



Course: (96)

I- Trematodes of poultry:

1) Family: Echinostomatidae

Genus: *Echinostoma*

Species: *Echinostoma revolutum*

Habitat:

Echinostoma revolutum is a trematode parasitizing the rectum and caeca of ducks, geese, fowls, aquatic birds and rarely man.

* Morphology:

* **Adult worms** are elongate, small to very small (up to 20 mm x 2.2 mm) with their cuticle covered with scales or spines.

Oral sucker is very small and surrounded dorsally and laterally with an incomplete ring of spines (**head collar**) bearing 1-2 rows of large spines.

Ventral sucker is much larger than the oral sucker and found in the anterior body fourth.

The digestive system consists of an oral opening, long esophagus which is partially surrounded by a small pharynx and two simple intestinal caeca reaching the posterior body end.

Testes are lobed, tandem in position and situated in the middle third.

Ovary is small, oval, and located anterior to the testes.

Uterus is short and directed forward filling the space between the ovary and ventral sucker. The common genital pore opens anterior to the ventral sucker.

Vitelline glands are large, follicular and occupy the whole lateral fields of the body.

The eggs are large, yellowish, thin shelled, operculated, immature and measure up to 120 x 60 μ .



***Echinostoma revolutum* adult**

* **Life cycle:**

Indirect life cycle in which two intermediate hosts are required:

- **First I.H:**

Water snails (*Lymnaea spp.*, *Melania spp.*, *Biomphalaria spp.*, *Bulinus spp.* or *Physa spp.*) from which cercariae emerge.

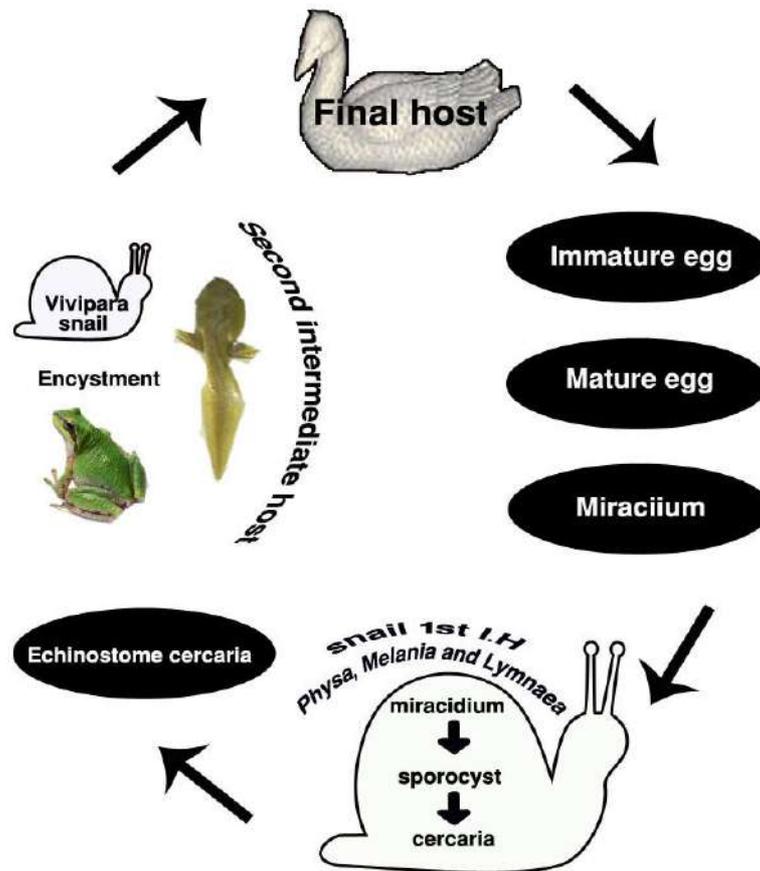
- **Second I.H:**

* Frog or water snails (*Vivipara spp.* or the same as first I.H) in which the metacercariae encyst.

* The cercaria is of leptocercus type (simple tail) with a head collar of spines around the oral sucker (Echinostome cercaria)

* The eggs hatch after developing under favorable conditions for about 3 weeks and the miracidium penetrated into intermediate host *Lymnaeaspp.*, *Melania spp.*, *Biomphalaria spp.*, or *Physa spp.* Cercariae are produced within 2-3 weeks and these either encyst in the snail or escape and enter another of the same species or different species as *Vivipara spp.* and Tadepoles as a second intermediate hosts then encyst.

* Ingesting these snails infects the final host and immature flukes grow to adults in 15-20 days.



Life cycle of *Echinostoma* spp

*** Pathogenicity:**

- * Heavy infections resulting in losses of pigeons. The small intestine of the affected birds showed hemorrhagic inflammation and diarrhea.
- * Early symptoms included off food, increased thrust, weakness in flight and pronounced diarrhea.
- * Death occurred in 4-10 days from increased weakness.
- * Atrophy of the pectoral muscles, engorged liver and intestinal congestion may occur. The lumen of the gut was filled with a hemorrhagic catarrhal secretion containing numerous flukes.

II- Cestodes of poultry and rabbits:

Order: Dilepididea

1) Family: Dipylididae

Genus: *Choanotaenia*

Species: *Choanotaenia infundibulum*

Distribution: They are found worldwide, with variable incidence, but are less frequent than other parasitic tapeworms of birds.

Habitat: The upper half of small intestine.

Definitive host: Chickens and other domestic and wild gallinaceous birds (e.g. turkey, pheasants, quails, etc.).

Intermediate host: House fly, *Musca domestica*, and beetles.

Morphological characters:

i. Grossly:

- Adult tapeworms are up to 25 cm long and 3 mm wide
- The segments are markedly wider posteriorly than anteriorly.
- Usually it has not more than 30 segments (proglottids),

ii. Microscopically:

- The scolex is small has suckers and rostellum armed with 16-20 slender hooks arranged in one row for attaching to the host's gut wall.
- Each mature segment has one set of genital organs. The genital pores are regularly alternating and opens near to the anterior border of the segment. The testes are numerous and located posteriorly.
- The uterus is sac like. However, the proglottids leave the body before they are completely gravid and may be the uterus is replaced by egg capsules.
- The eggs have an ovoid shape, contain an embryo (oncosphere) and have distinct elongate filaments.

Life cycle:

- *Choanotaenia infundibulum* has an indirect life cycle with domestic and wild birds as final hosts, and intermediate hosts are the house fly, *Musca domestica*, and beetles.
- The gravid segments of adult tapeworms are passed with the birds' feces (the diagnostic stage). They are motile and migrate quickly into the surrounding vegetation.

- The intermediate hosts ingest the gravid segments, which release the eggs in their gut after digestion. Then the eggs develop to cysticercoids in the body cavity of the intermediate hosts (the infective stage).
- The birds ingest flies or beetles contain the infective stage and after digestion, the cysticercoids release the young tapeworms that attach to the wall of the bird's gut.
- The time from infection and shedding of the first eggs (**prepatent period**) about 2 to 4 weeks.

Pathogenicity and clinical signs:

• Infections with *Choanotaenia infundibulum* are moderately pathogenic. Usually affected birds do not show serious clinical signs. Heavy infections may cause reduced growth, especially in young birds.

Diagnosis:

- Diagnosis is done through detection of gravid segments in the feces.
- Fecal examination must be done on fresh feces, because the gravid segments migrate quickly outside the droppings. The eggs are usually not found in the feces because they remain inside the migrating gravid segments.
- After necropsy the adult worms can be seen detected in the intestine.

Prevention and treatment:

- keeping the birds' bedding dry can help to avoid infections because it shortens the survival of the gravid segments and the eggs.
- Applying chemical insecticides in poultry houses to control flies, ants and termites.
- Infected birds with either broad-spectrum benzimidazoles (e.g. albendazole) or specific taenicides (e.g., niclosamide, praziquantel).

(2) Family: Dilepididae

Genus: *Amoebotaenia*

Species: *Amoebotaenia sphenoides*

Habitat: Small intestine.

Definitive host: Domestic fowl.

Intermediate host: The earthworms (e.g of the genus *Lumbricus*).

Morphological characters:

i. Grossly:

- It is very small, not longer than 4 cm.
- Adult appeared triangular in shape being narrower anteriorly and wider posteriorly.
- Usually it has not more than 25 segments (proglottids), which are broader than long.

ii. Microscopically:

- The scolex has suckers and rostellum armed with 12 to 14 hooks arranged in single row for attaching to the host's gut wall.
- Each segment has one set of the genital organs and the genitalpore is usually alternate irregularly at the maximum anterior end of the segment edge.
- The testes are transversely located in the posterior part of each segment arranged in single row.
- The uterus is sac like and slightly lobulated.

Life cycle:

- *Amoebotaenia sphenoides* have an indirect life cycle. The intermediate hosts are the earthworms(e.g of the genus *Lumbricus*).
- The gravid segments of adult tapeworms that contain the eggs are shed with the birds' feces.
- The earthworms ingest the gravid segments, which release the eggs in their gut after digestion. Then the eggs develop to cysticercoids in the body cavity of the earthworms through 14days.
- Fowls acquire the infection frequently after rains when the earthworms come to the surface. Fowls ingest such contaminated earthworms and the worms grow adult in four weeks.

Pathogenicity and clinical signs:

- Affected birds with *Amoebotaenia sphenoides* don't show clinical signs. Massive infections can cause reduced growth in young birds. Infections with more than 200 worms can cause enteritis, occasionally with hemorrhage.

Diagnosis:

- Diagnosis can be done through detection of gravid segments in the feces.
- Fecal examination must be done on fresh feces, because the gravid segments migrate quickly outside the droppings.
- After necropsy the adult worms can be seen as whitish projection of the intestinal villi.

Prevention and treatment: Changing the birds' bedding frequently and keeping it dry help to avoid infections because it shortens the survival of the eggs. Free-ranging birds should be kept off humid environments that are supportive of earthworms. Infected birds treated with either broad-spectrum benzimidazoles (e.g. albendazole) or specific taenicides (e.g., niclosamide, praziquantel).

Order: Hymenolepididea

1) Family: Hymenolepididae

Genus: *Hymenolepis*

General characters of this genus:

- Tape worms of this genus infect several species as man, rodents and birds
- The life cycle of adult worms usually is indirect need intermediate host as arthropods in which the metacestode (cysticercoids) is formed and the definitive host is infected when eat the intermediate host containing the cysticercoids.
- The most common species are *H. nana*, *H. diminuta*, *H. lanceolata* and *H. carioca*.

a) *Hymenolepis carioca*

Habitat: small intestine.

Definitive host: Domesticfowl.

Intermediate host: Beetles and *Stomoxys calcitrans*.

Morphological characters:

- The adult tape worm is slender and up to 8cm long.
- Scolex has un armed rostellum which replaced by rostellar sac.

Life cycle:

The life cycle is indirect and need intermediate hosts as dung beetles, ground beetles and *Stomoxys calcitrans*.

(b) *Hymenolepis lanceolata*

Habitat: small intestine.

Definitive host: Duck and geeze.

Intermediate host: Aquatic crustaceans.

Life cycle:

- The life cycle is indirect.
- The intermediate hosts are the aquatic crustaceans.
- Eggs with onchospheres passed in feces and are viable in water up to 26 days.
- Eggs are ingested by the intermediate host then develop into cysticercoids in the body cavity in 10-18 days after ingestion by fresh-water cyclop.
- Cysticercoids become infective in 20-30 days and mature in 15-25 days after ingestion by the final host.
- Duration of life cycle about 6 months.

Pathogenicity and clinical signs:

- Both *H. carioaca* and *H. lanceolata* are not highly pathogenic but heavy infections in birds cause enteritis, abdominal pain, loss of appetite, weakness and diarrhea.

(2) Family: Fimbriaridae

Genus: *Fimbriaria*

Species: *Fimbriaria fasciolaris*

Habitat: Small intestine.

Definitive host: Chickens and ducks.

Intermediate host: Cyclops spp.

Morphological characters:

- The adult worm is about 40cm long.
- The anterior portion of the body forms folded expansion (pseudoscolex) by which the adult attaches itself.
- The strobila is unsegmented but has cross striations give impression of segmentation.
- The rostellum is retractable and armed with 10-12 hooks.
- The genital pores are unilateral.

Life cycle:

- It is indirect and the intermediate hosts are Cyclops spp.

Order: Davaineida

Family: Davaineidae

General characters of this family:

- 1- Tape worms of this order are parasitic in mammals or birds.
- 2- Suckers and Rostellum armed with hooks.
- 3- Each mature segment provided with one set of genital organs.
- 4- The uterus replaced by egg capsules.
- 5- The intermediate hosts are invertebrates.
- 6- This order includes three genera *Davainea*, *Raillietina* and *Cotugnia*.

(1) Genus: *Davainea*

Species: *D. proglottina*

Common name: Dwarf tapeworm of poultry or the small chicken tape worm.

Distribution: It is found worldwide, causes disease called **davaineosis**.

Habitat: The duodenal loop of the small intestine.

Definitive Host: Fowl, pigeons and other gallinaceous birds.

Intermediate Host: slugs and snails.

Morphological characters:

i. Grossly:

- It is a small tapeworm, usually not longer than 4 mm (0.5- 3 mm) with only 4 to 7 segments (proglottids).
- The proglottids are whitish to translucent. Only the last one is gravid.

ii. Microscopically:

- Suckers armed with spines and rostellum has numerous hammer shaped hooks.
- Each mature segment has one set of genital organs and the genital pores are alternate regularly and they are found at the anterior end of the segment margin.
- Testes are 15-25 and scattered in the segment and the ovary is bilobed in the middle part of the segment. The compact vitelline glands are situated between the ovarian lobes.
- Only the last segment is gravidfilled with eggs which are lying singly in the parenchymatous capsules of the gravid proglottid.

Life cycle:

- The gravid segments are passed in the feces of the final host at afternoon or night (usually one gravid segment per tapeworm per day).
- The gravid segments are motile and climbing on the vegetation where they are swallowed by slugs and snails (intermediate hosts).
- Inside the intermediate host the eggs hatch and release the embryo which develops into cysticeroid in the body cavity within 3 weeks.
- The definitive host (fowl) acquires the infection by ingestion of infected snails or slugs.
- After ingestion, the young tapeworms are released and attach to the gut's wall.
- Theprepatent period (the time between infection and shedding of the first eggs) is about 14 days.

Pathogenicity and clinical signs:

- Adult tape worm is highly pathogenic for young birds.
- Heavy infections lead to hemorrhagic enteritis as it penetrates deeply into the intestinal mucosa and intestinal necrosis which may be deadly for the young birds.
- Chronic infections can decrease weight gains, reduce egg production, general weakness and even paralysis.

Diagnosis:

• Diagnosis is commonly performed only after necropsy as the gravid segments not always found in the feces of the definitive host so it is significant to inspect a representative sample of the flock and to examine intestinal smears under the microscope.

Prevention and treatment:

- Keeping the birds' bedding dry and frequent change of it to avoid infections.
- Free ranging birds are more susceptible than birds kept in cages so should be kept off humid environments.
- Using of molluscicides such as copper sulphate to kill the snails and slugs (chemical control)
- Infected birds treated with anthelmintics as benzimidazoles.

(2) Genus: *Railletina*

General characters of this genus:

- 1- Tapeworms of this genus are found in small intestine of domestic birds.
- 2- It is found **worldwide** and common in free-ranging poultry.
- 3- Adults are whitish in color.
- 4- The most common species are *R. tetragona*, *R. echinobothrida* and *R. cesticillus*.

(i) *R. tetragona*

Distribution: It is found worldwide and consider one of the largest tape worms of poultry.

Habitat: The posterior half of small intestine.

Definitive host: Domestic fowl, guinea fowls and pigeons.

Intermediate host: Ants(*Tetramorium*)

Morphological characters:

- Adults reach up to 25 cm long. It has a long, thin neck and a small scolex provided with four oval shaped suckers armed with 8-10 rows of small hooks. Also the rostellum provided with 100 minute hooks of 6 μ long arranged in one or two rows.
- The segments (proglottids) are wider than long. Each mature segment has single set of genital organs.
- The genital pore is usually unilateral.
- In the gravid segment the uterus break down into egg capsules each is containing 6-12 ova.

Life cycle:

- The final host is the birds.
- The intermediate hosts are ants particularly of the genus *Tetramorium* in which the cysticercoids are developed.
- The final host is infested by eating the infected ants containing the cysticercoid.

(ii) *R. echinobothrida*

Common name: Nodular tapeworm.

Distribution: In most parts of the world and consider one of the most prevalent parasite in birds.

Habitat: small intestine.

Definitive host: Domestic fowl.

Intermediate host: Antsand house flies.

Morphological characters:

(i). Grossly:

- Adult is whitish in color and highly elongated.
- The body measures about 25 cm long, and 1-1.5 cm broad.

(ii). Microscopically:

- The scolex carries four suckers and a rostellum.
- It resembles *R.tetragona* but it is characterized by a more heavily armed rostellum which armed with 200 hooks arranged in two rows besides the suckers are circular in outline and armed with 8-10 rows of hooks.
- Each mature segment has one set of the genital organs and the genital pore is unilateral but in occasional specimens is alternating.
- The uterus in the gravid segments breaks down into egg capsules each one is containing several eggs.
- The gravid segments frequently separate in the middle forming small windows in the posterior part of the adult worm.

Life cycle:

- Adult worm present in the small intestine of fowl (the final host) and the gravid segments passed in the feces of final host.
- The oncospheres are ingested by the ants of *Tetramorium spp.* and house flies (intermediate host), then the cysticeroid developed in the abdominal cavity of intermediate host.
- The final host (fowl) is infested by eating the infected intermediate host containing the cysticeroid.

(iii) *R. cesticillus*

Common name: Broad-headed tapeworm,

Distribution: All over the world. It is a relatively nonpathogenic species among intestinal tape worms of poultry despite its high prevalence.

Habitat: Small intestine.

Definitive host: Domestic poultry (fowls, turkeys, guinea fowls).

Intermediate host: Beetles.

Morphological characters:

i. Grossly:

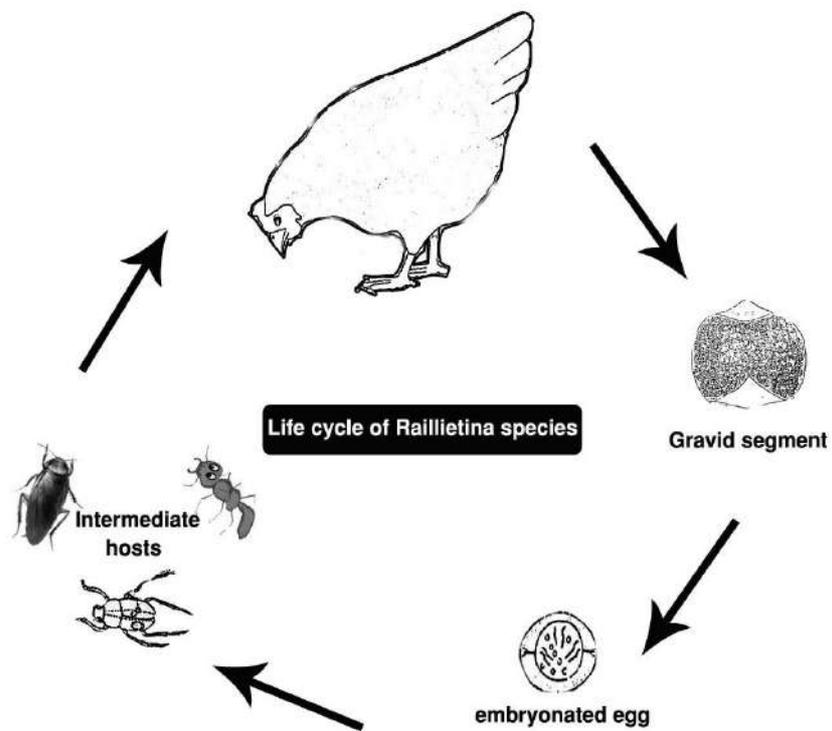
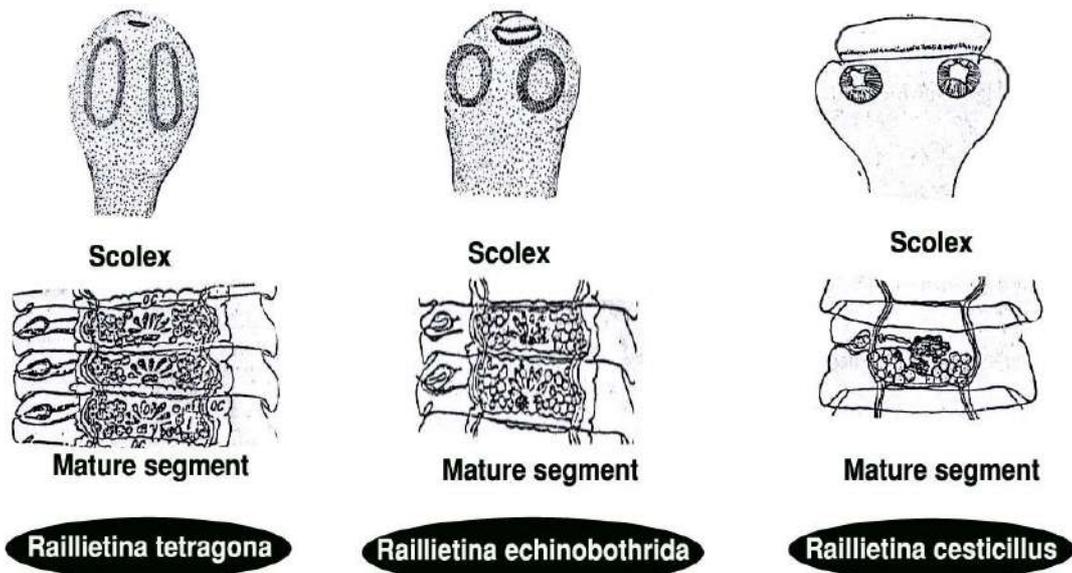
- It is small tape worm measuring 4 cm long, rarely 15 cm.
- Adult is whitish in colour.

ii. Microscopically:

- Scolex is large and broad.
- Rostellum is wide and protruded like a retractable piston in the middle of the scolex, armed with a double crown of 300-500 hammer-shaped hooks.
- Suckers are indistinct and are un armed.
- Each segment contains a single set of genital organs and the genital pore is unilateral.
- The gravid segments contain egg capsules each one has single egg.
- The eggs are provided with 2 funnel-shaped filaments between middle and inner membranes.

Life cycle:

- Beetles act as intermediate host. The beetles acquire the infection by ingestion of eggs and the cysticercoids developed within 14 days.
- Final host is infected by eating beetles containing cysticercoid. Adults develop within 2 – 3 weeks.



(3) Genus: *Cotugnia*

Species: *Cotugnia digonopora*

Habitat: Small intestine.

Definitive host: Fowls, ducks and pigeons.

Intermediate host: Ants

Morphological characters:

- Adult measures up to 11 cm. long.
- The rostellum provided with two rows of hooks.
- The suckers are not armed.
- The mature segment (proglottid) has two sets of genital organs in each segment.
- The uterus, in the gravid segment, breaks into egg capsules each containing only one ovum.

Life cycle:

It is unknown and may be ants act as intermediate host.

Tape worms infections of birds:

Pathogenicity:

- Tape worms of poultry related to the genera *Davainea*, *Raillietina*, *Amoebotaenia* and *Choanotaenia*.
- *Davainea proglottina*, although it is the smallest, is the most harmful one because it penetrates deeply into the villi causing marked enteritis, which is haemorrhagic in heavy infections.
- In chronic infections birds suffer from reduced growth rate and emaciation.
- *Raillietina tetragona* and *R. echinobothrida* follow next in order of pathogenicity.
- *R. echinobothrida* is as one of the most pathogenic tapeworms, causing visible nodules in intestine of chicken, with characteristic hyperplastic enteritis associated

with the formation of granuloma. The symptom is known as “nodular tapeworm disease” in poultry. Intestinal nodules measure up to 6 mm in diameter, which are visible, appeared as rugged swellings on autopsy contain necrotic tissues and leukocytes.

- *Raillietina tetragonais* less pathogenic but may cause emaciation and decreased production.
- Other species are non-pathogenic except in heavy infections cause decreased production and reduced growth rate.

Clinical symptoms of tape worm infections of birds:

-Young birds are frequently affected suffer from loss of appetite, anemia, reduced growth rate, decreased production and emaciation. And in heavy infections death may occur.

- *Davainea proglottina* infections cause diarrhea containing blood pigments and the bird may suffer from nervous symptoms as partial or complete paralysis.

Diagnosis:

- The clinical symptoms.
- Presence of large numbers of tape worm segments and eggs in the feces of the final host.
- Presence of intestinal nodules on autopsy (*R. echinobothrida*) or haemorrhagic enteritis (*Davainea proglottina*) as it is small, it is approved to take mucosal scrapping and examine microscopically.

Treatment and prophylaxis:

- Infected birds are treated with anthelmintics effective against tapeworms. as broad-spectrum benzimidazoles or specific taenicides (e.g., niclosamide, praziquantel).

Control measures

- Using of chemical insecticides to control ants, beetles and flies
- Chemical control of the snails and slugs with molluscicides such as copper sulphate.
- Frequent change of the birds bedding and keeping it dry.

III- Nematodes of poultry:

1) Family: Heterakidae

a- Genus: *Ascaridia*

Ascaridia galli

Morphology:

- * Adult worm inhabit the small intestine of domestic and wild birds.
- * It is the largest nematode of poultry. The worms are stout and densely white. Males are up to 7 cm while females are up to 12 cm long.
- * There are 3 lips around the mouth, the oesophagus has no posterior bulb and two narrow lateral alae run the whole length of the body.
- * The tail of the male has weakly developed caudal alae and **10** pairs of caudal papillae. Spicules are subequal and there is a circular precloacal sucker with a thick, cuticular rim.
- * The tail of the female is straight and conical. The vulva is found a short distance anterior to the middle of the body.
- * Eggs are distinctly oval with a smooth shell, measuring 70 x 40 μ and contain one cell when freshly laid.

Life cycle:

- * The life cycle is direct. Infection occurs by ingestion of eggs containing L₂ and the egg becomes infective at optimal temperature in a minimum of 10 days.
- * The parasitic phase is non-migratory and most of the parasitic development takes place in the intestinal lumen as well as burrowing into the intestinal mucosa.
- * Egg is sometimes ingested by the earth worms which may act as transport hosts.
- * The prepatent period ranges from 5-6 weeks in chicks to eight weeks or more in the adult birds.

*** Pathogenesis:**

1- When large numbers of the developing parasites penetrate into the intestinal mucosa, they cause catarrhal enteritis which may become haemorrhagic in heavy infestations.

2- Large numbers of adult parasites may cause intestinal obstruction and even rupture of the intestine which usually ended by death.

*** Diagnosis:**

By detection of the characteristic egg in feces, which should be confirmed by post mortem examination, as the egg of *Ascaridia* is usually confused with that of *Heterakis*.

*** Treatment:**

Treatment with piperazine salts or levamisole is best administered in drinking water.

b- Genus: *Heterakis*

* The adult worm inhabits the caeca of domestic and wild birds (fowls, turkeys, ducks and geese). It is small and whitish with long pointed tails. Males are up to 1.3 cm and the females up to 1.6 cm long.

* **Mouth** is provided with 3 lips and the oesophagus has a strong, posterior bulb. There are two narrow lateral alae extend some distance down the sides of the body.

* **Male** tail is provided with caudal alae supported by **12** pairs of the caudal papillae. A large prominent precloacal sucker is present and the spicules are **unequal**.

* **Female** posterior end is pointed, tapering and without alae, papillae or precloacal sucker. The vulva is slightly behind the middle of the body.

* **Egg** is oval with a smooth shell and is difficult to distinguish from that of *Ascaridia galli*.

*** Life cycle:**

1. The life cycle is direct. Infection occurs by ingestion of eggs containing L2 or larvae dormant in earth worms which act as a transport host.
2. The parasitic phase is non-migratory and the three parasitic moults appear to occur entirely in the cecal lumen and/or burrowing into the cecal mucosa for a short period (2-5 days), and quickly return to the lumen. The prepatent period is about four weeks.

*** Pathogenesis:**

- * *Heterakis gallinae* is the commonest nematode parasite of poultry and is usually regarded as being non-pathogenic.
- * Its chief pathogenic importance is as a vector of the protozoan parasite “**Histomonas meleagridis**” the causative agent of **Black-head disease** in turkeys.
- * The organism can be transmitted from bird to another inside the egg of *Heterakis gallinae* and in the earth worm containing hatched larvae of the worm.

2) Family: Subuluridae

Genus: *Subulura*

Subulura brumpti

Morphology:

- * Adult worm inhabits the caecum of birds. Beetles and cockroaches act as intermediate hosts. Male is upto 1 cm and the female is up to 1.4 cm long.
- * A small buccal capsule is present with three small teeth at its base. The oesophagus has a small swelling posteriorly followed by a deep constriction and a spherical bulb.
- * **Male** tail has large lateral alae and **10** pairs of small caudal papillae as well as two equal spicules.
- * **Eggs** subglobular, thin-shelled and containing L1 larva when passed in feces and measures 70 μ in diameter.

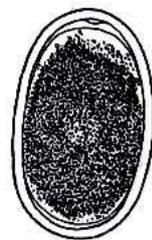
*** Life cycle:**

* Indirect life cycle where the larvated eggs containing L₁ passed in feces, ingested by the arthropod intermediate host (beetles and cockroaches).

* Inside the intermediate host, the egg hatches and L₁ released and developed to L₃ in their body cavities.

* Infection of the final host is by ingestion of the arthropod containing L₃ where there is no migration or invasion of the alimentary mucosa. The prepatent period is 5- 6 weeks.

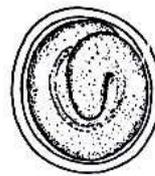
* **Pathogenesis:** In massive infections, there are inflammatory reactions in the caeca.



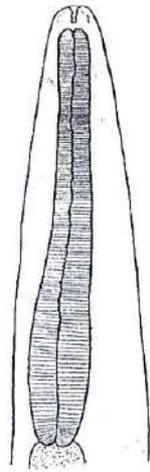
Ascaridia galli
egg



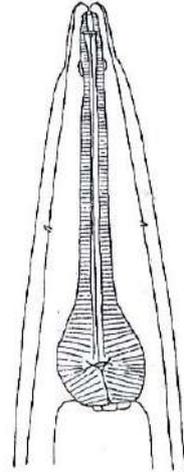
Heterakis gallinae
egg



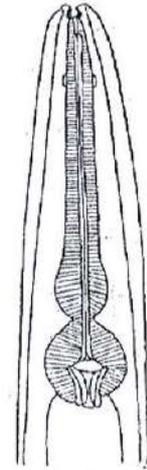
Subulura brumpti
egg



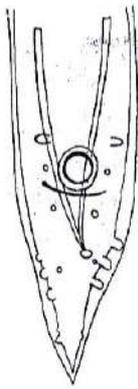
Ascaridia galli
Anterior end



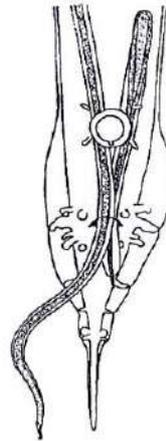
Heterakis gallinae
Anterior end



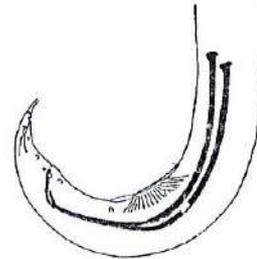
Subulura brumpti
Anterior end



Ascaridia galli
Posterior end



Heterakis gallinae
Posterior end



Subulura brumpti
Posterior end

3) Family: *Amidostomatidae*

Genus: *Amidostomum*

Spp. *A. anseris*, *A. rallich* and *A. skrjabini*

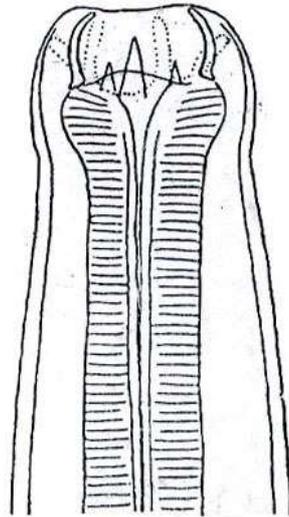
* Morphology:

* It is slender and reddish, with short and wide buccal capsule which has 3 pointed teeth at its base.

* Male measures up to 16 mm. long, while female measures up to 24 mm. long.

* The male bursa is provided with 2 large lateral lobes, small median lobe and dorsal ray is short. Spicules are equal and long.

* Vulva present in the posterior part of the body.



Amidostomum anseris
Anterior end

* **Habitat:**

The adult worms are found in the mucosa of gizzard and sometimes in proventriculus of duck, geese and pigeon.

* **Life cycle:**

* The eggs pass out in droppings of infested birds in partly developed stage. Active embryos develop within few hours and hatching takes place within few days.

* Susceptible bird becomes infested by swallowing of food or drinking water contaminated with infective double-sheathed larvae, or percutaneous through the podoves of the bird.

* Development in the final host is with or without migration. Third stage larvae are found in the glands of the tunica propria, where they reach maturity in about 40 days .

* **Pathogenecity:**

* The worms are very pathogenic to theyoung birds. The parasites burrow in the mucous and submucous tissues of the gizzard and proventriculus, sucking blood and causing marked irritation, inflammatory changes and haemorrhage.

* In severe cases, there is an extensive necrosis of the mucosa of the gizzard. Heavily infested birds lose their appetite and become emaciated, anaemic , weak and easily tired.

4) Family: Syngamidae

Genus: *Syngamus*

Spp.*S. trachae*

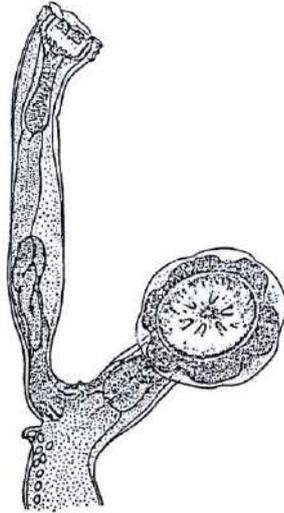
(Red lung worm, Gape-worm)

* **Morphology:**

* Adults are reddish in colour. Males measure up to 6 mm long. The male is **permanently** attached in copulation with female thus giving a **Y-shaped** appearance of the pair.

* The mouth is wide and devoid of leaf crowns. The buccal capsule is thick, cup-shaped and shallow with 6-10 small teeth in the bottom.

* The bursa and rays of the male are short, the dorsal rays is split to the base. The vulvais in the anterior third of the body. Eggs are 100 μ long x 40 μ wide, with a thickened mucoid plug at each end.



Syngamus trachea
Adult male & female

* **Habitat:**

Adult worms are found attached with inner surface of trachea of chickens and turkeys.

* **Life cycle:**

* The eggs are deposited by the female under the bursa of her continuously attached male consort escape into the trachea.

* Two moults occur and a third stage larva enclosed in both cuticular sheaths is present in 7 days.

* Hatched larvae eaten by dung-infesting earth worms, slugs and maggots of Diptera such as house flies. They burrow through the intestinal wall and encyst in the tissues or remain free in body cavity (paratenic host).

* Birds become infested by swallowing the embryonated eggs or larvae with contaminated food or by eating any of the parasitized paratenic hosts.

* The larvae liberated from paratenic hosts in the gut of the birds, burrow into the wall, enter the venules of the hepatic portal vein, and are carried forward through the liver and into the lungs.

* They leave the vessels of the pulmonary vein for the air sacs, where the third moult occurs by the third day and a fourth stage larva with developing buccal capsule appears.

* A week after infestation, the final moult has occurred and immature adults migrate in the air passage to reach the trachea, by the 7th day of infection, where they are ready to copulate and attach the tracheal mucosa.

* The prepatent period ranged between 18 – 20 days.

Pathogenicity:

* The effect of *S. trachea* is most severe in young birds, where migration through the lungs may cause pneumonia and death.

* In less severe infections, adult worms cause a haemorrhagic tracheitis, excessive mucous production that may lead to partial obstruction of the air passages with subsequent difficult breathing.

5) Family: Trichostrongylidae

Genus: *Trichostrongylus*

Species: *T. tenuis*:

Habitat: Occurs in the caecum of chicken & other domestic birds.

Morphology:

* These are thin hair-like small worms of pale reddish brown colour.

* Buccal capsule is ill-defined. The bursal formula: ventral rays are separated and dissimilar, the ventro-ventral being thin, latero-ventral one is thick and parallel to laterals.

*The postero-lateral ray is divergent and lying close to the externo-dorsal one. The dorsal ray is cleft near its tip and each branch has two terminal digitations.

* Spicules are short and accessory piece or gubernaculum is present. The vulva usually has a prominent flap.

*** Life cycle:**

* Life cycle is direct and non-migratory.

* The preparasitic phase is typically trichostrongyloid where the development from the egg to the infective L3 takes 1-2 weeks.

* Infection by ingestion of the infective sheathed L3 which exsheathed in the abomasum.

* The larvae penetrate deeply between the intestinal villi (in intestinal species) or abomasal glands (in stomach species), where they do the last two parasitic moults (L4 and L5).

* The young adults emerge onto the mucosal surface where they become mature and copulate. The prepatent period in animals is about 3 weeks, while it is 10 days in birds.

6) Family: *Trichuridae*

Genus: *Capillaria*

Morphology:

* These are very thin, hair-like worms which are not readily visible by the naked eyes in unprepared gut contents.

* Although many species occur in mammals and birds, those infesting birds are of general veterinary significance.

* The life cycle being direct in some species, while others have indirect one.

a) *C. obsignata*

The adult worms inhabit the small intestine and caecum of chickens, turkeys, geese and pigeons.

*** Life cycle: (direct life cycle)**

* The first larval stage developed in eggs at the exterior.

* Infestation of the host takes place by eating egg containing 1st larval stage.

* Hatching the 1st larval stage takes place in the host.

* Worms reach maturity in about 18 days.

* **Pathogenicity:** Emaciation and diarrhea, hemorrhagic enteritis.

b) C. caudinflata

The adult worms are found in the mucosa of small intestine of chickens, turkey, geese and pigeons.

* **Life cycle:**

The infective stage developed in earthworms. The intermediate host containing the infective stage is eaten by the final host (birds).

IV) Arthropods of poultry:

Order: Phthiraptera (Lice)

B) Suborder: Mallophaga (Biting lice)

Morphology:

* They are very small 1-5 mm long, wingless, dorsoventrally flattened and the head is broader than long. The mouthparts adapted for chewing or biting.

* They eat feathers and epidermis, but very few of them suck blood. The antennae are short (3-5 segments).

* Meso- and metathorax are fused to form one piece. There is one pair of spiracles on the ventral surface of mesothoracic segment.

* The tarsi of species parasitize on birds have two claws, while those parasitic on mammals have one claw.

* The abdomen reaches about 11 segments of which only nine are visible. The abdomen bears 6 pairs of spiracles at the outer margin of the first six segments.

* They are permanent ectoparasites.

* Metamorphosis is incomplete (Hemimetabolate).

*** Common species of birds:**

1- *Menopon gallinae* (shaft louse of poultry):

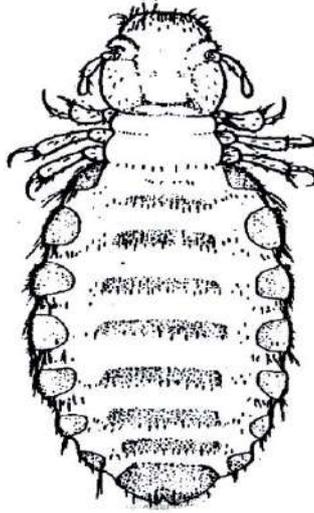
It occurs on fowls, ducks and pigeons. It is small (male is 1.7 mm and female is 2 mm in length). Each of the thoracic and abdominal segments has one dorsal row of bristles. The eggs are laid in clusters on the feathers.

2- *Menacanthus stramineus* (yellow body louse of poultry):

It occurs on the skin of fowls and turkeys. It is somewhat bigger than the other species (male 2.8 mm, female 3.3 mm long). Each of the abdominal segments has two rows of bristles. The eggs have characteristic filaments on the anterior half of the shell and on the operculum and they are laid in clusters on the feathers near the skin and sometimes around the cloaca.

3- *Columbicola columbae* (slender pigeon louse):

These lice feed on the barbules of the feathers always near the proximal end. Adults are commonly found on flight feathers of the wings and nymphs are found on the feathers on the back of the head of pigeons



Damalinia spp.
Biting lice

Order: Acarina

{1} Suborder: Mesostigmata

Genus: *Dermanyssus*

Spp.: *Dermanyssus gallinae*

(Chicken mite or red mite of poultry)

It affects poultry and many other birds. The eggs are laid near the nests. The eggs hatch in two days. The non feeding larvae moult to the protonymphal stage within 2 days. Both protonymphs and deutonymphs require blood meals. Adults are usually nocturnal feeders, hiding by day in cracks and crevices near host birds.

* **Medical importance:**It produces anaemia, irritation and transmit fowl Spirochaetes.

{2} Suborder: *Sarcoptiformes*

Family: *Sarcopotidae*

a) Genus: *Notoedres*

Notoedres cati

This type of burrowing mites is closely related to *Sarcoptes* but it has more restricted host range (cats and rabbits). Morphologically, it could be distinguished from *Sarcoptes* by the presence of concentric thump print striations on dorsal surface and the absence of spines. Also, females on the host are characteristically found aggregated in groups known as “nests”. Severe cases are noted on the face and head of rabbits.

b) Genus: *Cnemidocoptes*

This is the burrowing mite of domestic birds.

1) *Cnemidocoptes mutans* (Scaly leg in poultry):

It affects the skin of legs (under the leg scales) causing the leg scales to loosen and rise. The leg shafts and toes become rough and thickened due to scale and crust formation which is accompanied with lameness and distortion of the feet and claws.

2) *Cnemidocoptes gallinae* (Depluming itch in poultry):

This mite burrows into the feather shafts causing itching and inflammation. The feathers break off readily and easily pulled by the birds especially at the neck and wings.

3) *Cnemidocoptes pilae* (Scaly face in cage birds):

It attacks the bare and lightly feathered areas including the back, head, neck, inside the wings, legs and feet. It causes little pruritis and lesions developed slowly, over a number of months.

3} Suborder: *Ixodoidea* (Soft ticks)

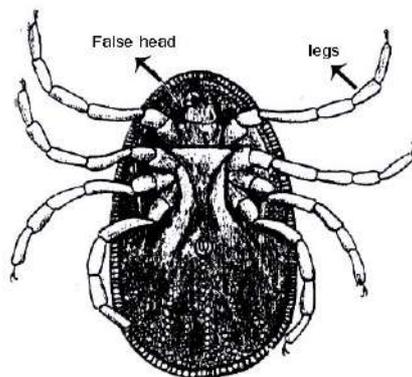
Family: *Argasidae* (Soft ticks)

Morphology:

- * They are temporary ectoparasites on birds and mammals unless the larval stages are permanent under the bird wings.
- * The integument of all stages except larvae, is leathery, wrinkled, granulated, mammillated or covered with tubercles.
- * The dorsal body surface is ornamented with radial arranged discs. In nymphs and adults, the capitulum is not visible from the dorsal view, being situated anteriorly on the ventral surface. When eyes are present, they are lateral in position in folds above the legs, but usually absent.
- * The stigmata are small and placed anterior to the coxa of the 4th pair of legs. Sexual differentiation between male and female is difficult.
- * The adults and nymphal stages feed during night and hidden under the stones, in cracks, and bedding during the day.
- * The females feed several times and produce several egg batches. The eggs are large in size and few in number.

a) Genus: *Argus* (Bird ticks)

Argas persicus (ticks of chickens) and *Argas reflexus* (ticks of pigeons)



Argas spp. adult

* **Life cycle:**

* The females lay their eggs in cracks, crevices, under the stones, between the wall and the door, or in bedding of poultry houses or under the bark of trees.

* The females feed several times during egg laying. The eggs are yellowish brown & spherical. These eggs hatch to produce larvae (circular outline, subterminal mouth parts visible from above and no stigmata).

* The larvae attach themselves to the host, particularly under the wing, where they feed for about a week. The larvae fall off the host and have a period of inactivity before moulting to become nymphs.

* There are two to four nymphal stages before the adult. Adults and nymphs are nocturnal. The unfed adult tick is pale yellow in color, becoming darker when fed. In outline, the body is oval to pear-shaped being broadest behind the legs at about the level of the anus.

* **Medical importance:**

1- They irritate the birds, suck the blood and decrease their production.

2- They produce tick-paralysis in birds.

3- They transmit fowl *Aegyptianella pullorum* and Spirochaetes.

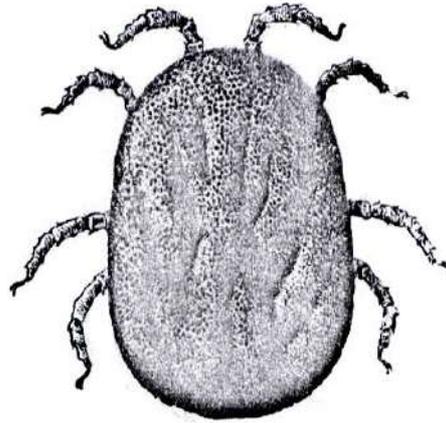
b) Genus: *Ornithodoros*

(Mammals ticks)

Ornithodoros moubata* and *Ornithodoros savignyi

(Eyed or sandy tampon)

These two species have become associated with man and/or domestic animals (mammals). They live in cracks or wells and in the earth floors. During the day they hide away in dark locations. The integument bears mammillae.



***Ornithodoros moubata* adult female**

* **Life cycle:**

* The adult females lay eggs in batches. The eggs are large, spherical, glistening and golden yellow.

* The eggs hatch in about 8 days at 30°C to larvae. These larvae did not feed and remain motionless until they moult into nymphs four days later.

* The nymphs feed on blood tacking 20-25 min. to a full meal. After an interval, the first nymphal stage moults into the second stage which feeds and repeats the process. The number of nymphal stages is variable with adult males being produced after 4 nymphal stages and the female after five.

* **Medical importance:**

They transmit *Trypanosoma cruzi* and vectors of endemic relapsing fever caused by *Borrelia duttoni*.

V) Protozoa of poultry:

Genus: *Trichomonas*

Trichomonas gallinae

- *Trichomonas gallinae* is a cosmopolitan parasite of pigeons.
- Domestic and wild turkeys and chickens may also become infected.
- It causes disease in pigeons called **canker**.

Morphology:

- The organism is pyriform in shape, motile with four anterior flagella but no trailing posterior flagellum.
- Undulating membrane extends along the two thirds of the body.
- Single nucleus.
- Axostyle is narrow and extends a short distance posteriorly.
- Cytostome is present.

Life cycle & mode of transmission:

- *T. gallinae* present in the oral-nasal cavity or anterior end of the digestive and respiratory tracts.
- *T. gallinae* has been transmitted by direct oral transmission.
- Trophozoites are the infectious stage and reproduce by binary fission but do not form a resistant cyst. Therefore, they die quickly when passed out of the host.
- Canker (trichomoniasis) is most common condition of pigeons infecting about 80%
- *T. gallinae* considered normal oral flora in adult pigeons.
- The disease only occurring when birds are stressed.
- Trophozoites transferred from the crop of adults to squabs during feeding. Pigeon milk (regurgitated food & fat laden crop lining cells).
- Trophozoites from infected birds' oral secretion may also be transmitted via contaminated surface water and feeders.

- Poultry and turkeys can contact the disease by consuming water or food contaminated by saliva or crop secretions of infected pigeons.

Pathogenesis:

- Trophozoites invade the mucosa of the upper intestinal tract (buccal cavity, sinuses, pharynx, esophagus, crop).
- Liver and other organs are occasionally invaded.
- Raised yellow caseous lesions (cankers) first appear in mouth & spread to the upper digestive tract.
- Lesions can enlarge, become confluent & caseous material may occlude the esophagus.
- Liver lesions appear on surface as solid, white or yellow circular masses.

Clinical Signs

- Birds will have difficulty closing their mouth; they will drool & make continuous swallowing motions
- Greenish to yellow fluid appears in oral cavity or dripping from beak.
- Ruffled and emaciated appearance.

Diagnosis:

- Clinical signs & gross lesions restricted to the upper portion of the digestive tract are suggestive of trichomoniasis.
- Microscopic observation of large numbers of *T. gallinae* in direct smears from oral fluids or lesions in the mouth, crop or digestive tract is confirmatory.

Control & Treatment:

- Eliminate infected birds & suspected carriers from flock.
- Practice proper sanitation & ensure there is a source of fresh, clean water.
- Prevent pigeons from contaminating water & food supply of poultry.
- Anti-flagellate drugs - dimetronidazole & ronidazole.

c) Genus: *Tetratrichomonas*

Tetratrichomonas gallinarum

- ***Tetratrichomonas gallinarum*** is a parasite of the lower digestive tract and liver of turkeys, domestic fowls and guinea fowls.

Morphology:

- It is a pear-shaped organism, motile with four anterior flagella and a posterior flagellum, which extends behind the body.
- Axostyle is long, slender and projects from the posterior end of the body.

Transmission:

- Infection occurs by ingestion of the parasite in contaminated food and water.
- Multiplication occurs by longitudinal binary fission.

Pathogenesis and clinical signs:

- Liver lesions in turkeys (fatal enterohepatitis) are similar to that produced by *Histomonas meleagridis*. Differentiation can be done by observation of the causative parasite in a direct smear from the lesion.

Family: Monocercomonadidae

Genus: *Histomonas*

Histomonas meleagridis

Agent and host range:

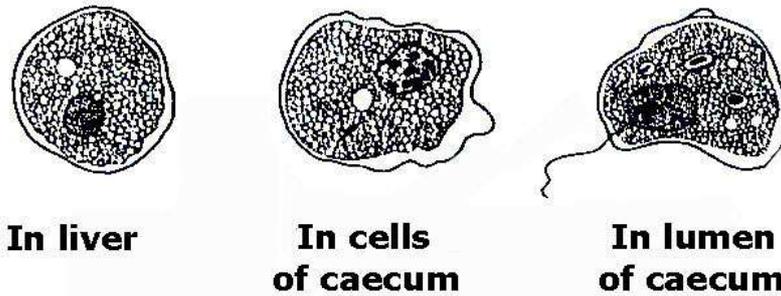
- *Histomonas meleagridis* is a **cosmopolitan** parasite affecting gallinaceous fowl (turkeys, chickens, pheasant, quail, & grouse).
- Turkeys - highly susceptible to infection & most infected turkeys die (**Blackhead disease or enterohepatitis or histomoniasis**)
- Chickens - easily infected but usually a milder form of disease.
- It inhabits the lumen of cecum and parenchyma of liver.

Site of infection: cecum & liver

Morphology:

- *H. meleagridis* is a microscopic, pleomorphic protozoan, and can exist in two forms, amoeboid and flagellated but there is no cyst form.

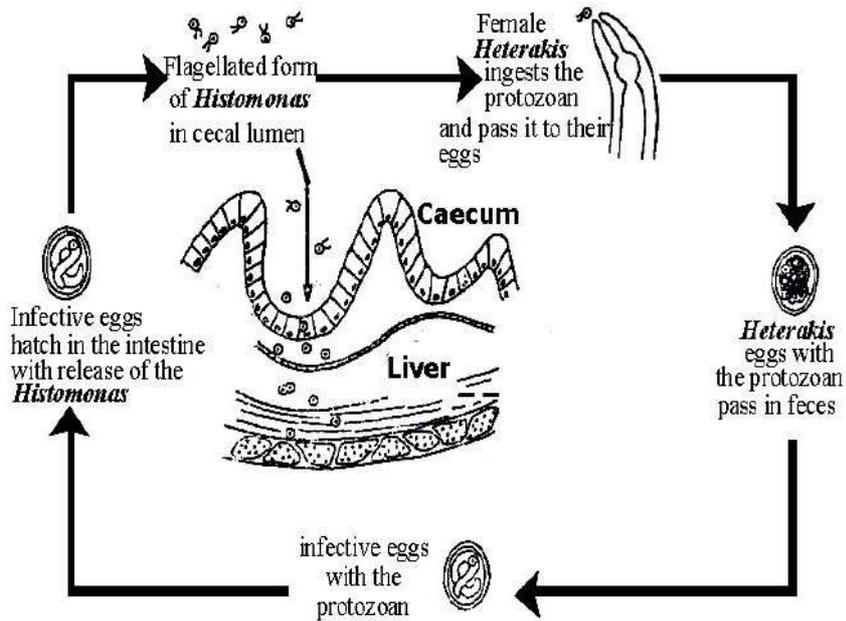
- Within the tissue, it is present as an amoeboid protozoan, while in the lumen or free in the contents of caecum, it lives as an elongated flagellated form.
- The amoeboid form is typically 8-15 μm in diameter, whereas the flagellated form can reach up to 30 μm in diameter.



Forms of *Histomonas meleagridis*

Life cycle:

- There is no cyst form, and the parasite reproduces by binary fission.
- Indirect transmission is the most common route by the cecal nematode, *Heterakis gallinae*
- Flagellated forms of *Histomonas* in the cecal lumen are ingested by *Heterakis gallinae* in which the organisms may reach the ovaries and penetrate their eggs.
- Birds become - infected by ingesting *Heterakis* eggs in soil or by eating earthworms (paratenic host of the nematode).
- By either route, *Histomonas* liberated into the intestine will penetrate the cecal wall & passes to the liver via the portal circulation.



Life cycle of *Histomonas meleagridis*

Pathogenesis:

- Disease results when *Histomonas* penetrates the cecal wall & invades the liver via the blood stream (histomoniasis).
- Cecal lesions - cecum becomes thickened (edematous) & lumen is filled with yellow caseous smelly exudate.
- Liver lesions - circular depressed focal necrosis (>bull's eye=) yellow-green with grayish peripheral areas (1-2 cm) which may coalesce to involve the entire liver, appear by approximately 10 days post infection.

Clinical signs:

- Appear 2-3 weeks post infection.
- Hunched appearance, droopy wings & tail, ruffled feathers.
- Anorexia, emaciation, weakness and depression.
- Head may (or may not) turn black or cyanotic (due to deficient oxygenation of the blood)
- Foul smelling, brilliant yellow sulfur-colored diarrhea.
- Mortality high in young turkeys (50-100%)
- Low mortality in chickens, but up to 30% have been reported in young birds.

Diagnosis:

- History of a disease in young turkeys with a high mortality rate.
- Brilliant yellow (sulfur) feces combined with the cecal & liver lesions are Pathognomonic.

Treatment & Control

- Good sanitation.
- Turkeys & chickens must be raised separately
- control *Heterakis gallinae* in birds & limit access to nematode eggs & earthworms.
- No current treatment approved - in the past, prophylactic & therapeutic treatment with nitroimidazoles (dimetronidazole, ipronidazole, and ronidazole)

Order: Diplomonadida

- Members of this order are bilaterally symmetrical and provided with 1-4 pairs of flagella. Cyst form is usually present.
- Most of species are parasitic.
- This order includes one family of veterinary medical importance.

Family: *Hexamitidae*

a) Genus: *Giardia*

- Common intestinal disease of mammals & birds found worldwide (cosmopolitan), especially in warm climates, caused by various *Giardia* species. Giardiasis is a recognized **zoonosis**.
- Often called (Beaver fever) in humans, but more likely those humans are source of infection.

Site of infection: *Giardia* inhabits duodenum & upper small intestine and attaches to the brush border of epithelial cells by a ventral sucking/adhesive disk.

Morphology:

- It has two life stages.

1) Trophozoite

- It is motile feeding stage and non-infectious.

- The trophozoite is bilaterally symmetrical, pear or pyriform to ellipsoidal in shape. The anterior part is broad and round while the posterior end is narrow and tapering. When seen from front the trophozoite looks like a tennis or badminton racket with convex dorsal surface and a ventral sucking/adhesive disk.

- It has pair of rod like axostyles down the centre of the body on the ventral surface & two median bodies.

- Approximately 12-20 μm long, by 7-10 μm wide.

- It has four pairs of flagellae emerge out from the anterior end and there is a pair of bilaterally arranged nuclei (Monkey face).

2) Cyst

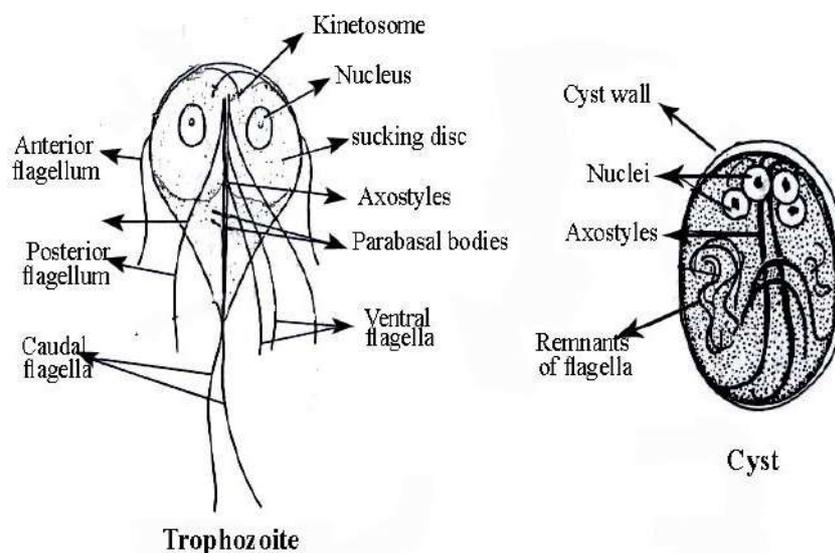
- It is the infectious stage (immediately infectious to host).

- It is environmentally resistant.

- It is oval shaped, 9-12 μm long by 7-9 μm wide.

- Internal structures are visible with light microscopy.

- It contains four nuclei (i.e. 2 trophozoites/cyst), axostyle and median bodies.



Giardia lamblia

Life cycle:

- Life cycle is simple direct, cysts ingested by the host & excystation occurs after exposure to both acid of stomach & alkaline of small intestine to release two trophozoites into duodenum.

- Trophozoites reproduce by asexual binary fission & feed & colonize small intestine.

- Severity of disease is dependent on the number of feeding trophozoites.
- Trophozoites encyst in response to increasing concentrations of bile within feces (i.e. reabsorption of water, dehydrates feces as it passes through intestine towards rectum, therefore bile concentration increases at the same time as free cholesterol decreases).
- Both cysts & more rarely, trophozoites can be passed in feces.
- Cysts resistant & survive (**infectious stage**), whereas trophozoites are fragile & die quickly (**non-infectious**)
- Shedding of cysts reach up to 10⁶ cysts per gram of feces.

• **Mode of transmission:**

- The parasite is transmitted when the cysts are swallowed along with the food, faecal contamination of drinking water and improper hygienic conditions.
- **prepatent period:** 7-10 days

Pathogenesis:

- Severity of disease dependent on dose of infection i.e. number of cysts ingested
- Trophozoites do not invade tissue (normally) but instead attach to the brush border of the mucosal epithelium of the duodenum & upper small intestine, this may lead to more severe chronic intestinal disorders.

Clinical Signs:

- Most infections are asymptomatic
- Clinical signs range from slight abdominal discomfort to severe abdominal pain & cramping, explosive watery, pale, foul-smelling diarrhea with mal-absorption.
- The parasite leads to upset of fat metabolism leading to deficiency of fat soluble vitamins.

Diagnosis:

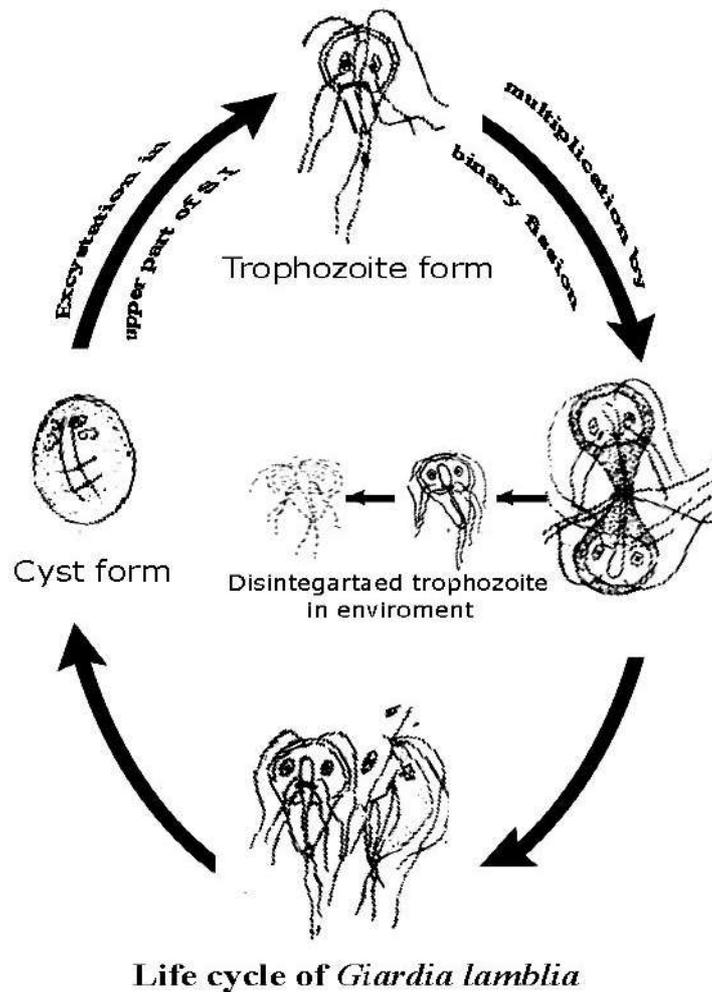
- By detection of cyst and/or trophozoite forms in diarrheic feces.

Control:

- Good hygiene & proper sanitation.
- Cysts can stick to the fur & be a source for re-infection, the positive animal should receive a bath at least once during treatment
- Disinfectants on surfaces.

Treatment:

- Treatment by fenbendazole & metronidazole.



a) Genus: *Hexamita*

- *Hexamita* is a genus of parasitic diplomonads. It is similar to *Giardia*.
- It includes three species are *H. columbae*, *H. meleagridis* and *H. muris* which are recognized in turkeys, pigeon and rodents.
- It causes disease called hexamitiasis or infectious catarrhal enteritis of birds (turkeys, pigeons, quail, pheasants, partridge, ducks & peafowl)

Morphology:

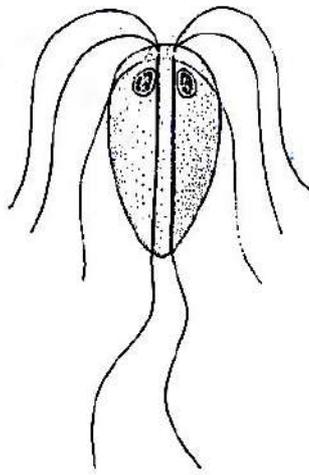
- *Hexamita* has a pyriform body with two nuclei anteriorly.
- It has two axostyles and motile with six anterior and two posterior flagella.
- The parasite able to produce cyst forms (rarely formed).

i. *Hexamita meleagridis*

- It inhabits the small intestine of turkeys.
- Infection takes place by ingestion of trophozoites or cyst form in contaminated food and/or water.
- Adult birds are symptomless and carriers, while young ones suffer from severe catarrhal enteritis associated with high mortalities.

ii. *Hexamita columbae*

- It occurs in the small intestine of pigeon causing catarrhal enteritis.



Hexamita meleagridis

Life cycle:

- Direct life cycle – trophozoites is the infectious stage, reproduce by binary fission.
- Fecal-oral route of transmission (feces containing trophozoites or cysts contaminate food or water).
- Trophozoites colonize crypts of duodenum & upper jejunum.

Pathogenesis:

- Catarrhal enteritis (inflammation of the mucous membranes).
- Results in distention of upper small intestine.
- Swollen, bulbous, liquid filled small intestine.

Clinical signs:

- Listlessness, inappetence, anorexia.
- Birds huddle together near heat source & "chirp" constantly.
- Greenish-yellow, foamy or watery diarrhea.
- Rapid weight loss due to diarrhea (dehydration).
- Affected birds that survive remain stunted.

Diagnosis:

- History, clinical signs & microscopic examination of intestinal contents.
- Trophozoites detected in freshwet mounts of intestinal contents of the duodenum

Treatment & Control:

- Remove carrier birds& disinfect buildings, feeders & waterers.
- Separate adult & young birdsor use an all-in/all-out strategy.
- Biosecurity- prevent contact between turkey poults & captive or wild birds.
- Nitroimidazoles are the most effective treatment options.

Subphylum: Apicomplexa

Subphylum Apicomplexa includes three classes of veterinary medical importance:

1. Class: Coccidia.
2. Class: Piroplasmidia
3. Class: Haemosporidia.

1. Class: Coccidia.

(1) Family: *Eimeriidae*

Genera of veterinary medical importance are:

- a) Genus: *Eimeria*.
- b) Genus: *Isospora*.
- c) Genus: *Tyzzeria*.
- d) Genus: *Cryptosporidium*.

a) Genus: *Eimeria*

The species of this genus is the cause of coccidiosis among poultry, rabbits and other animals. Most of coccidia are intracellular parasites of the intestinal tract, but few species occur in other organs as the liver and kidney. Each species is usually found in a specific location within the intestinal tract, some are found in the caecum, others in the duodenum. Some species are found above the host cell nucleus, while others are found beneath it.

Common species of chickens: *E. tenella*, *E. necatrix*, *E. maxima*, *E. mivati*, *E. mitis*, *E. brunette*, *E. acervulina* and *E. praecox*

Common species of turkey: *E. meleagridis* and *E. adenoides*

Common species of ducks and geese: *E. anatis*, *E. anseris* and *E. truncate*

Common species of rabbits: *E. stidaei*, *E. magna* and *E. perforans*

* **Life cycle:**

* It is a direct life cycle, including three successive phases; the schizogony (stage of asexual reproduction) following the infection; gametogony (stage of sexual reproduction and ended by formation of zygotes) and sporogony (formation of spores) which is the unique stage occurring outside the host.

* The infective stage is the sporulated oocyst which contains four sporocysts, each containing two sporozoites (i.e. **tetrasporocystic dizoic oocyst**). It has a double layered wall being spherical, oval or ellipsoidal in shape and varies greatly in size

according to the different species. In some species, a micropyle may be present at one pole of the oocyst and may be covered by a micropyle cap in others.

(1) Shizogony (asexual reproduction):

* Following the infection by ingestion of the infective sporulated oocysts, excystation occurs in the digestive tract and the four sporocysts are liberated. Then, sporozoites (activated by trypsin and bile) leave the sporocysts. Each sporozoite penetrates an intestinal epithelial cell, rounded up and then known as “**trophozoite**”.

* After few days, each trophozoite has divided by multiple fission to form a “**schizont**”. The latter is a structure containing a

* large number of elongated, nucleated organisms known as “**merozoites**”. This stage of development is known as “**schizogony or merogony**” which is the asexual stage of reproduction.

* When the division is completed and the schizont becomes mature, the host cell and the schizont ruptures and the merozoites are liberated into the intestinal lumen, escape to invade the neighboring cells. This stage of schizogony may be repeated and the number of schizont generations is species dependant.

(2) Gametogony (sexual reproduction):

* Following the schizogony, the stage of sexual reproduction (gametogony or gamogony) begins when the last generation of merozoites invades the intestinal epithelium and differentiate into male and female gametocytes.

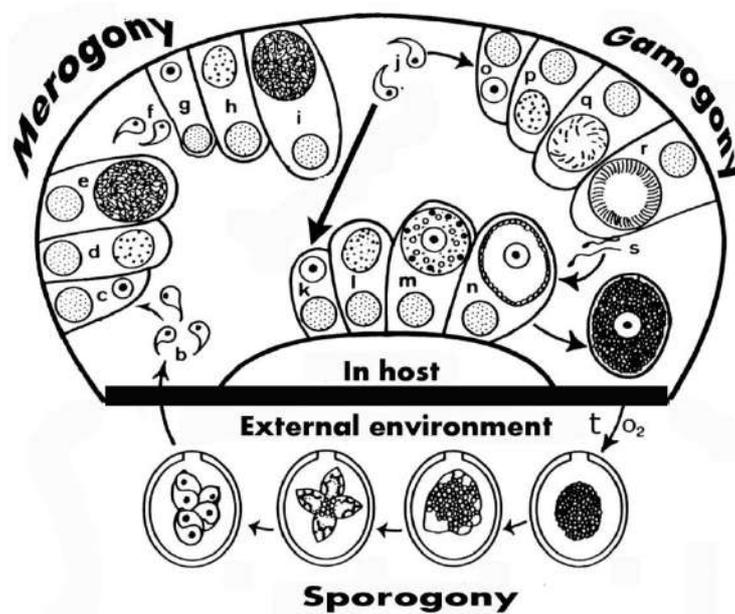
* The female gametocyte (macrogametocyte) remains unicellular but increase in size to fill the parasitized cell. It can be differentiated from the trophozoite and the developing schizonts by having a single large nucleus with a clear central karyosome and peripheral granules arranged on the inner surface of its wall. These granules will later form the inner wall of the oocyst after fertilization.

* The male gametocyte (microgametocyte) undergoes repeated division to form a large number of flagellated, nucleated organisms, the microgametes, which later liberated by the rupture of the host cell.

* Fertilization occurs when a microgamete penetrates into a macrogamete, fusion of their nuclei takes place and the zygote is formed and then known as “**unsporulated oocyst**”. There is no further development usually takes place until this unsporulated oocyst is liberated from the host’s body in the feces.

(3) Sporogony (formation of sporocysts):

* The sporulation stage begins on the ground and under suitable conditions of oxygenation, high humidity and optimal temperature of about 27°C. The nucleus divides twice followed by the protoplasmic mass resulting in four rounded sporoblasts and in some species, the remaining protoplasm forms the **oocystic residual body**. Each sporoblast secretes a wall of retractile material and becomes known as “**sporocyst**”, while its protoplasm divides into two banana-shaped sporozoites. In some species, the remaining protoplasm within the sporocyst forms a **sporocystic residual body**. So, the oocyst becomes consisting of outer double layered wall enclosing four sporocysts, each containing two sporozoites and referred to as a sporulated oocyst (**tetrasporocystic dizoic**) which is the infective stage.



Life cycle of *Eimeria* spp.

* **Pathogenesis of *Eimeria* species:**

* *Eimeria* species is the cause of a disease condition among poultry and other farm animals, commonly known as “coccidiosis”.

* Pathogenicity of coccidia depends on:

- Number of the infective dose of ingested oocysts.
- Number of the host cells destroyed.
- Location of parasite in the host tissues and within the host cells.
- Age and general condition of the animal.
- Degree of acquired and natural immunity.

* Coccidiosis is characterized by high mortality rates due to massive destruction of the epithelial cells of intestine either due to massive invasion of the infective sporozoites or rupture of cells containing schizonts or male gamonts. Clinically, there is unthriftiness and usually bloody diarrhea and/or allergic reactions due to the rupture of intestinal cells.

* **Diagnosis:**

* Coccidiosis can be diagnosed by finding the coccidial oocysts in microscopic examination.

* The presence of oocysts in the feces, even in the presence of disease signs, is not necessarily proof that the signs are due to coccidia and not to some other agent.

* Coccidia may cause severe symptoms and even death early in their life cycle before any oocysts have been produced (*E. tenella* of chicken). Consequently, failure to find oocysts in a diarrheic feces does not necessarily mean that the disease is not coccidiosis.

* The only sure way to diagnose coccidiosis, is by finding lesions containing coccidia at post-mortem. It is not enough to look for oocysts, but schizonts, merozoites and gametes inside the host cells must be sought for and recognized.

* **Treatment:** The first practical anticoccidial drugs were the sulfonamides.

b) Genus: *Isospora*

Intracellular intestinal protozoa whose life cycle is identical to that of genus *Eimeria* but differs in the process of sporulation. The mature (sporulated) oocyst contains two sporocysts, each containing four sporozoites (i.e. **disporocystic tetrazoic oocyst**). Also, in *Isospora*, extraintestinal stages in spleen, liver and lymph nodes may occur beside the intestinal stages especially in those infecting pigs. Rodents may take the infection and may act as reservoirs for dog species.

* **Habitat**: Small intestine.

* **Common species**: *Isospora gallinae*

c) Genus: *Tyzzeria*

- *Tyzzeria pernicioso*: inhabit the small intestine of ducks.

- *Tyzzeria anseris*: inhabit the small intestine of geese.

* **Life cycle**: It is similar to that of *Eimeria* sp. The sporulated oocyst contains 8 naked sporozoites (not contain sporocysts).

* **Pathogenesis**:

* There are an inflammation and hemorrhagic areas seen throughout the small intestine especially the upper half. The intestinal wall is thickened, rounded and white spots are visible through its serosal surface.

* In severe cases, the lumen is filled with blood and often contains cheesy exudates.

d) Genus: *Cryptosporidium*

* The parasite has been found enclosed in a parasitophorous vacuole, the outer covering of which is derived from the enterocyte cell membrane.

* Some organisms have been found in the stomach, bile duct, pancreatic duct, gall bladder and tonsils of various mammals. In birds, the respiratory tract, conjunctival sac, bursa and cloaca are usually involved.

* **Habitat**: Small and large intestine.

* **Species of Cryptosporidium in chickens:** *Cryptosporidium meleagridis* and *Cryptosporidium tyzzeri*.

Life cycle:

Similar to that of *Eimeria* species, but the developmental stages and formation of oocysts take place outside the cells on the **brush borders** of the host epithelial cells.

Class: Haemosporidia

Family: Plasmodidae

These are sporozoa whose development is similar to that of coccidia with a difference that the life cycle is shaded by two hosts. The schizogony cycle occurs in vertebrate host, while gametogony and sporogony occur in a blood sucking insect, invertebrate host (vector). Zygotes are motile and sporozoites are naked.

Three genera of veterinary medical importance:

- a) Genus: *Plasmodium*.
- b) Genus: *Haemoproteus*.
- c) Genus: *Leucocytozoon*.

a) Genus: Plasmodium

Avian malaria

The avian species of *Plasmodium* fall into 2 groups, depending upon whether their gametocytes are round or elongate:

(1) Species with round gametocytes:

P. gallinaceum (chicken), *P. relictum* (pigeon) and *P. cantherium* (passerine birds).

(2) Species with elongate gametocytes:

P. durae (turkeys), *P. circumflexum* (passerine birds) and *P. elongatum* (passerine birds).

* **Life cycle:**

The cycle is similar to that of other Plasmodium species of man. The exo-erythrocytic stages occur in the endothelial cells and the reticulo-endothelial cells of spleen, brain & liver.

* **Pathogenesis:**

There is an anaemia with spleen & liver enlargement. The body temperature fluctuates and the birds may become paralysed and die due to blocking of the brain capillaries by the exo-erythrocytic stages. Disease produced is chicken malaria.

b) Genus: *Haemoproteus*

Haemoproteus columbae

A parasite of domestic and wild pigeons, doves and other wild birds. Gametocytes occur in peripheral blood. Mature ones are crescent-shaped, partially encircling the nucleus of the host cell.

1) Macrogametocyte: Stained dark-blue cytoplasm with dark red compact nucleus. Pigment granules are dispersed throughout the cytoplasm.

2) Microgametocyte: Stained pale-blue to pinkish cytoplasm with pale pink and diffuse nucleus. Pigment granules are collected in polar spherical masses.

* **Life cycle:**

* Sporozoites are injected to the birds by an infected hippoboscid fly.

* The sporozoites enter the blood stream and invade the endothelial cells of the blood vessels of the lungs, liver and spleen, where they round up to form early schizonts.

* Each schizont undergoes multiple fission to form 15 or more small unpigmented bodies (cytomeres), each with a single nucleus. Each cytomere continues to grow and its nucleus undergoes multiple fission.

* Finally, the host cell becomes hypertrophied and is filled with a number of multinucleate cytomeres.

* Each cytomere produces numerous of merozoites, subsequently, the endothelial cell breaks down and the merozoites pass into the blood stream.

* Schizogony is repeated and the merozoites enter the red blood cells and become macrogametes and microgametocytes. Though multiple infections of erythrocytes with trophozoites may occur, it is rare for more than one mature gametocyte to exist in a cell. Subsequent development occurs in hippoboscids flies.

* In the stomach of the fly, the microgametocytes produce 4 or more snake-like microgametes by exflagellation.

* They fertilize the macrogametes and the resultant zygotes are ookinetes, which go to the mid-gut wall and form oocysts on its outer surface. These grow and produce large numbers of falciform sporozoites. These break out of the oocysts into the body cavity and pass to the salivary glands where they accumulate and are injected into a new host by the fly.

*** Pathogenesis:**

H. columbae is only slightly pathogenic. In heavy infections, the birds may appear restless and go off food, and anaemia may result from destruction of erythrocytes. The liver and spleen may be enlarged and dark in color.

c) Genus: *Leucocytozoon*

* Schizogony occurs in the endothelial and parenchymatous cells of liver, heart, kidneys and other organs of avian hosts.

* Gametocytes occur in circulating blood mainly lymphocytes and rarely erythrocytes.

* The mature gametocytes are elongated, oval 14-15 μ m length. Gametocytes show the same coloration as in *Haemoproteus* but pigment granules are **never** seen in their cytoplasm.

* Transmission occurs by *Simulium* sp., where fertilization and sporogony take place.

* **Species and hosts:**

Species	Host
<i>L. simondi</i>	Duck and geese
<i>L. smithi</i>	Turkeys
<i>L. caulleryi</i>	Chickens

The gametocytes are in the leucocytes and erythrocytes. Schizogony occurs in the liver, heart, lung & spleen. Invertebrate host is *Simulium* sp.

* **Life cycle:**

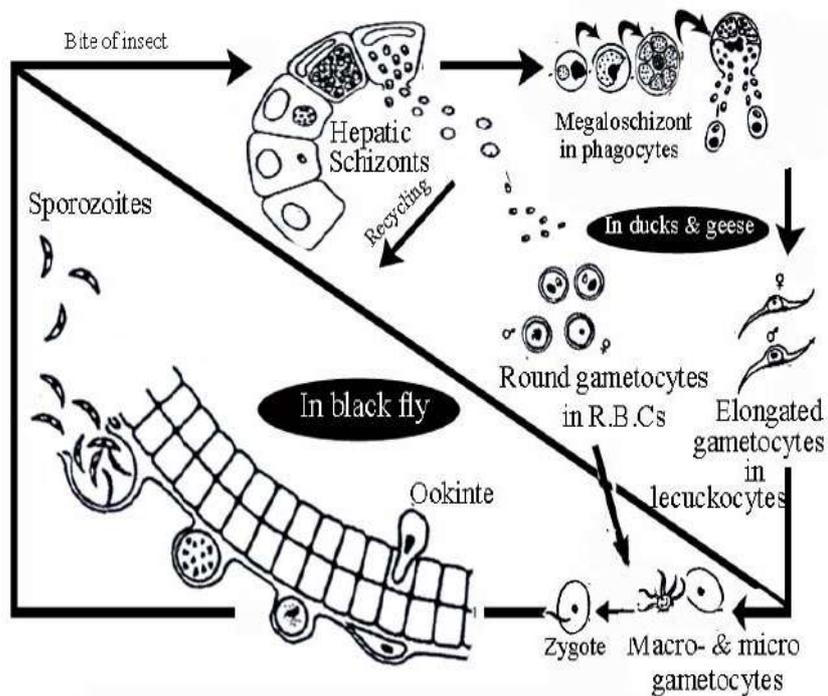
Birds become infected when bitten by a black fly vector (*Simulium* spp.). The sporozoites enter the blood stream, invade various tissue cells, and initiate schizogony. Two types of schizonts occur:

(1) Megalochizonts:

They develop in the macrophages of brain, lung, heart, kidney and intestine. They are large about 100 μ in diameter. The developmental sequence includes the trophozoite, schizont and cytomere. The last stage attains a large size due to the a great number of merozoites.

(2) Hepatic schizonts:

They develop in the macrophages of the liver and are much smaller (15 μ in diameter) than the magalochizont. They form a number of cytomeres, which in turn form small merozoites by multiple fission. The final generation of merozoites enters the blood and grow into micro- and macrogametocytes. Gametogony begins with the development of the gametocytes and their appearance in the blood. It is completed in the black flies with the formation of sporozoites.



Life cycle of *Leucocytozoon spp.*

* **Pathogenesis:**

* *L. simondi* is markedly pathogenic for young ducks and geese.

* Ducklings are restless, anorexic and show rapid breathing due to large number of megaloschizonts in the capillaries of lungs.

* The clinical signs of leucocytozoonosis are sudden in onset, the disease in older birds is less acute.