Figure 13.3 A consensus tree obtained by Littlewood et al. using both molecular and morphological characters. Free-living members of the phylum appear mostly at the base of the tree. A sister-group relationship between Digenea (Trematoda) and Aspidobothrea is supported, as is the basal position of catenulids and monophyly of the Neodermata.


Fig. 1. Representatives of Classes in Phylum Platyhelminthes: a. and b. Turbellaria (a. Tricladida, b. Rhabdocoela); c. Cestoidea (Cestoda); d. e. and f. Trematoda (d. Monogenea, e. Aspidogastrea, f. Digenea).
Phylum Platyhelminthes

(A) Phylogenetic relationships - a key to understanding parasitism?

(B) 18S rDNA

(C) 28S rDNA

interrelationships of the phylum
• **Definition of digenetic.** :of or relating to a subclass (Digenea) of trematode worms in which sexual reproduction as an internal parasite of a vertebrate alternates with asexual reproduction in a mollusk.

• **Monogenetic:** (of certain trematode worms) having only one generation in the life cycle, without an intermediate asexual generation.
Fig. 2. Example of life cycle of a monogenetic trematode (a. onchocercidium; b. and c. developmental stages; d. adult of Neobenedenia melleni) (Redrawn from Jahn & Kuhn, 1932)

Figure 15.1  Typical trematode life cycle. Many variations occur.
Drawing by William Ober and Claire Garrison.
Fig. 5. Subclass Aspidogastrea (a. ventral view; b. lateral view).
Figure 14.6 *Aspidogaster conchicola*, a common parasite of freshwater clams.

(a) Dorsal view, showing general body form. (b) Lateral view.

Drawing by William Ober and Claire Garrison.
Lobatostoma albulae
L. Pacificum
L. manteri
Aspidogaster conchicola

Figure 1. Life cycle of Lobatostoma manteri.
Lobatostoma manteri is an example of a species which has obligate vertebrate hosts (Fig. 1). Adult worms live in the small intestine of the snubnosed dart, Trachinotus blochi (Teleostei, Carangidae), on the Great Barrier Reef. They produce large numbers of eggs which are shed in the faeces. If eaten by various prosobranch snails, larvae...
- Excretory duct
- Excretory pore
- Vitelline gland
- Cecum
- Ovary
- Vitelline duct
- Seminal receptacle
- Testis
- Vas efferens
- Vas deferens
- Mehli's gland
- Laurer's canal
- Internal seminal vesicle
- External seminal vesicle
- Cirrus pouch
- Prostate cells
- Genital pore
- Oral sucker
- Prepharynx
- Pharynx
- Esophagus
- Metraterm
- Uterus
- Acetabulum
- Seminal receptacle
- Cirrus
- Vitelline reservoir
- Excretory bladder
Fig. 6a. Important diagnostic features illustrated.
Figure 15.19  Schematic representation of the oogenotop of a digenetic trematode.
Fig. 10.6. Male reproductive system of digenetic trematode. A. Complete system showing constituent parts. B. Cirrus sac of species with internal seminal vesicle. C. Terminal portion of species with external seminal vesicle. CI, cirrus; CS, cirrus sac; ESV, external seminal vesicle; ISV, internal seminal vesicle; PG, prostate glands; TES, testis; VASD, vas deferens; VASE, vas efferens.
Tegumen: Syncytial epidermis

a. 
Basal membrane
Basal lamina

b. 
Apical membrane
Basal membrane
Basal lamina

Structure of the cestode integument

- Microthrix
- EPM
- IPM
- BM
- Circular muscle
- Longitudinal muscle
- Transverse muscle
- Glycogen zone
- Nucleus
- Tegumental cell

- SER
- Lipid inclusion
- Vesicle
- Golgi
- RER
- Mitochondrion
- RO
- Vacuole
Figure 15.1  Typical trematode life cycle.
Many variations occur.
Drawing by William Ober and Claire Garrison.
POSSIBLE LIFE CYCLES OF DIGENETIC TREMATODES

Metacercaria — Adult (1)

Sporocyst — Cercaria (penetrates definitive host) — Adult (2)

Sporocyst (daughter)

Mesocercaria — Metacercaria — Adult (3)

Sporocyst (mother)

Redia — Redia — Cercaria — Metacercaria — Adult (4)

Redia (mother) (daughter)

Cercaria — Metacercaria — Adult (5)

Miracidium

Cercaria (eaten by definitive host) — Adult (6)

Redia — Redia — Cercaria — Metacercaria — Adult (7)

Redia (mother) (daughter)

Cercaria — Metacercaria — Adult (8)

(1) Diplostomum flexicaudum (Cort and Brooks, 1928)
(2) Trichobilharzia physellae (Talbot, 1936)
(3) Alaria mustelae Bosma, 1931
(4) Fasciola hepatica Linnaeus, 1758
(5) Metorchis conjunctus (Cobbold, 1860)
(6) Proterometra dickermani Anderson, 1962
(7) Stichorchis subtriquetus (Rudolph, 1814)
(8) Caecincola parvulus Marshall and Gilbert, 1905
Fig. 8. Miracidia (a. Phylodistomum sp.; b. Leucocochlidomorpha constantiae; c. Halipegus sp.). (Redrawn from Allison, 1943).
Fig. 9. Sporocysts (a. branched sporocyst of Paramphistomum sp.; b. branched with pigmented brood sac, Leucoclitia sp.; c. unbranched sporocyst of Strigea sp.)
Fig. 10. Mother redia.

Fig. 11. Daughter redia.
Figure 15.24  A few of the many types of cercariae.
(a) Ancylostoma caninum; (b) metacercaria; (c) schistosoma cercaria; (d) gynacanthrus cercaria; (e) plerocercus cercaria; (f) orthocercus cercaria; (g) uterine cercaria; (h) mesocercus cercaria; (i) esophagocercus cercaria; (j) echinostoma cervaria; (k) hysterothylacum cervaria; (l) metacercus cervaria; (m) directional cercaria; (n) platycaudate cercaria; (o) pharyngostomum cercaria; (p) platycaudate cercaria without oral sucker; (q) diplogaster cercaria; (r) cercaria; (s) rhabdocoel, or rhabdocoel cercaria.
Phylum: Platyhelminthes
Class: Trematoda
Subclass: Digenea
Order: ....a
Families: ....ae

Phylogeny and classification of the Digenea (Platyhelminthes: Trematoda)¹

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Fig. 6. Revised classification of the Digenea based on the results of Bayesian inference of 18s rDNA and mtDNA combined (see Fig. 3).
O. Paramphistomiformes ➔ cercaria with eyespots, encyst in the open, body elongated, ventral sucker large, hind part of the body

O. Echinostomatiformes ➔ cercaria encyst in open, spines on body or spiny collar (mostly but not always) includes Fasciolidae

O. Hemiuriformes ➔ tadpole like tail hind body section (tail+ecsoma)

O. Strigeiformes ➔ cup shaped forebody (Diplostomidae: Alaria americana), some classifications include Schistosomatidae

O. Opisthorchiformes ➔ general oval shape (small/weak suckers) no cirrus sac and cirrus adult body often with spines, Clonorchis sinensis

O. Plagiorchiformes ➔ general oval shape, large suckers, small spines on body (Paragonomius westermani)
Paramphistomatidae

Megalodiscus temperatus (rectum / bladder of frogs) Heliosoma as intermediate host.
Echinostomatidae

Echinostoma ilocanum
Hemiuridae

Hemiurus rugosus, Looss, 1907
(fish gut)
Strigeidae

Strigea elegans (snail, tadpole, garter snake/duck, owl)

Alaria canis (snail, tadpole/frog, (mouse), fox/dog)
Opisthorchiidae

Clonorhis sinensis
Plagiorchiidae

Paragonomius kellicotti
Lung worm of minks in North America (snail, crayfish)
Fasciolidae

Fasciola hepatica (snail, herbivor)
Fasciola hepatica and gigantica. Ventral view of formalin fixed, unstained specimens. Compare size and note the ventral suckers in both parasites.
Schistosomiasis

1. Eggs hatch releasing miracidia
2. Eggs in feces
3. Eggs in urine
4. Miracidia penetrate snail tissue
5. Cercariae released by snail into water and free-swimming
6. Cercariae lose tails during penetration and become schistosomulae
7. Penetrate skin
8. Circulation
9. Migrate to portal blood in liver and mature into adults
10. Paired adult worms migrate to:
   A. Mesenteric venules of bowel/rectum (laying eggs that circulate to the liver and shed in stools)
   B. Venous plexus of bladder
   C. S. japonicum
   D. S. mansoni
   E. S. haematobium
Schistosoma japonicum, Liver and splenic enlargement. Nearly 800 worms were removed from this patient.
Plagiorchiformes
Figure 18.8 Life cycle of *Paragonimus westermani*.
(a) Shelled embryo passed in feces or sputum. (b) After development miracidium hatches spontaneously and penetrates snail. (c) Sporocyst. (d) Redia. (e) Cercaria is shed into water and penetrates crab. (f) Metacercarial cyst in tissue of freshwater crab. (g) Cats or humans infected by eating undercooked crab. (h) Adult fluke in lungs.

Drawing by William Obee and Claire Gunnison.