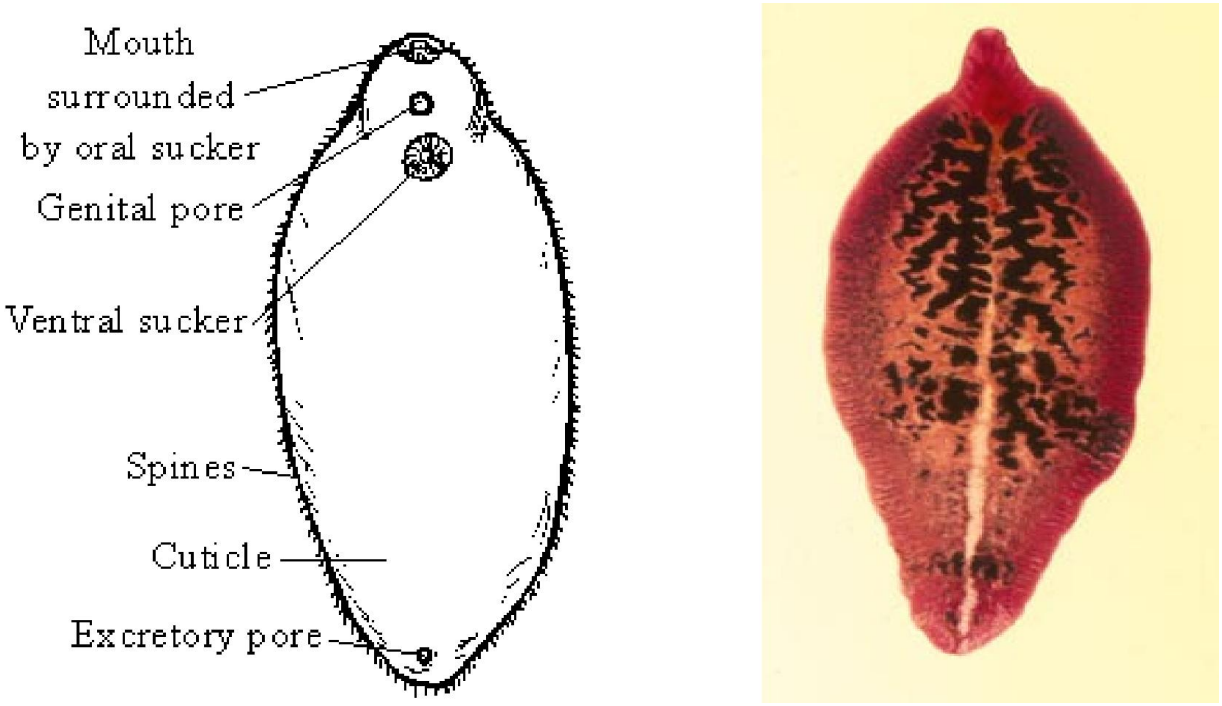


Fig. (11): *Fasciola gigantica* (unstained and stain) worms

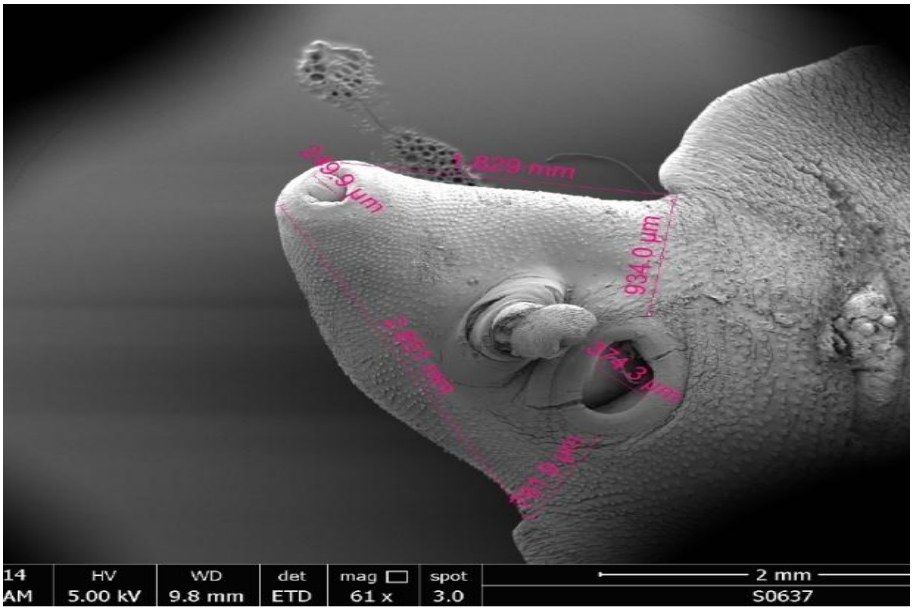


Fig. (12): The apical zone of *Fasciola gigantica* with oral and ventral suckers and genital pore (61 X). By scanning electron Microscope. Prof. Dr. Suzan A. Al-Azizz and Huda S. Farhan

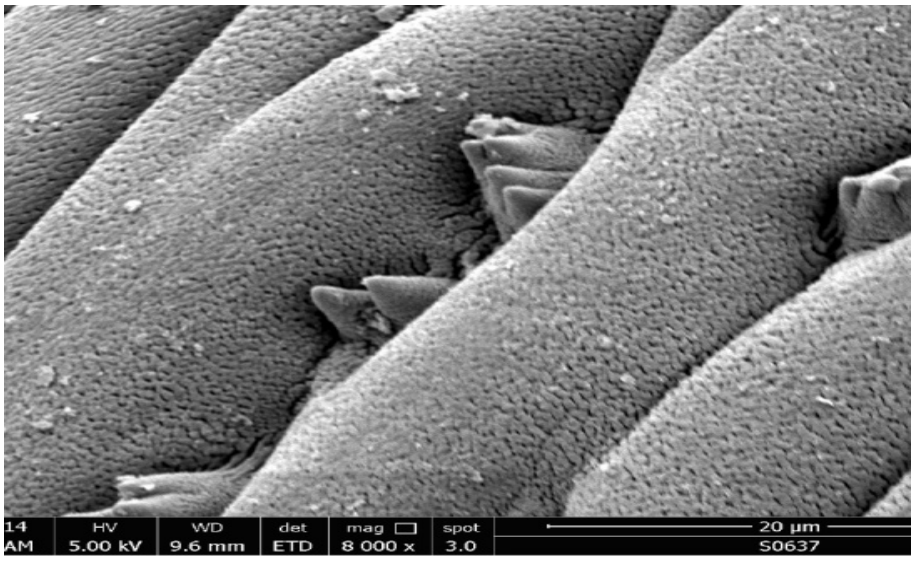


Fig. (13): Spiny tegument of the cirrus genital organ of *Fasciola gigantica* (8000 X). By scanning electron Microscope. Prof. Dr. Suzan A. Al-Azizz and Huda S. Farhan

Treatment:

- **Bithional**
  - Highly Effective
  - Large Dose
  - High Cost
  - Long Treatment Period
- **Triclabendazole**
  - Easier to Use
  - 1-2 Oral Doses in 24 hrs
  - Virtually 100% Effective
- **Surgery**

Order: Plagiorchiformes

Adults are quite diverse in this order, and many do not resemble one another. Larvae and juveniles share more similarities than adults. Wall of excretory bladder epithelial. Cercaria with simple tail and dorsal finfold. Oral stylet usually present (xiphidiocercariae).

Most species have small eggs and most (but not all) have eggs that must be eaten by snail to hatch and tend to be medium-small worms; most intestinal

Below are some representative species:

Dicrocoelium dendriticum (family: Dicrocoeliidae)

Phylum: Platyhelminthes

Class: Trematodes

Subclass: Digenea

Order: Plagiorchiforms

Family: Dicrocoeliidae

Genus: *Dicrocoelium*

Species: *D. dendraticum*

The disease called Dicrocolidiasis.

Intermediate host: First: land snails, Second: Ants

Final host: Cattle

Site of infection: portal and hepatic vessels

Synonyms include *Dicrocolium lancelatum* and *Distoma dendraticum*. Medium sized, elongate, and flattened worms ("lancet fluke") (ca 6-10 x 1.5-2.5 mm), body pointed at both ends, and cecae simple; ovary post-testicular. Common in Europe and Asia; introduced into Australia and North America.

Life-cycle

Adults in bile ducts, gall bladder, and pancreatic ducts of sheep, cattle, goats, pigs, cervids, lagomorphs, some rodents, and rarely humans, eggs passed embryonated out with feces, eaten by land snails, and about 55 different species of snails have been shown to be suitable hosts then hatch into two sporocyst generations after that xiphidiocercaria accumulate in pulmonary chamber of snail, cercaria aggregate as masses and secrete thin cyst wall. Snail then coats cercaria with mucus, and deposits slime balls containing numerous cercaria (dozens to hundreds) in slime trails, this slime balls eaten by ants. About 17 species and several genera of ants have been found to be suitable second intermediate hosts (in USA, *Formica fusca*); ants love to eat slime balls and even feed them to the larval ants. Most metacercaria encyst in hemocoel and are infective to final host; however, 1-2 encyst in depression between roots of subesophageal nerves leading to mouthparts (never become infective), as temperature decreases in the evening, ants climb up grass and clamp down with mandibles. Uninfected ants return to colony. Paralyzed ants found only at temperatures under 20 C^0, mandibles release when ants warm up the next morning, so, ruminants graze in evenings and mornings, ingesting these exposed ants, metacercaria excyst in duodenum, migrates up common bile duct and development to adult**.**

Fig. (14): Adult worm *Dicrocoelium dendriticum*

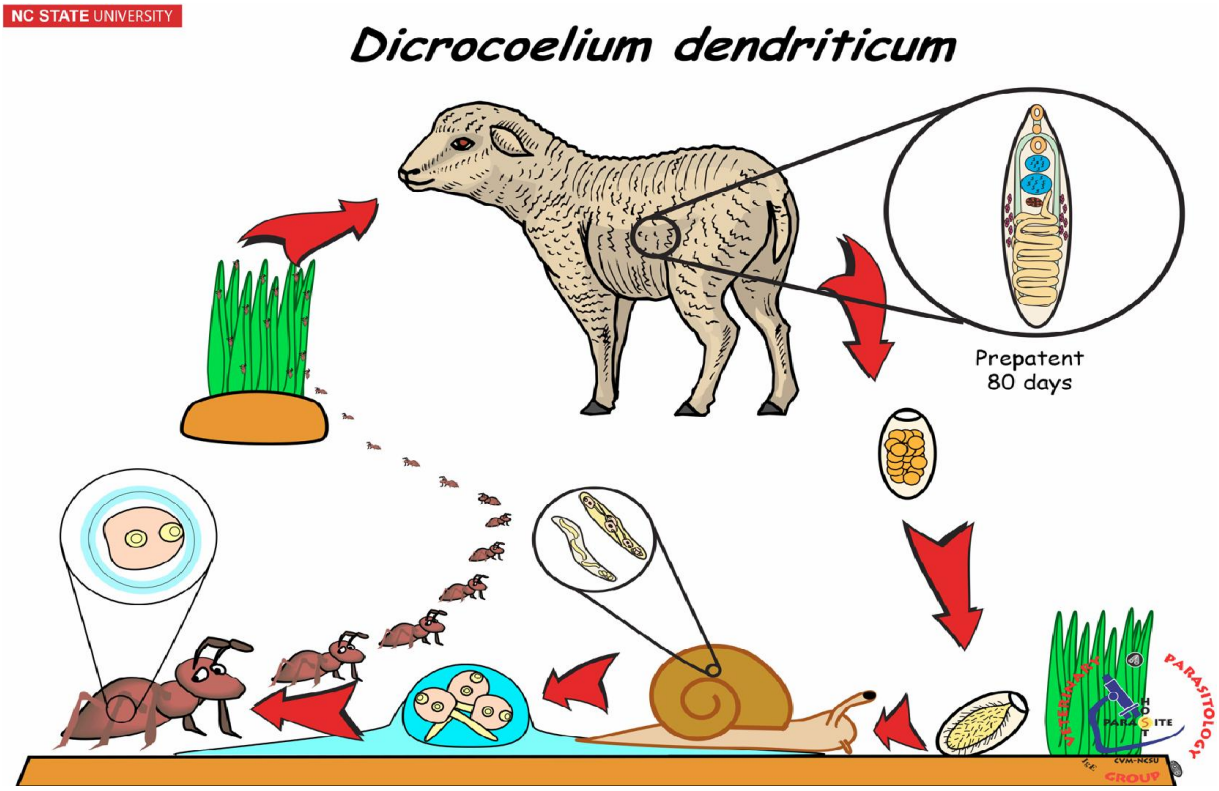


Fig. (15): Life cycle of *Dicrocoelium dendriticum*

Treatment:

1- Hexachloroethan and Fouadein, which cutoff ova production from adult worms.

2- Hetholein (19-22)mg/Kg. body weight

3- Thibendazol (200-300) mg/kg body weight which can kill 96%from adult worms.

Order: Opisthorchiformes

Typically: worms in medium to small size, testes usually posterior, cirrus absent and seminal receptacle present. Eggs passed fully embryonated, while, metacercariae encysted in fish.

Clonorchis sinensis (syn. *Opisthorchis sinensis*) (family: Opisthorchiidae)

Phylum: Platyhelminthes

Class: Trematodes

Subclass: Digenea

Order: Opisthorchiforms

Family: Opisthorichidae

Genus: *Opisthorichis*

Species: *O. sinenesis*

The disease is Opisthorchiosis

Intermediate host: First: snails, Second: fishes

Final host: Human

Adults of the Chinese liver fluke live in bile ducts, are elongate, 8-20 x 1.5-5 mm. Asiatic in distribution, infecting cats, humans, dogs, badgers, mink, etc. Large, dendritic testes posteriorly that are tandem

Life-cycle

Adults in bile ducts, produce up to 4000 eggs per day; live about 6 months, eggs passed in feces fully embryonated, eaten by snails (most common, *Parafossarulusmanchouricus*) one sporocyst and one redial generation, cercaria with eyespots; when contacts solid object swims upward, attaches to fish epithelium; over 100 species of cyprinids suitable, enters through skin, encysts under scales or in muscle as metacercaria. Some crustacea will also support the metacercaria after that fish eaten, so, metacercaria excyst; migrate to common bile duct. Pathologically includes erosion of the biliary epithelium. There is also evidence to suggest that this parasite is probably carcinogenic to humans.

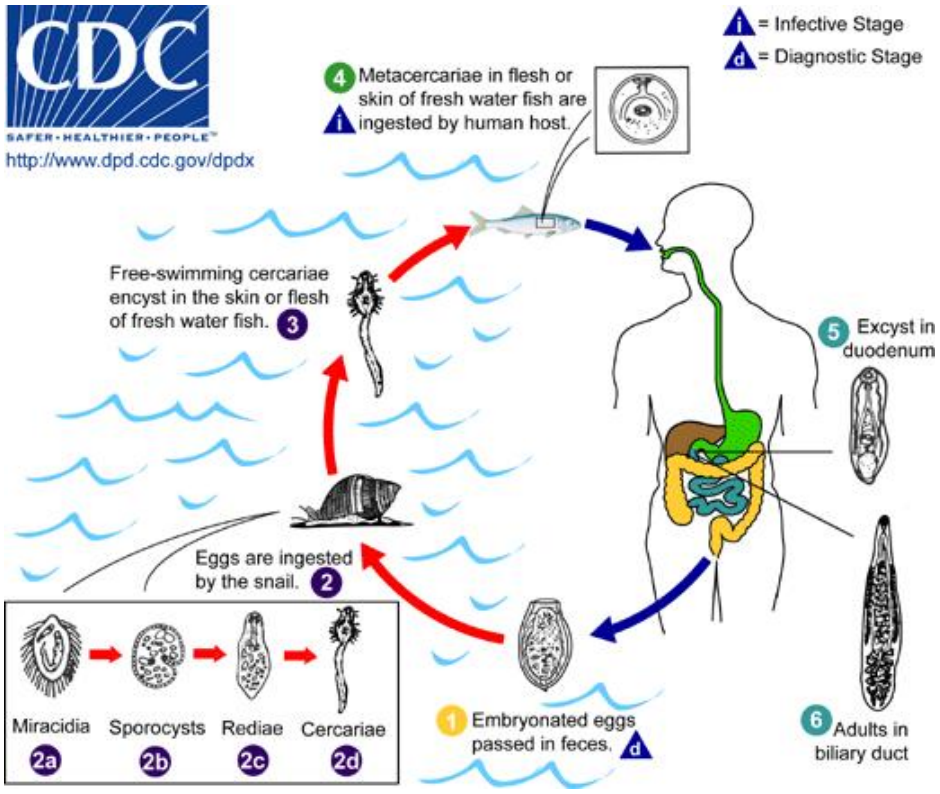


Fig. (16): Life cycle of *Clonorchis sinensis*

Opisthorchis felineus (syn. *Opisthorchis tenuicollis*)

in Europe and Asia, and which also uses a variety of mammals as hosts especially felids, other carnivores, and humans. Evidence is not adequate to conclude that this parasite is a cause of cancer.

Opisthorchis viverrini

in southeast Asia infects up to 10 million humans. Evidence suggests that this parasite can induce cholangiocarcinoma in humans.

Intestinal Flukes

1- Family: Echinostomatidae: *Echinostoma* spp.

Phylum: Platyhelminthes

Class: Trematodes

Subclass: Digenea

Order: Echinostomatiformes

Family: Echinostomatidae

Genus: *Echinostoma*

Species: *E. revolotum*

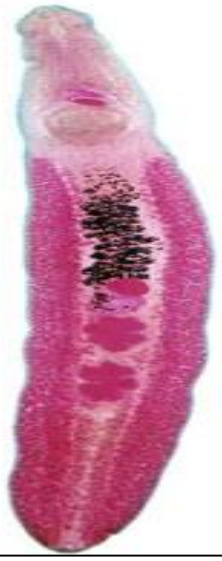


Fig. (17): Adult worm *Echinostoma sp.*

Intermediate host: First: snails, Second: Fishes, tadpoles, Planaria

Final host: Birds

Site of Infection: Intestine

Tend to be relatively non-host specific in semi-aquatic vertebrates. Many species elongate; anterior sucker and large acetabulum anterior, 27-51 circumoral collar of spines, depending upon species

Life-cycle

Adults in gut, eggs passed in feces, hatch; miricidia penetrate snails , for instance, sporocyst; two redia, cercaria, metacercaria in molluscs, planaria, fish, tadpoles, etc. eaten by definitive host

Typical species

A. ***Echinostoma caproni*** **(in mammalian and avian hosts; Africa)**

B. ***Echinostoma trivolvus*** **(in mammalian and avian hosts; North America)**

C. ***Echinostoma revolutum*** **(in mammals and birds; Europe and Asia)**

Order: Paramphistomiformes

This order often placed as a superfamily of the order Echinostomatiformes. Composed of amphistomes (acetabulum at or near posterior end). Usually thick, fleshy worms. Ovary usually post-testicular

2- Family: Paramphistomidae: *Paramphistomum cervi*

Phylum: Platyhelminthes

Class: Trematodes

Subclass: Digenea

Order: Paramphistomatiforms

Family: Paramphistomidae

Genus: *Paramphistomum* sp.

Cosmopolitan in distribution. Adults in rumen of domestic animals, pickish in color

Pathogenic; in large numbers can cause intestinal ulceration and death; secondary bacterial infections

Life-cycle

Adults in rumen, eggs out with feces, mature in water to miricidium hatches; penetrates multiple genera of snail hosts, one sporocyst and two redial generations, cercaria encyst on aquatic vegetation, eaten by herbivore, excyst

in duodenum; penetrate gut; migrate through tissues to abomasum, enter lumen and migrate anteriorly to rumen, mature in 2-4 months.

Fig. (18): Adult worm *Paramphistomum cervi* attach in ruminant of the host

Fig. (19): Intermediate host (snail) in the life cycle of *Paramphistomum cervi*

Treatment:

It can be use the drug Hexachloroethan or Pentonine for treat the infected animals as 180 gr./kg. body weight, and using mollescicide as a chemical control to kill the snails (intermediate hosts).

Heterophyes heterophyes:

Phylum: Platyhelminthes

Class: Trematodes

Subclass: Digenea

Order: Opisthorchiforms

Family: Heterophyidae

Genus: *Heterophyes*

Species: *H. heterophyes*

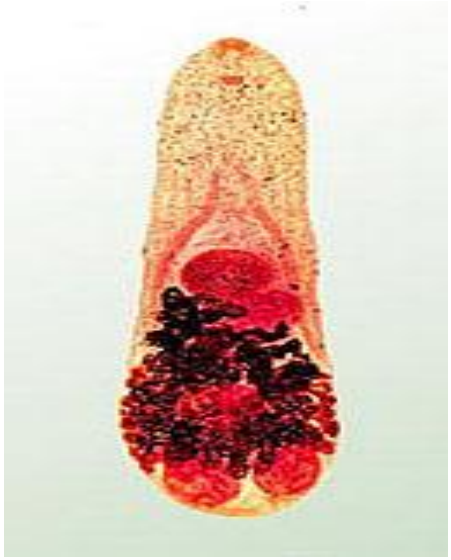


Fig. (20): Adult worm
Heterophyes heterophyes

in fish eating mammals in Asia and North Africa; utilize brackish water fish such as mullet for second intermediate hosts.

Name: ***Heterophyes heterophyes***

Definition: **Fish tape worm (intestinal flukes)**

Distribution: **Egypt, Far East, Middle East & Africa.**

(For Egypt it found near to Port said

& Abu Rawash)

Disease: **Heterophiasis**

Diagnostic Stage: **Eggs in stool (yellowish oval eggs containing**

mature miracidium)

Infective Stage: **Encysted metacercaria in fish muscles.**

Mode of infection: **Eating raw or undercooked fish, mainly**

boulty & bory containing encysted metacercaria

in their muscles

Treatment: **Praziquantel (Distocide® ,Biltricide®) &**

Niclosamide (Niclosan ® , Yomesan ®)

Prevention: **Proper disposal of human sewage**

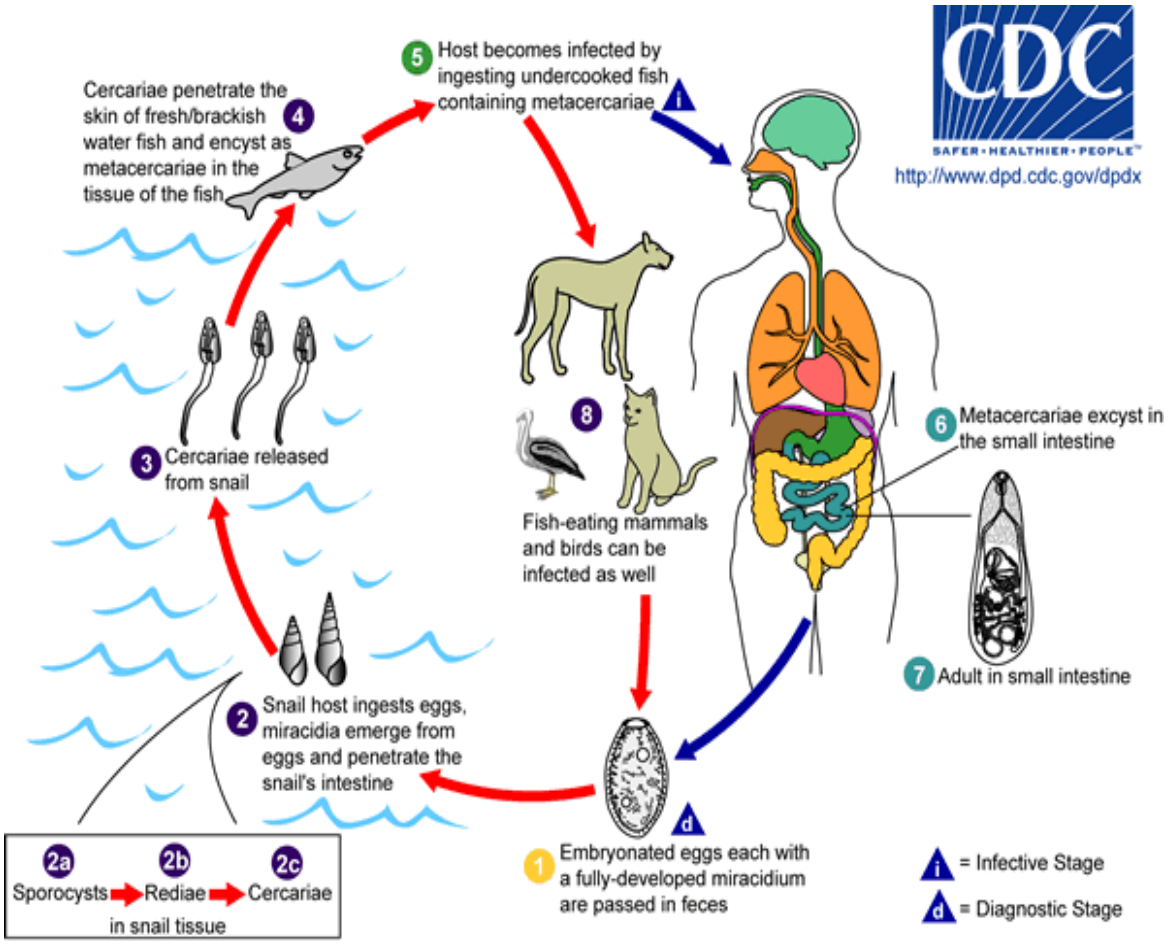
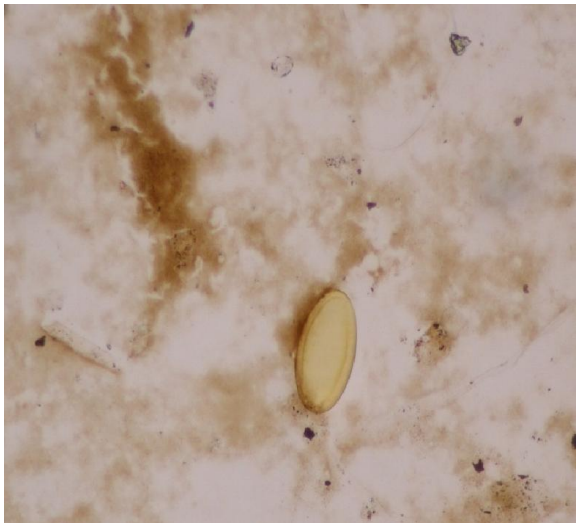


Fig. (21): Life cycle of *Heterophyes heterophyes*

Presence of the flukes in human intestine initiate intestinal mucosa inflammation, most of patients are asymptomatic, if symptoms appear, abdominal pain & non bloody diarrhoea occurs. The diagnostic feature

of adult worm: have three suckers: interior, posterior and genital, with rough spiny tegument. Furthermore, adult worm is the smallest trematodes in size (2 mm in length). While, Egg found in feces or stool of heterophiasis, with Yellowish oval egg with conical operculum, thick shell and mature miracidium.



Ovum

Snail *(Prienella conica)*

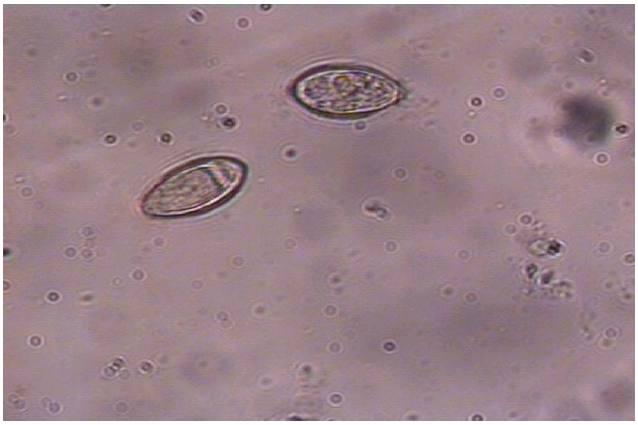
Fig. (22): ovum of *Heterophyes heterophyes* and intermediate host snail

Metagonimus yokogawii:

in fish eating mammals in Asia; utilizes freshwater trout, other salmonids, and cyprinids, for second intermediate hosts. The adult which measured 1-2.5 X 0.4-0.7 millimeter, the whole body is covered with spiny cuticle, ventral sucker at right side of the body. Egg with operculum

and miracidum inside egg shell measured 27-30 X 15-17 µm, the figure of this parasite collected from dog's intestine from Basrah city/ southern Iraq in 2004 by Prof. Dr. Suzan Al-Azizz as a first record in Iraq and Basrah city.

A



B

Fig. (23): A- Adult *Metagonimus yokogawei* isolated from dog's ingestine, B- Ova with miracidium incide

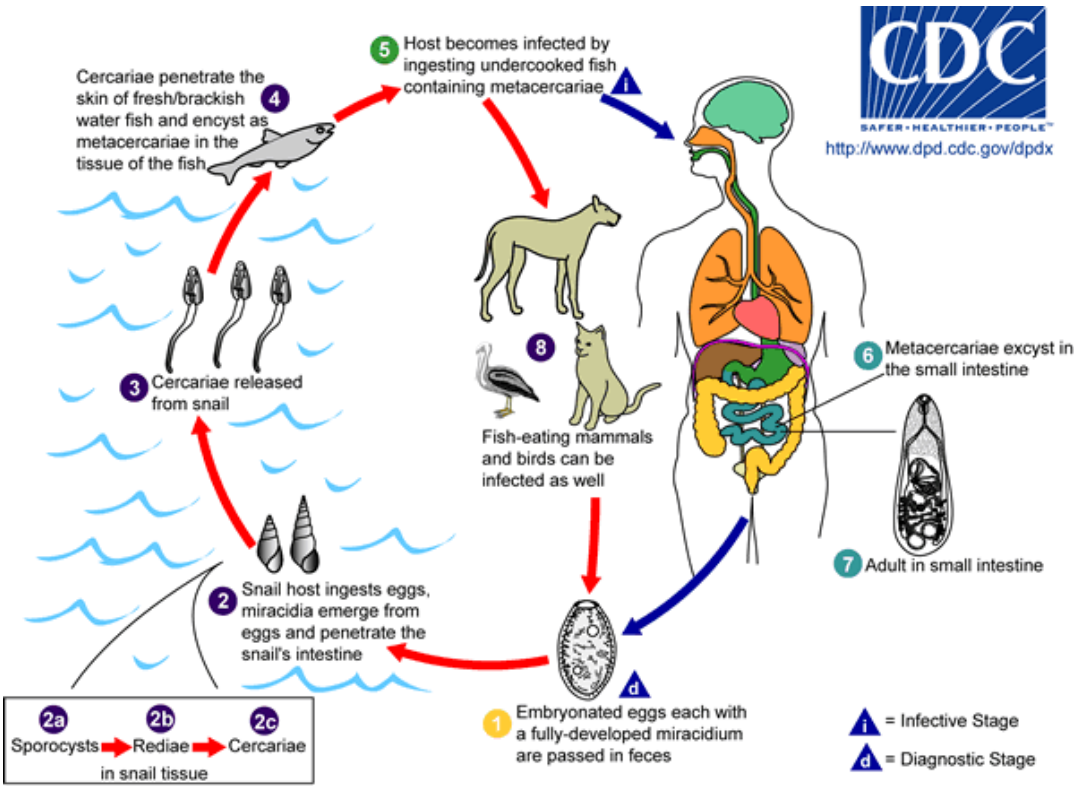


Fig. (24): Life cycle of *Metagonimus yokogawei*

Lung Flukes

1- Family: Troglotrematidae:

Paragonimus westermani

The human lung fluke, it is found in the Orient including India and Philippines. Nearly 50 known species in the genus; this particular species is found in North America. Large, fleshy worms that live in the lungs. Found in canines, pigs, felids, raccoons, goats, muskrats, opossum, and even two reports from humans also.

Definitive host becomes infected by eating improperly cooked crustacean. Adult infections become established in lungs but larval forms may wander into brain, pleura, mesentery, etc.(ectopic infection). Reservoir hosts include - dogs, cats, pigs, rodents, and other animals

Man becomes infected by eating improperly cooked crabs, ingestion of metacercaria from cutting boards where salads are fixed, medicinal use of crab juices). Smoked or pickled crab do not kill.

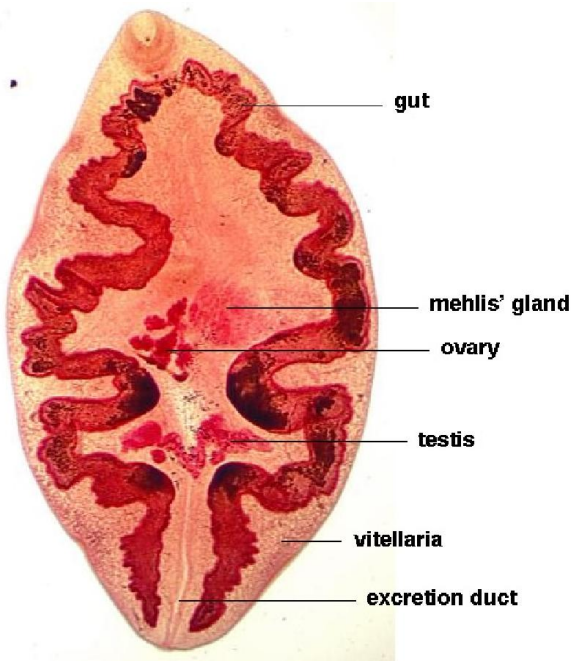


Fig. (25): Adult *Paragonimus westermani*

Pathology

•Early invasive stages usually asymptomatic.

•In the lung or ectopic site, connective tissue forms pseudo tubertules. In the CNS, they can cause paralysis and in rare cases can be fatal. In the heart they can cause severe damage and can be fatal.

•Lung infections cause chronic cough, bloody sputum, pneumonia -like conditions.

Prevention includes

– Cooking of crabs, crayfish

–Care when eating salads, no crab juice.

–Proper disposal of feces and sputum.

Life-cycle

Adults encysted as pairs in lungs, eggs up trachea; out with feces, then, mature in environment in several weeks after that hatch to miricidium which penetrates special intermediate host snail (*Pomatiopsislapidaria*), then, sporocyst and two redial generations, later, cercariae either emerge and penetrate crayfish (i.e. *Cambarus* spp.) , or snail with cercariae eaten by crayfish. Other *Paragonimus* spp. may use freshwater crabs or other crayfish species. The metacercaria in gills, muscle eaten by definitive host

which bores through gut wall; through diaphragm and penetrates lung directly maturation into adults.

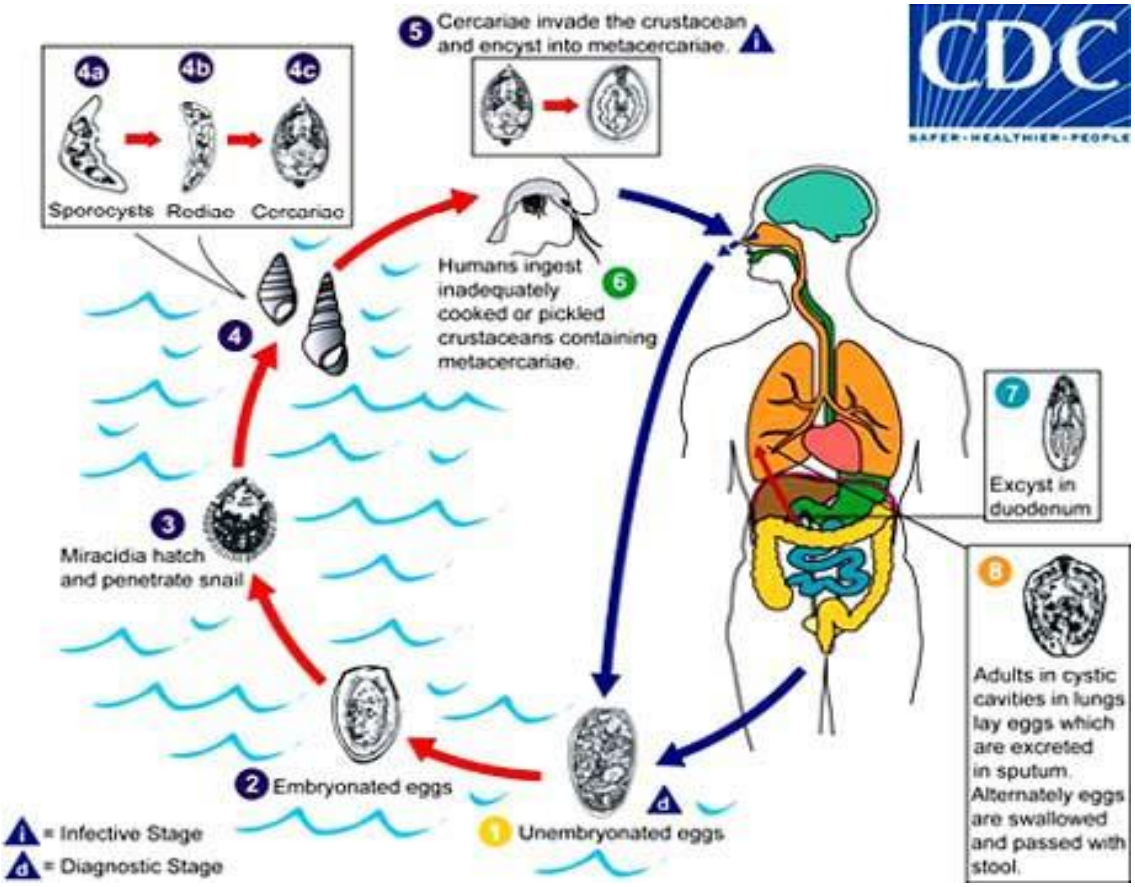


Fig. (26): Life cycle of *Paragonimus westermani*

Blood Flukes

Family: Schistosomatidae:

Schistosoma and other spp.

Elongate bodies without pharynx, in birds (many genera); mammals (3 genera), eggs non-operculate, live in blood vessels, especially mesenteric blood vessels.

Schistosoma spp. (in mammals; 4 groups)

A. *Schistosoma haematobium* group

- 7 species
- most use *Bulinus* snails as intermediate host.
- indigenous to Africa and adjacent regions
- most with posterior spine on egg
- *S. haematobium, S. intercalatum, S. mattheei* in primates. Available evidence suggests that *S. haematobium* can cause urinary bladder carcinoma
- *S. mattheei, S. bovis, S. curassoni, S. margrebowiei, S. leiperi* in artiodactyla

B. *Schistosoma mansoni* group

- 4 species
- most used *Biophalaria* snails as intermediate host.
- indigenous to Africa; introduced to the Caribbean and South America
- most with large, sublateral spine of egg

  Species:

1. *S. mansoni* in primates and rodents

2. *S. rodhaini* in carnivores and rodents

3. *S. edwardiense, S. hippopotami* in artiodactyla

C. *Schistosoma indicum* group

- 4 species
- most species use *Indoplanorbis* snails as intermediate hosts.
- indigenous to Asian countries
- Most species have egg with terminal spine

1. *S. indicum, S. spindale, S. nasale* in artiodactyla
2. *S. incognitum* in rodents, carnivores, and artiodactyla

D. *Schistosoma japonicum* group

- 4 species
- variety of snails as intermediate hosts.
- indigenous to Asian countries
- most eggs spherical or subspherical, with small spine
- *S. japonicum* in primates, rodents, and carnivores. Evidence suggests that this parasite may cause hepatic carcinoma.

1. *S. mekongi* in primates and carnivores
2. *S. sinensium, S. malayensis* in rodents

life-cycle of *Schistosoma* spp.

Adults in veins in visceral region; females inch down into venioles to release eggs, eggs trapped in capillaries; granuloma; out with feces or urine or

remain trapped, embryonate en route, then hatch to miracidia, miricidium penetrates snail and two sporocyst generations released after that furcocercouscercariae released and penetrate skin of definitive host resulting to schistosomule migrates; blood vessels; heart; liver, this will be matures in about three weeks and migrate down veins to sites of infection; en route males and females pair.

Pathology and Immunology

- adults evade immune system by coating themselves with host proteins
- adults cause little damage
- most pathology associated with eggs; many carried to exotic sites
- delayed type hypersensitivity around egg granulomas; leaking antigens; eosinophilia; neutrophilia
- blood vessel occlusion; fibrosis; bloody diarrhea; bloody urine; edema; ascites; cirrhosis
- a few reports have suggested that the pharaoh Akhenaton may have had *Schistosoma haematobium*
- some historical reports have suggested that Napoleon Bonaparte, who had chronic dysuria, may have acquired *Schistosoma haematobium* during his Egyptian campaign of 1798.

Other Genera and Species

- ***Schistosoma tiumdouthitti***

  1-rodents and lagomorphs in far North America

2- hepatic portal system

- ***Heterobilharzia americanum***

1. medium sized mammals; carnivores; in North America
2. in raccoons

- ***Gigantobilharzia, Bilharziella, Trichobilharzia, Microbilharzia*, etc.**
  Found in birds
- ***Ornethobilharzia turcestanicum***

Found in the blood vessels of cattle.

So, Generally:

- Schistosome: A parasitic trematode worm contracted from infested water that is capable of causing liver, gastrointestinal tract and bladder disease.
- Three main species of these trematode worms (flukes) ----- Schistosoma mansoni, S. haematobium, and S. japonicum, that produce disease in humans.
- Schistosomiasis or bilharzia after the German physician Theodor Bilharz (1825-1862). Nickname "Bill Harris" by British soldiers serving in Europe during WWI.

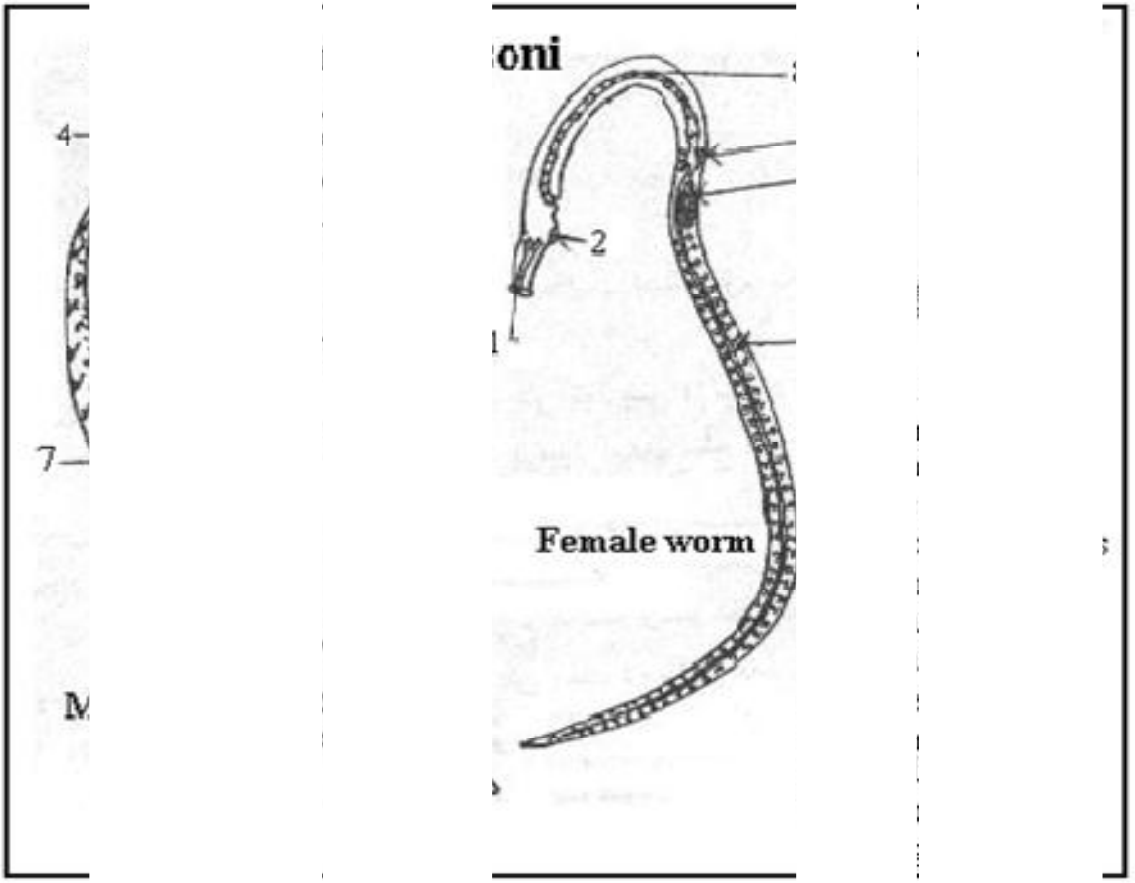


Fig. (27): Typical structure of male, female and ovum of *Schistosoma mansoni*

Fig. (28): Ovum of *Schistosoma mansoni*

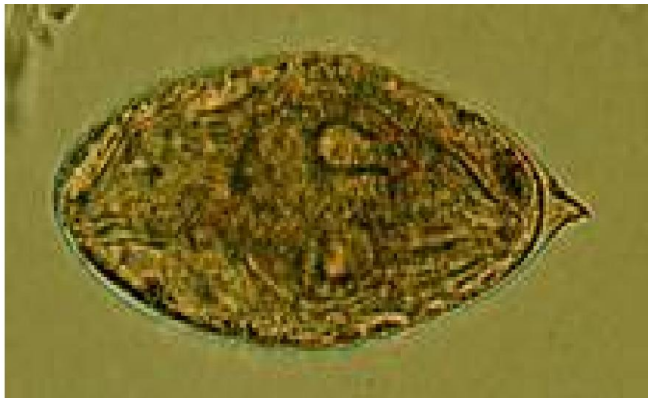


Fig. (29): Ovum of *Schistosoma haematobium*

Ova of *S. mansoni* with lateral spin Ova of *S. haematobium* with terminal spin

Fig. (30): Ovum of *Schistosoma japonicum*

Ova of *S. japonicum* with minute spin or knob

Definitive Host/ Intermediate Host

- Definitive host: Human
- Intermediate host: Snail

  Biomphalaria (S. mansoni)

  Bulinus (S. haematobium)

  Oncomelania (S.japonicum)

- Reservoirs: monkeys, rodents, cats, dogs, cattle, horses, swine, wild mammals.

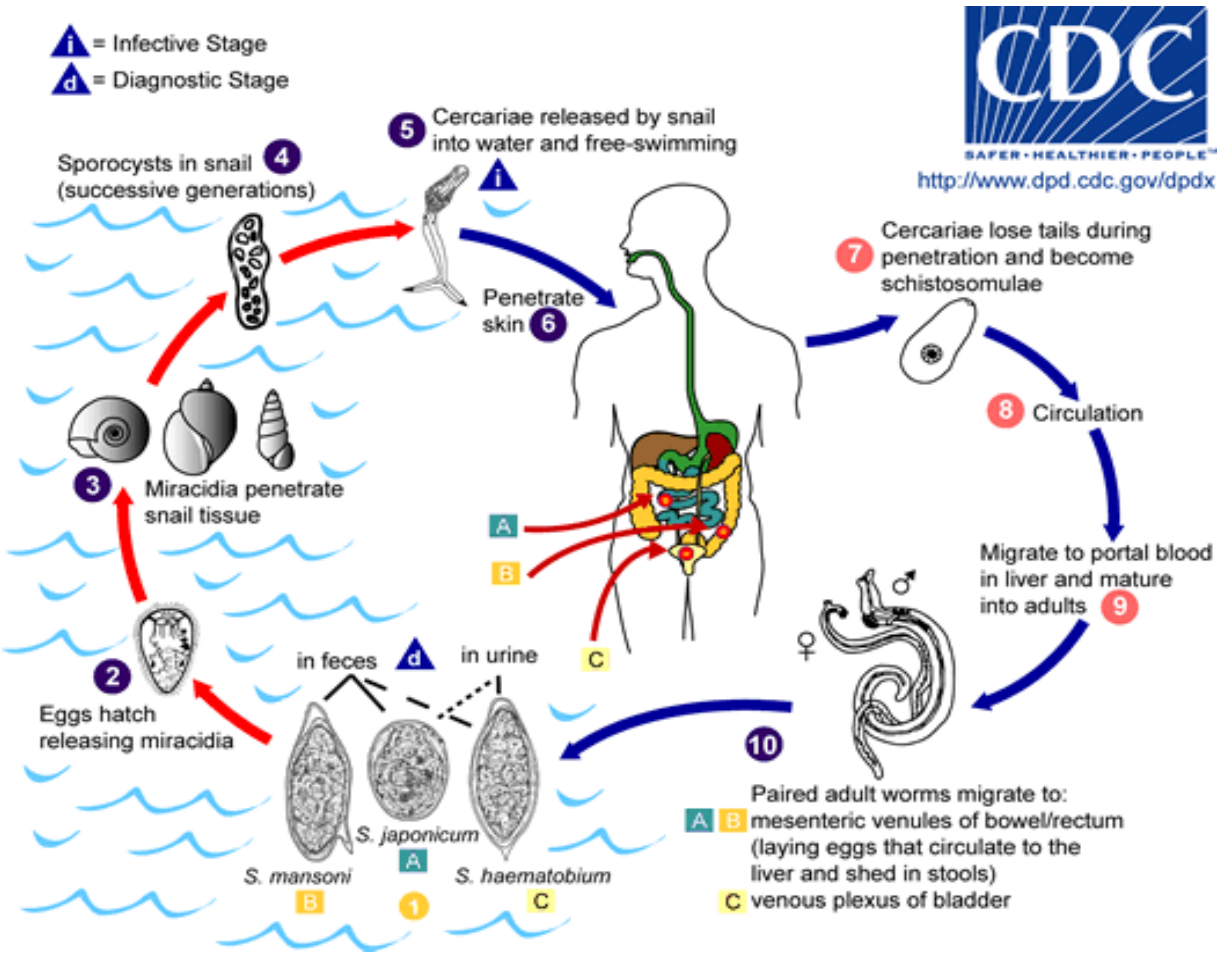


Fig. (31): Life cycle of *Schistosoma spp.*

many cause swimmer's itch, where cercaria penetrate skin, die, and cause inflammation in abnormal hosts

Pathogenesis

1-S. mansoni

- most pathogenic

- site of infection: veins of large intestine

2-S. haematobium

- bloody urine
- site of infection: veins of bladder

3-S. japonicum

- high morbidity
- site of infection: veins of small intestine

Clinical Symptoms

Migratory phase

- Symptomless

Acute phase (Katayama fever)

- Chills, fever, fatigue, headache, muscle aches, cough, abdominal pain, diarrhea, and eosinophilia.

Chronic phase

- Bloody diarrhea, enlargement of liver and spleen, ascites, bloody urine, bladder cancer, kidney problems, CNS lesions.

Control & Prevention

- Education of the public
- Sanatation of drinking water
- Diagnosis and treatment
- Management of the environment
- Control of the intermediate hosts (freshwater snails).

Diagnosis

- Microscopic identification of eggs in stool or urine (most practical)
- Tissue biopsy- rectal or bladder biopsy may demonstrate eggs when stool or urine examinations are negative.
- Antibody detection
- Morphologic comparison with other intestinal parasites

Treatment

- praziquantel -drug of choice, effective in the treatment of all forms of Schistosomiasis, with virtually no side effects
- Oxamniquine -used exclusively to treat intestinal schistosomiasis in Africa and South America
- Metrifonate - effective for the treatment of urinary schistosomiasis
- No vaccinations currently available.

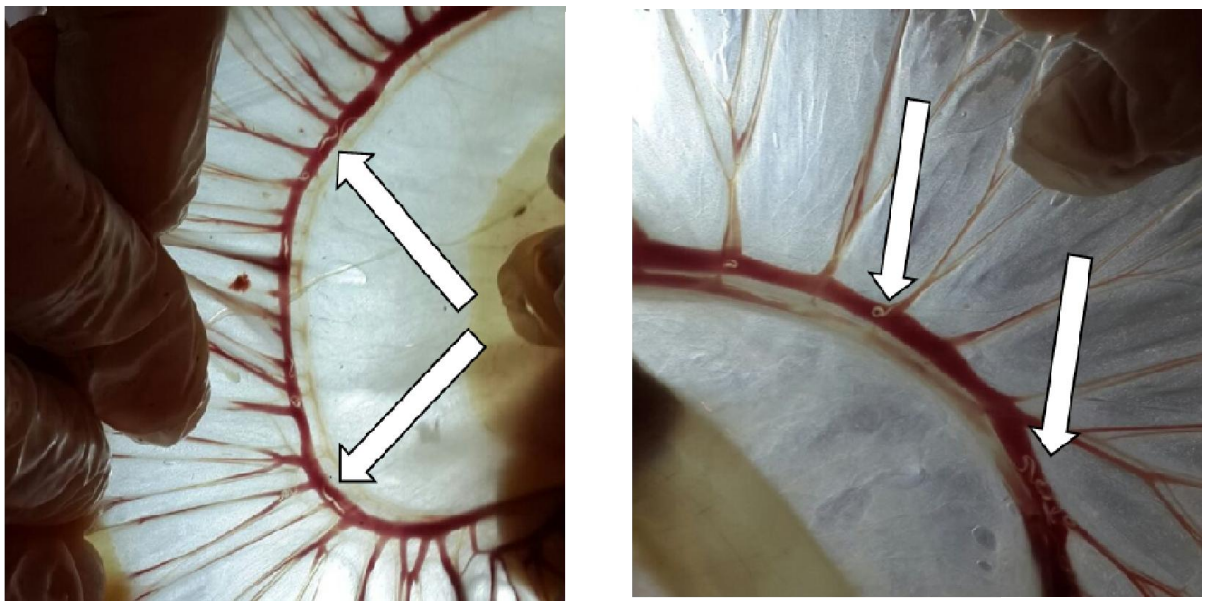


Fig. (32): The site which *Schistosoma spp.* Could be found

Ornithobilharzia turkestanicum

Orienthobilharzia spp. is a Schistosomes infection that cause Orientobilharziasis disease in a large number of animals including goats, sheep, cattle and other mammals and they live in the portal or intestinal veins of the infected animals with causing emaciation, anemia and diarrhea, with incidence extraction of blood and mucosal material in the host feces, and infection may lead to acyesis or abortion in females and reduce the possibility of growth in young with wide spread in many countries at the world including Russia, Mongolia, Turkey, India, Iran, China and Iraq.

Fig. (33): Oral and ventral sucker of male *Ornithobilharzia turkestanicum*, by: Ismael W. Ismael amd Prof. Dr. Suzan Al-Azizz and Assist. Prof. Dr. Hana N. Abdullah

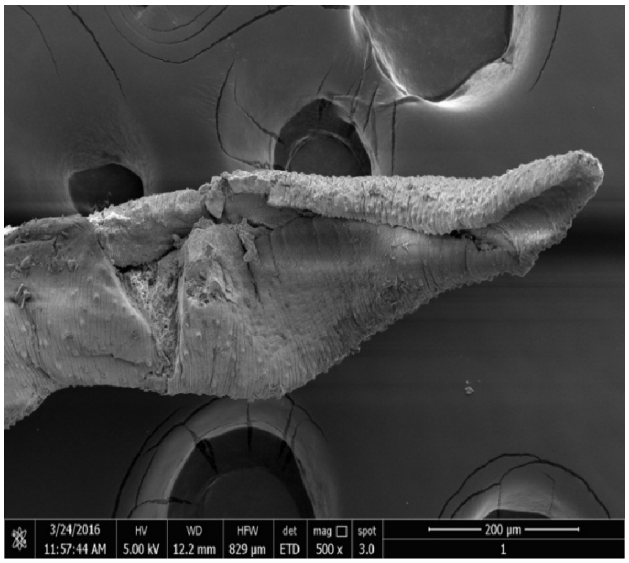


Fig. (34): Gynecophoric canal of male *Ornithobilharzia turkestanicum*, by: Ismael W. Ismael amd Prof. Dr. Suzan Al-Azizz and Assist. Prof. Dr. Hana N. Abdullah

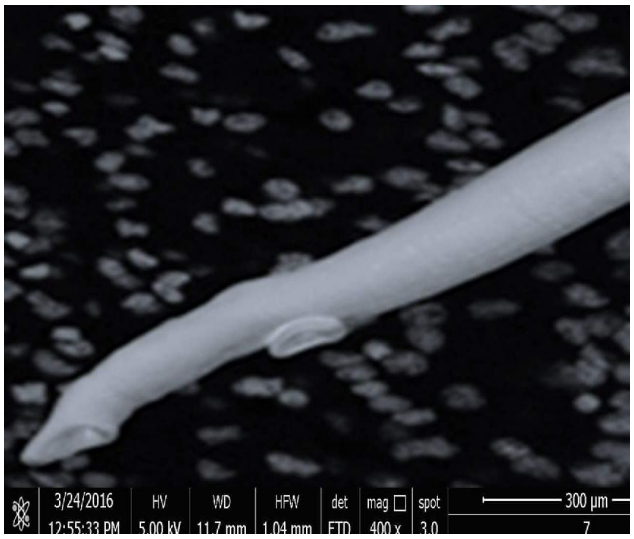


Fig. (35): Adult female of *Ornithobilharzia turkestanicum*, by: Ismael W. Ismael amd Prof. Dr. Suzan Al-Azizz and Assist. Prof. Dr. Hana N. Abdullah

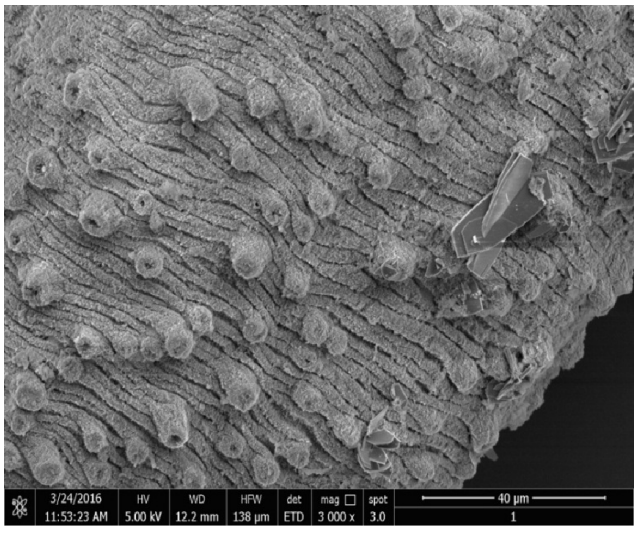


Fig. (36): Spiny tegument of *Ornithobilharzia turkestanicum*, by: Ismael W. Ismael amd Prof. Dr. Suzan Al-Azizz and Assist. Prof. Dr. Hana N. Abdullah

Schistosoma cercarial dermatitis or swimmers itch

Schistosoma of animals or birds other than man (usually rodents and birds) try to penetrate the skin of man, they cannot establish themselves in the blood vascular system of man causing sores in different part of their body and the causing called swimmer's itch or diggers itch, where cercaria penetrate skin, die, Often cause a dermatitis which can be severe and in some cases life threatening and cause type of inflammation and allergic reaction in abnormal hosts with few days later it’s disappear.

Fig. (37): swimmers itch

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