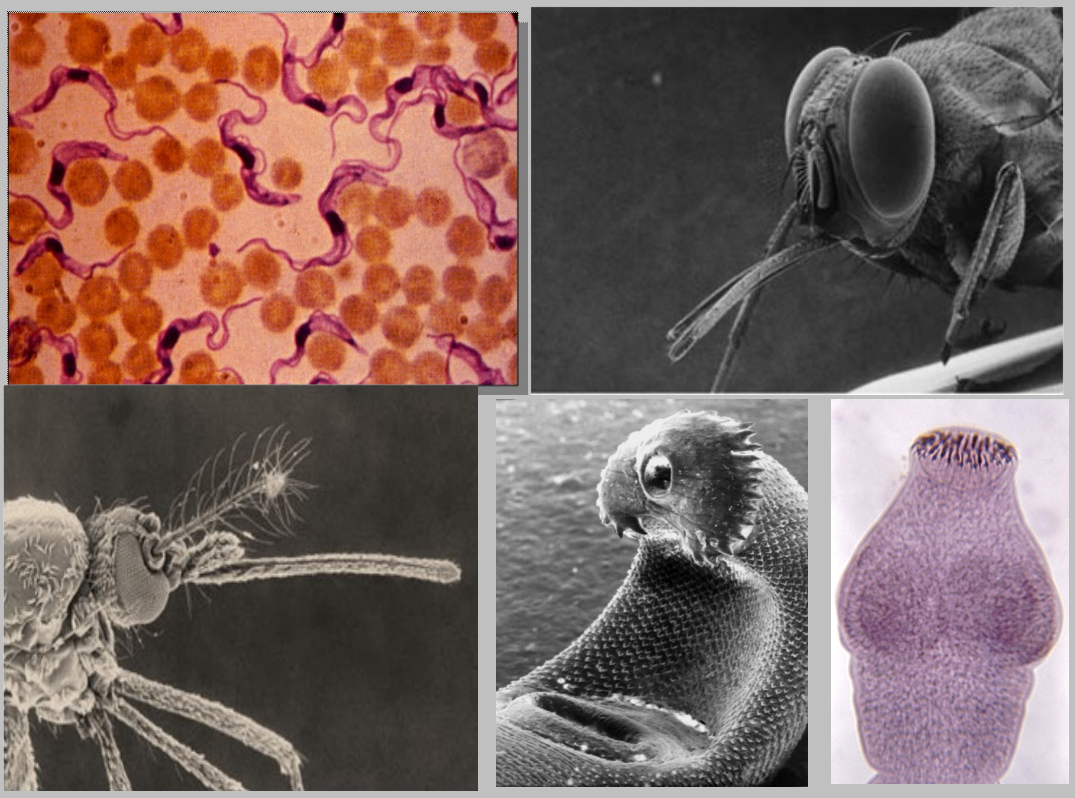
Chapter 5

General classification of Parasites, Characters of various Phyla: Protozoa, Arthropoda, Platyhelminths,Nemathelminths, Acanthocephala



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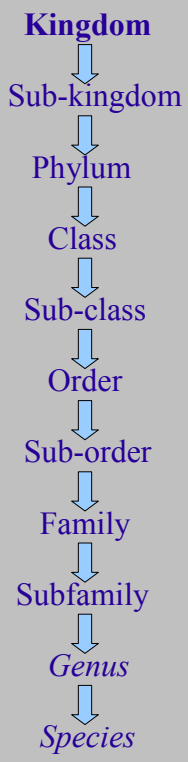
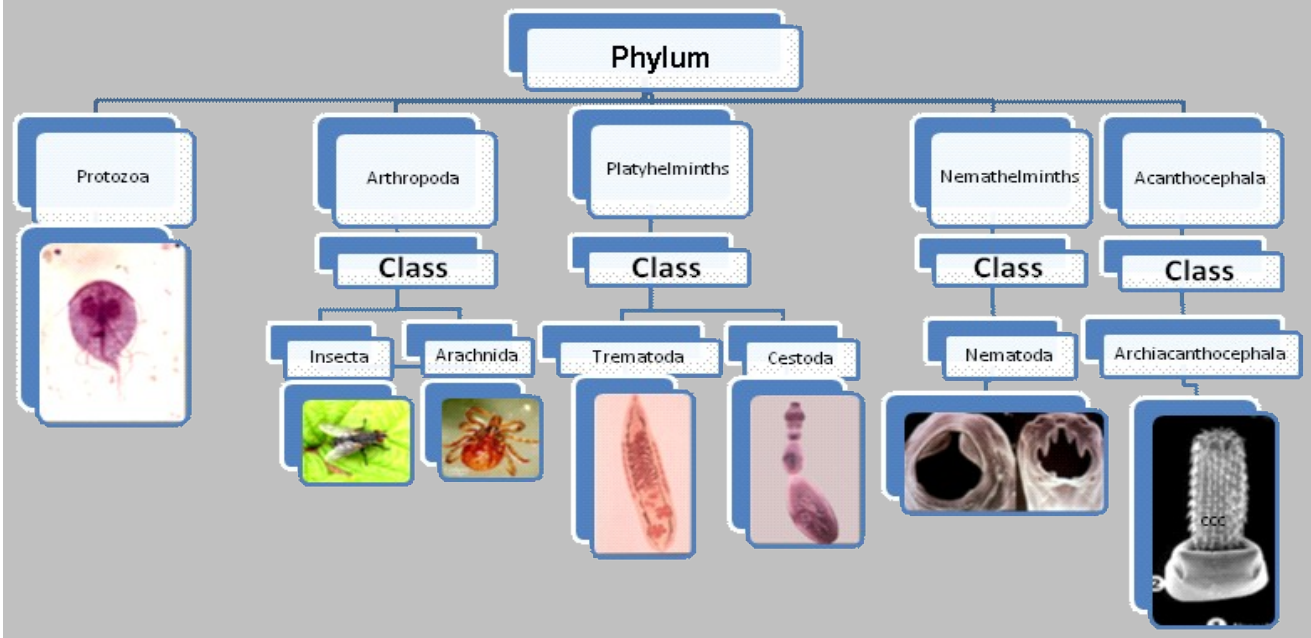
Hierarchy in classification :

Species of animals are placed under the Animal kingdom. In order to express the closeness or distant relationship of animal species, a system of classification has been developed. Very closely related species are grouped under the Genus. Closely related genera are grouped under the families. Families which are close together are grouped under Sub-order, Orders, Class, Phylum and then under the Kingdom. Following flow chart indicates the hierarchy of this classification system ;-



General classification of parasites:-

Various animal parasites are generally classified as follows:-



Character of the Phylum Protozoa

Protozoans are unicellular organisms. *Proto* means first and *zoon* means animal, hence this group of organisms are considered evolved first in the earth (Fig. 1 & Fig. 2). Within the cell, various activities of metabolism, locomotion etc. are carried out by the cell organelles. Protozoans are Eukaryotic, that means their nucleus is enclosed in a defined membrane. Usually, only one nucleus is present, however, in some forms, more than one nucleus may be present at one or all the stages of development. The cytoplasm is divided into ecto and endo plasm. The ectoplasm is a homogenous mass

and hyaline in appearance. The endoplasm contains granules, vacuoles, and sometime pigments. Protozoans move by gliding or by the help of pseudopodia, cilia or flagella. Nutrition of protozoa may be holophytic, holozoic, and saprozoic. Reproduction of protozoa may occur by asexual process i.e., binary fission, schizogony, budding, endopolygony endodyogeny, or by sexual means i.e., conjugation, syngamy, gametogony. At present more than 65, 000 species of protozoa have been identified. While majority of them are free living, nearly 7000 species are parasitic to vertebrates and invertebrates. Some of them remain as commensals. Comparatively, only a few number of protozoans have true veterinary and medical significance.

Salient differences between Protozoa and Protophyta

Protozoa	Protophyta
Protozans have a well defined nucleus	Nuclear material is scattered in cytoplasm
Protoplasms are bounded by a non –rigid cell membrane called periplast	Protophyta are bounded by a fairly rigid cell wall made of cellulose.
Protozoan nutrition is holozoic, i.e., utilize preformed food	Nutrition is holophytic, i.e., prepare their own food by the help of photosynthesis in the chloroplast
Divide longitudinally mostl, with certain exceptions like in ciliates	Divide transversely to the longitudinal axis of the body.

Classification of Protozoa

Due to the newer findings on the morphology, life cycle, cytology, electron microscopy, biochemistry etc. of the Protozoa, the classification has been constantly changed. While the relation to the gene pool of the population is based to categorize the Genera, the Species classification is based on the differences in morphology, physiology and behavioural aspects. The DNA and protein determines the validity of a species. Polysaccharides leads to Genera and lipids leads to individual species.

Some important Classes under the sub-kingdom Protozoa of veterinary importance:-

Sub-kingdom : **Protozoa** Goldfuss, 1918 emended von. Siebold, 1845

Phylum : **Sarcroastigophora** Honigberg and Balamuth, 1963

Sub-phylum : Mastigophora Diesing, 1866

Class : Phytomastigophorea Clakins, 1909

Class : Zoomastigophorea Clakins, 1909

Family	: Trypanosomtidae, Doflein, 1901,
	: Retromonadidae, Grasse, 1952
	: Hexamitidae Kent, 1880
	: Monocercomonadidae Kirby, 1947
	: Trichomonadidae Kirby, 1946
Subphylum	: Sarcodina Schmarda 1871
Order	: Amoebidae Ehrenber 1830
Family	: Endamoebidae Calkins, 1926
Phylum	**: Apicomlexa Levine 1970**
Class	: Sporozoea Leukart, 1879
Sub-class	: Coccidia Leukart, 1879
	: Piroplasmida Levine, 1961
Phylum	**: Microspora Sprague, 1977**
Class	: Microsporea Delphy, 1963
Phylum	**: Ciliophora Doflein, 1901**
Class	: Kinetofragminophorea, de Puytorac et al., 1974

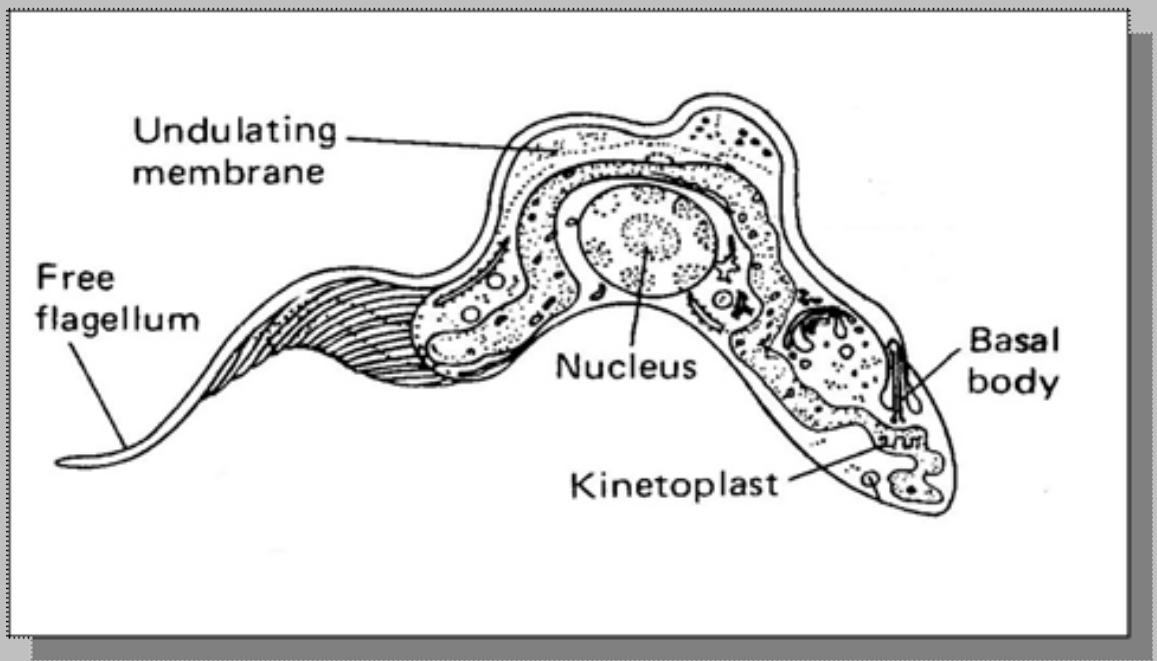


Fig. 1 . Structure of a heamoprotozoan parasite, *Trypanosoma* species

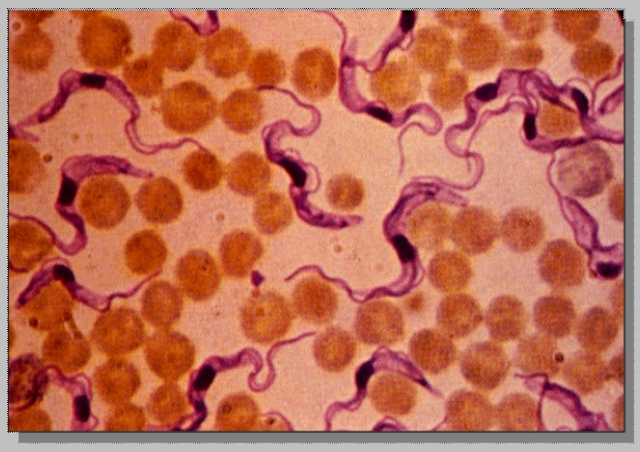


Fig. 2 . Photomicrograph showing Typanosomes in the blood smear of a patient

Character of the Phylum Arthropoda

The word arthropoda is derived from the Greek word *arthros* which mean jointed and *podos* means legs. Hence the members of this Phylum are characterized by the possession of jointed legs. The Phylum arthropoda contains a vast number of diversified species. At least 8,00,000 species have been described by now. It is estimated that, species under this Phylum contains about 80% of the all known animals of earth. Arthropods body is covered by an exoskeleton which is made of chitin (Fig. 3). Generally, the body is divisible into head, thorax and abdomen. Thorax has three segments and the abdomen is composed of 11 segments. There is no body cavity in arthorpods but it has a heomocele. The developmental stages are egg, larva, pupa and adult that occurs through a process known as moulting or ecdysis. Appendages on the body are paired. Alimentary canal is divided into stomodaeum, mesenteron, and proctodeum. In different groups the respiratory organs are modified to take the forms of gills, trachea, gill books, and lung books. Nervous system components are cerebral ganglion, circum-oesophaeal commissures and nerve cords. Generally arthropods are unisexual.

Some important Classes under the Phylum Arthoropoda of veterinary importance:-

Phylum	**: Arthropoda**
Class	: Crustacea Lamark, 1815
Sub-classes	: Entomostraca Muller, 1785
	: Malacostraca Laterille, 1802
Class	:Myriapoda Lankester, 1904
Class	: Insecta Linnaeus, 1758
Class	: Arachnida Lamarck, 1815
Class	: Pentastomida Heymons, 1926

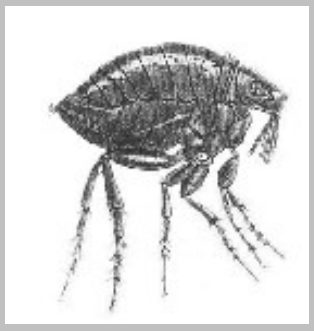


Fig. 3. Showing an arthropod specimen, flea (***Tunga penetrans***)

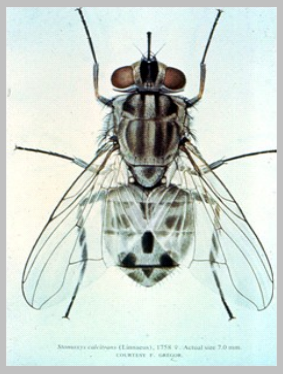


Fig. 4. Showing an arthropod specimen , fly

Meaning of Helminth:

The word **helminth** is derived from the Greek words *helmins* or *helminthos*, which means a **worm**. The word **helminth** or **worm** is generally applied only to the parasitic or non-parasitic species which belongs to the phylum **Platyhlminths** (this phylum includes trematdoes or flukes, eg. *Fasciola gigantica* and cestodes or tape worms eg., *Taenia solium*) and **Nemathelminths** (this phylum includes nematodes or round worms eg., *Ascaris suum*)

Characters of Phylum Platyhelminths:

Platyhelminths have a dorsoventrally flattened body. They have no body cavity. Their internal organs are embedded in tissues called parenchyma. The same specimen contains both the male and female reproductive organs, for which they are called hermaphrodites. The unit of excretory system in plathyhelminth is known as flame cells. They possess no respiratory and blood vascular system. Most of the organisms are parasitic. The life cycle of platyhelminths are indirect, i.e., to complete their life cycle, the platyelminths require at least one intermediate host.

The Phylum Platyhlminths have our Classes under it. They are:-

1. Class: **Turbellaria**
2. Class: **Trematoda**
3. Class: **Eucestoda**
4. Class : **Cotyloda**

1. Class: Turbellaria

Commonly known as eddyworms, helminths of this class are chiefly non-parasitic species which live in fresh water, sea or land, the body is covered with cilia, have no veterinary parasitological importance.

2. Class: Trematoda

Trematodes are commonly known as flukes. They have an alimentary system.

Characters of the Class Trematoda

Bodies of the trematodes or flukes are dorsoventrally flattened. They are

unsegmented and leaf like in appearance. Trematodes do not have a body cavity and the internal organs are embedded in a parenchyma. They have some adhesive structures known as suckers with which they attach the internal organs of their hosts. They have a mouth which leads to a muscular pharynx, oesophagus and an intestine that divides into two branches (in some species, the branching may be very high and complex) and ends into two blind sacs. Trematodes have no anus and digestive system is incomplete. The unit of excretory system in trematode is known as flame cells. Ducts arise from the flame cells unite to form a common excretory duct leading to an excretory bladder which opens posteriorly. The reproductive system of trematode is hermaphroditic except in the Family Schistosomatidae in which the sexes are separate. The life cycle pattern varies in different sub-classes i.e., direct in Monogenea, and indirect in Digenea. The Class Trematoda has three Subclasses, i.e., i) Monogenea, ii) Aspidogastrea and iii) Digenea.

Characters of the Sub-class Monogenea

Species under this Sub-class are ecto-parasites to cold blooded aquatic vertebrates like fish, amphibians and reptiles. Life cycle is Direct, requires no intermediate host. Have no veterinary parasitological significance.

Characters of the Sub-class Aspidogastrea

Species under this Sub-class are parasitic to fishes, turtles, mollusca and crustaceans. Have no veterinary parasitological significance.

Characters of the Sub-class Digenea

The shape and size of Digenean trematode varies in species that belongs to different Families. In general they are dorsoventrally flattened and leaf like (Fig. 5). In the Family Schistosomatidae, the worms are long, thin and hair like. Body is covered by a thin membrane, known as tegument. In some specimen, the tegument is spiny. Tegument is a metabolically active structure. Digenetic trematodes have two organs of attachment known as suckers. Usually, the anterior sucker is placed at the anterior part of the body. The position of posterior sucker varies in different species. The posterior sucker is also known as acetabulum. They have an incomplete digestive system. It starts with mouth that leads to a pharynx, oesophagus and then it divides into two and then runs posteriorly which ends as blind caeca. In some forms, each intestinal caeca may again divide and sub-divide into a complex caecal branching. Anus is absent. The unit of excretory system is known as flame cells. Ducts arising from flame cells unite to form a common duct that leads to an excretory bladder which opens posteriorly. They have a primitive nervous system, sense organs are absent in adults, the larval stages have patches of pigment known as eye spots in the anterior part of the body. Digenetic trematodes are in general heprmaphrodites, except in the Family Schistosomatidae , where the sexes are separate(Fig.6). All the Digenetic trematodes have indirect life cycle, i.e., they require at least one

intermediate host to complete their life cycle. The stages in the life cycle of Digenetic trematodes are egg, miracidium, sporocyst, redia, crcaria, metacercaria and adult. Have profound veterinary parasitological significance.

Fig. 5. Two digenetic trematodes, *Fasciola hepatica*(left); *Fasciola gigantica* (right)

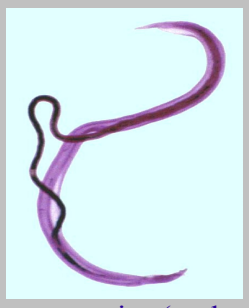


Fig. 6. *Schistosoma* species (male and female)

Some important genera under the Digenea of veterinary importance:-

Suborder	: Prosostomata Odhner, 1905
Family	: Dicrocoellidae , Odhner, 1911
Genus	: *Dicrocoelium* Dujardin,1845
	: *Eurytrema* Looss, 1899
Family	: Fasciolidae Railliet, 1895
Genus	: *Fasciola* Linnaeus, 1758
	: Fasciolides Ward 1917
	: Fasciolopsis Looss, 1899
Family	: Prosthogonimidae Nicoll, 1924
Genus	: *Prosthogonimus* Luhe , 1899
Family	: Opisthorchidae Braun, 1901

Genus	: *Opisthorchis* Blanchard, 1895
	:*Clonorchis* Looss, 1907
	: *Metrorchis* Looss 1899
Family	: Paragonimidae Dollfus, 1939
Genus	: *Paragonimus* Braun, 1899
Family	: Paramphistomatidae Fischoeder, 1901
Genus	: *Paramphistomum* Fischoeder, 1901
	:*Cotylophoron* Stiles and Goldberger, 1910
	:Calicophoron Nasmark, 1937
	:*Ceylonocotyle* Nasmark, 1937
	:Gignatocotyle Nasmark, 1937
	: *Gastrothylax* Poirier, 1883
	:Fischoederius Stiles and Goldberger, 1910
	:Carmyerius Stiles and Goldberger, 1910
	:Gastrodiscus Leuckart, 1877
	: *Gastrodiscoides* Leiper, 1913
	: *Pseudodiscus* Sonsino, 1895
Family	: Schistosomatidae Poche, 1907
Genus	: *Schistosoma* Weinland, 1858
	:Ornithobilharzia, Odhner, 1912
	:Bilharziella Looss, 1899
	:Heterobilharzia Price, 1929
	:Bivitellobilharzia Vogel and Monning, 1940
	:Austrobilharzia Jhonston, 1917
	:Gigantobilharzia Odhner, 1910
	:Trichobilharzia Skrjabin and Zakharow, 1920

3. Class: Eucestoda

They are the true tapeworm, have no alimentary canal and body cavity, nutrients are absorbed through the body covering, known as tegument. Body is flat, long ribbon like (Fig.7). The length may vary from few millimeter to several meters. The entire body may be divided into i) head or scolex ii) neck and iii) strobila. The **scolex** (head) usually contains a) four suckers, which may contain hooks or may not contain hooks and b) a rostellum at the anterior tip , which may also contain hooks or

may not contain hooks. Neck joins the scolex with strobila (body). The strobila is composed of a number of segments also known as proglottids. The stroblia has a) immature, ii) mature and iii) gravid proglottids. Each mature segment or proglottid contains at least one set of both male and female reproductive organs, hence, Eucestodes like Trematodes are hermaphrodites. The life cycle of Eucestodes are indirect, ,i.e., they require at least one intermediate host to complete their life cycle.

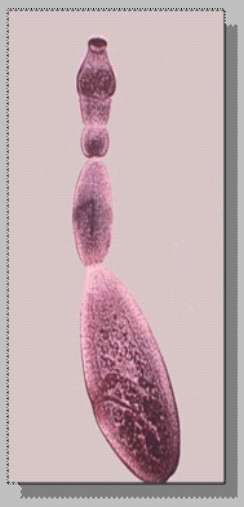


Fig.7. Example of an Eucestodan tapeworm *Echinococcus granulosus*

Some important genera under the class Eucestoda of veterinary importance :-

Class : Eucestoda Southwell , 1930

Order : Anoplocephalidea Wardle, McLeod and Radinovsky, 1974

Family: Anoplocephalidae Blanchard, 1981

Genus : *Anoplocephala*, Blanchard, 1848

:*Paranoplocephala*, Luhe, 1910

: *Moniezia*, Blanchard, 1891

Family: Thysanosomidae Fuhermann, 1907

Genus: *Avitellina*, Gough, 1911

: *Stilesia*, Railliet, 1893

:*Thysanosoma* Diesing, 1835

Order : Davaineidea Wardle, McLeod and Radinovsky, 1974

Family:Davaineidae Fuhrmann, 1907

Genus : *Davainea* Blanchard, 1891

: *Raillietina*, Fuhrmann, 1920

: *Cotugnia* Diamare, 1893

Order : Dilepididea Wardle, McLeod and Radinovsky, 1974

Family : Dilepididae Railliet and Henry, 1909

Genus : *Amoebotaenia* Cohn, 1900

Family : Dipylidiidae Wardle, McLeod and Radinovsky, 1974

Genus : *Choanotaenia* Railliet, 1896

: *Dipylidium* Leuckart, 1863

: *Metroliasthenes* Ransom, 1900

Order : Hymemolepididea Wardle, McLeod and Radinovsky, 1974

Family : Hymemolepididae Railliet and Henry, 1909

Genus : *Hymemolepis* Weinland, 1858

Order : Taeniidea Wardle, McLeod and Radinovsky, 1974

Family : Taeniidae Ludwig, 1886

Genus : *Taenia* Linnaeus, 1758

:*Echinococcus* Rudolphi, 1801

4. Class: Cotyloda

Previously, this group of worms was known as Cestodaria, or Pseudophyllidea which now includes some new orders. Scolex in unarmed and bears bothria (Fig.8). Genital pore of the species usually open mid ventrally. They are mostly parasitic in fishes, some of them are found in domestic animals and human being

Fig.8. Example of a Cotyloda tapeworm , bothria (= Scolex of Eucestoda) of *Diphyllobotrium latum*

Some important genera under the class Cotyloda of veterinary importance :-

Class	**: Cotyloda,** Wardle, McLeod and Radinovsky, 1974
Order	**:** Diphyllidea Wardle, McLeod and Radinovsky, 1974
Family	: Diphylobothriidae Luhe, 1910
Genus	: *Diphylobothrium* Luhe, 1910
	: *Spirometra* Mueller, 1937

Characters of Phylum Nemathelminths:

Worms of this phylum have a cylindrical body with tapering ends. Unlike, Platyhelminths, sexes are separate in Nemathelminths. This Phylum contains three Classes :-

1. Class : **Nematoda**
2. Class : **Nematomorpha**
3. Class : **Acanthocephala**

1.Class : Nematoda

Nematodes are commonly known as round worms. They have tapering body ends. Body

is not metamerically segmented. Body is covered with a membrane known as cuticle which may undergo a great modification depending upon different species. The cuticle covers the hypodermis and the layers of muscle cells. Nematodes have an alimentary canal, which starts at one end of the body as mouth, runs posteriorly as esophagus, and then through the cylindrical body and ends in an anus at some distance from the other end of the body. The portion of the body between the position of anus to the tip of the body is known as tail. In between the muscles cells and the alimentary tract, there is a space filled with some fluid known as perienteric fluid. There are lateral canals in the body wall and glands which are regarded as excretory organs. They have no flame cells like that in trematodes. They are unisexual. Life cycle may be direct, i.e., do not require an intermediate host or indirect , i.e., require at least one intermediate host. They are parasitic to domestic animals and birds. The class Nematoda has two sub-classes, i.e., i) Secernentia (formerly Phasmidia) and ii) Adenophorea (formerly Aphasmidia)

Characters of the Sub-class Secernentia (Phasmidia):

Species under this sub-class has phasmids in their body. They have cervical and caudal papillae (sensory structures). They contain a caudal ala (wing like expansion of the cuticle) or bursa (a modification of the cuticle in the posterior part of male specimens which facilitates copulation). They have excretory canals(Fig.9).

Some important Family under the sub-class Secernentia (Phasmidia) of veterinary importance :-

Phylum	: Nemathelminths Schneider, 1873
Class	: Nematoda Rudolphi, 1808
Sub-class	: Secernentia Dougherty, 1958
Order	: Ascaridida Skrjabin and Schulz, 1940
Superfamily	: Ascaridoidea Railliet and Henry, 1915
Family	: Ascarididae Baird, 1853
Superfamily	: Oxyuroidea Railliet, 1916
Family	: Oxyuridae Cobbold, 1864
Superfamily	: Subuloroidea Travassos, 1930

Family : Heteakidae, Railliet and Henry, 1924

Order : Rhabditida Chitwood, 1933

Superfamily : Rhabditoidea Travassos, 1920

Family : Strongyloididae Chitwood and McIntosh, 1934

Order : Strongylida Molin, 1861

Superfamily : Strogyloidea Weinland 1958

Family : Strongylidae Baird, 1853

: StephanuridaeTravassos and Vogelsang, 1933

: Syngamidae Leiper, 1912

Superfamily : Ancylostomatoidea Chabaud, 1965

Family : Ancylostomatidae Loss, 1905

Superfamily : Tricchostrongyloidea Cram, 1927

Family : Trichostrongylidae, Leiper, 1912

: Dictyocaulidae Skrjabin, 1941

Superfamily : Metastrongyloidea Lane, 1917

Family : Metastrongylidae Leiper, 1908

Order : Spirurida Chitwood, 1933

Superfamily : Spiruroidea Railleit and Henry, 1915

Family : Spiruridae Oerley, 1885

: Thelazidae Railiet, 1916

Superfamily : Filaroidea Weinland, 1958

Family : Failaridae Claus, 1885

: Setaridae Skrjabin and Schikhobalova,1945

: Onchocercidae Chabaud and Anderson, 1959

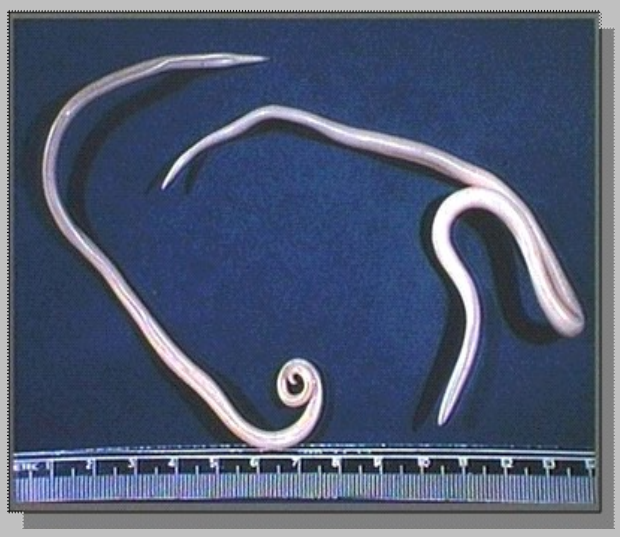


Fig.9. Example of Secernentia, *Ascaris lumbricoides* (large round worm of human being)

Characters of the Sub-class Adenophorea (Aphasmidia) :

Species under the sub-class Adenophorea (Aphasmidia) have no phasmids. Oesophagus is cylidrical. Caudal papillae are absent. Eggs of the parasite has plugs at both the ends with an unsegmented embryonic mass inside(Fig.10).

Some important Family under the sub-class Adenophorea (Aphasmidia) of veterinary importance:

Phylum	: Nemathelminths Schneider, 1873
Class	: Nematoda Rudolphi, 1808
Sub-class	: Adenophorea Chitwood 1958
Order	: Enoplida Schuurman, Stethoven and Delenerz, 1933
Superfamily	: Trichuroidea Railliet 1916
Family	: Trichinellidae Ward, 1907
	: Trichuridae Railliet, 1915
	: Capillaridae Neveu-Lemaire,1936
Superfamily	: Dioctophymatoidea Railliet, 1916
Family	: Dioctophymatidae Railliet, 1915

Fig. 10. Example of Adenophorea (*Trichuris trichuria* , human source)

Class :Nematomorpha

Worms of this class is known as hair worms or Gordiacea. Neither the adults, nor the larvae of these worms are parasitic to domesticated animals.

Class: Acanthocephala

Acanthocephalans are also known as thorny headed worms. They have a cylindrical body with thick body covering. They have a retractable proboscis at one end of the body covered with spines. Alimentary canal is absent. They have flame cells. The sexes are separate and the life cycle is indirect , i.e., requires at least one intermediate host.

Important genera under the class Acanthocephala of veterinary importance:

Class	: Acanthocephala Rudolphi, 1808
Order	: Archiacanthocephala Meyer, 1931
Family	: Oligacanthorhynchidae Meyer, 1931
Genus	: *Macrocanthorhynchus* Travassos,1916
Species	: *hirudinaceus*

Reference

Soulsby, EJ.L. 1982. Helminths, Arthoropods and Protozoa of Domesticated Animals. Seventh Edition ELBS, London.

Acknowledgement :

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