

48 (47) Testes posterior to the ovary and vitellarium	Gonocerca (Gonocercidae) [Fig. 4.5.4C]	
49 (50) The vitelline follicles extend posteriorly to level of the ovary or anterior testis.....	Thaparotrema (Opisthorchiidae) [Fig. 4.5.5G]	
50 (49) The vitelline follicles extend posteriorly to level of posterior testis.....		51
51 (52) Body oval; oral sucker without enlarged oral spines, opens subterminally.....	Neocladocystis (Cryptogonimidae) [Fig. 4.5.4A]	
52 (51) Body fusiform; oral sucker with enlarged oral spines, opens terminally	Brientrema (Cryptogonimidae) [Fig. 4.5.3G]	
53 (54) Vitellarium reaching posterior extremity.....		55
54 (53) Vitellarium not reaching posteriorly extremity.....		59
55 (56) Uterus extending to, or near to, posterior extremity.....	Orientocreadium (Orientocreadiidae) [Fig. 4.5.5H]	
56 (55) Uterus not extending to, or near to, posterior extremity.....		57
57 (58) Intestinal bifurcation at the posterior margin of the ventral sucker	Allocreadium (Allocreadiidae) [Fig. 4.5.2B]	
58 (57) Intestinal bifurcation anterior to the ventral sucker.....	Plagioporus (Opecoelidae) [Fig. 4.5.5F]	
59 (60) Testes symmetrical.....	Malawitrema (Macroderoididae) [Fig. 4.5.5D]	
60 (59) Testes oblique.....		61
61 (62) Genital pore extracaecal.....		63
62 (61) Genital pore intercaecal.....		65
63 (64) Genital pore submedian at level of oral sucker.....	Emoleptalea (Cephalogonimidae) [Fig. 4.5.2G]	
64 (63) Genital pore submarginal, sinistral, at the level of pharynx... [<i>incertae sedis</i> in the superfamily Plagiorchioidea (<i>sensu lato</i>)] [Fig. 4.5.5C]	Heterorchis	
65 (66) Seminal vesicle bipartite.....	Glossidium [<i>incertae sedis</i> in the superfamily Plagiorchioidea (<i>sensu lato</i>)] [Fig. 4.5.5J]	
66 (65) Siminal vesicle unipartite.....	Astiotrema [<i>incertae sedis</i> in the superfamily Plagiorchioidea (<i>sensu lato</i>)] [Fig. 4.5.5I]	

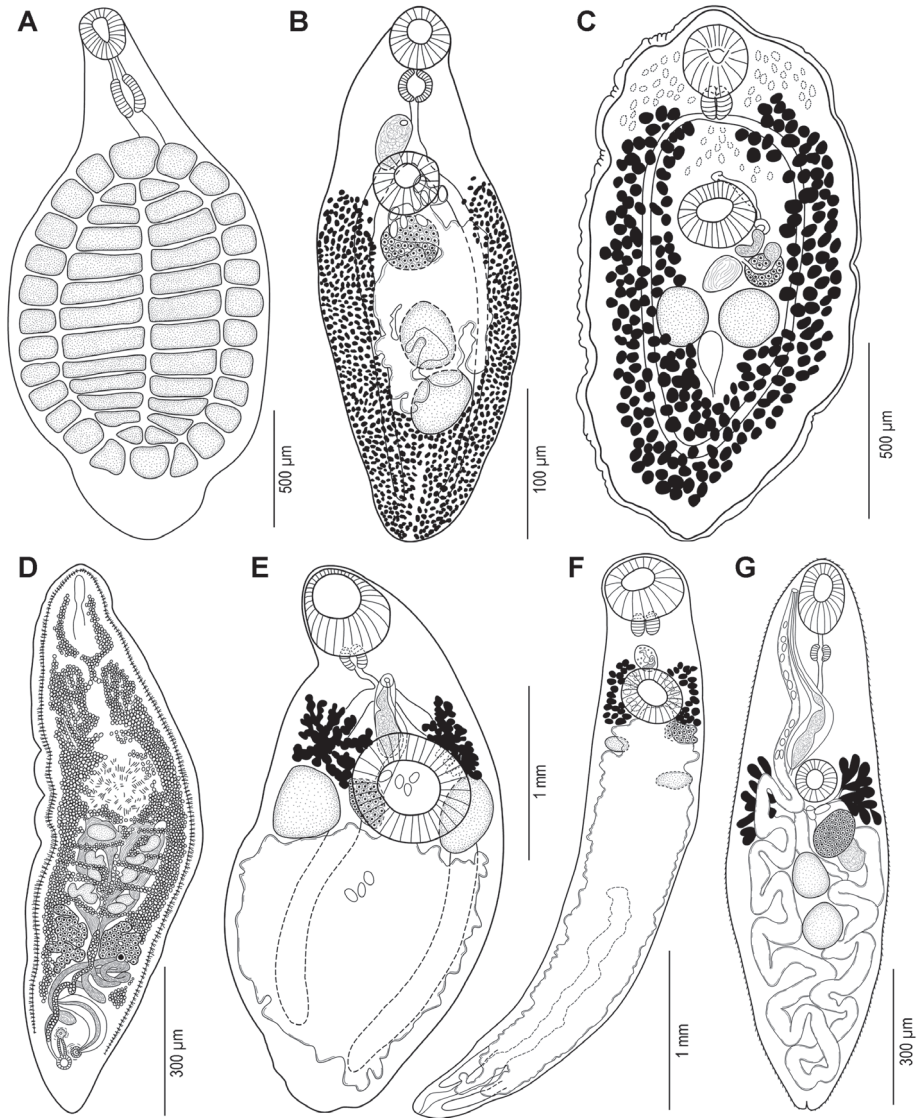


Fig. 4.5.2. Trematoda. **A.** *Aspidogaster africanus* Saoud, Mohamed et Abdel-Hamid, 1974 from *Labeobarbus bynni*; **B.** *Allocreadium mazoensis* Beverly-Burton, 1962 from *Clarias gariepinus*; **C.** *Trematobrien haplochromios* Dollfus, 1950 from *Pseudocrenilabrus philander*; **D.** *Sanguinicola chalmersi* Odhner, 1924 from *Auchenoglanis occidentalis*; **E.** *Callodistomum diaphanum* Odhner, 1902 from *Ctenopoma kingsleyae*; **F.** *Cholepotes ovofarctus* (Odhner, 1902) from *Synodontis schall*; **G.** *Emoleptalea exilis* (Looss, 1899) from *Bagrus bajad*. (Modified from Looss 1899; Odhner 1924; Beverly-Burton 1962; Manter 1962; Saoud et al. 1974; Jones 1982; Bray 2002.)

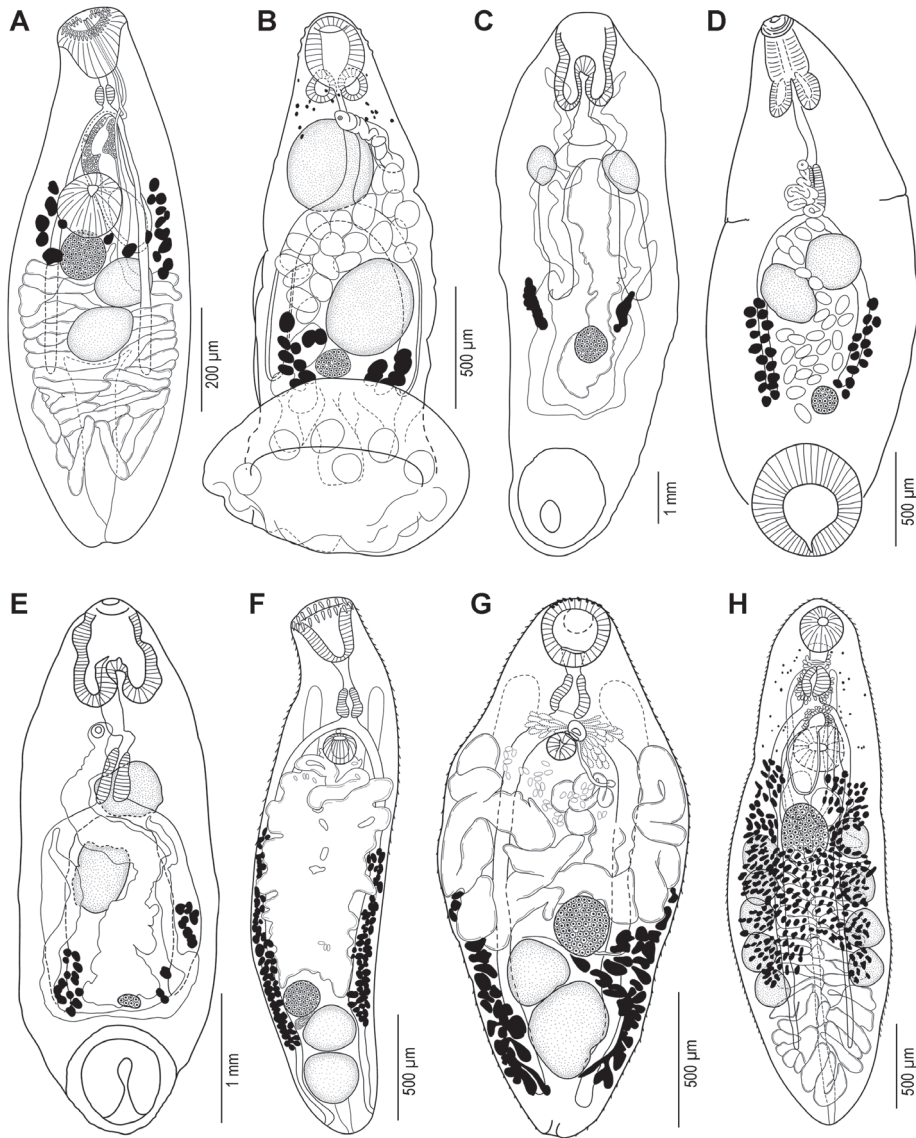


Fig. 4.5.3. Trematoda. **A.** *Masenia ghanensis* (Fischthal et Thomas, 1968) from *Heterobranchus longifilis*; **B.** *Basiodiscus ectorchis* Fischthal et Kuntz, 1959 from *Synodontis schall*; **C.** *Brevicaecum niloticum* McClelland, 1957 from *Citharinus citharus*; **D.** *Panamphistomum benoiti* Manter et Pritchard, 1964 from *Pseudocrenilabrus philander*; **E.** *Sandonia sudanensis* McClelland, 1957 from *Distichodus nefasch* or *S. schall* (host not specified); **F.** *Acanthostomum absconditum* (Looss, 1901) from *Bagrus bajad*; **G.** *Brientrema malapteruri* Dollfus, 1950 from *Malapterurus electricus*; **H.** *Siphodera ghanensis* Fischthal et Thomas, 1968 from *Chrysichthys nigrodigitatus*. (Modified from McClelland 1957; Manter & Pritchard 1964; Fischthal & Thomas 1968a, b.; Moravec 1976; B and G – holotypes illustrated by T. Scholz).

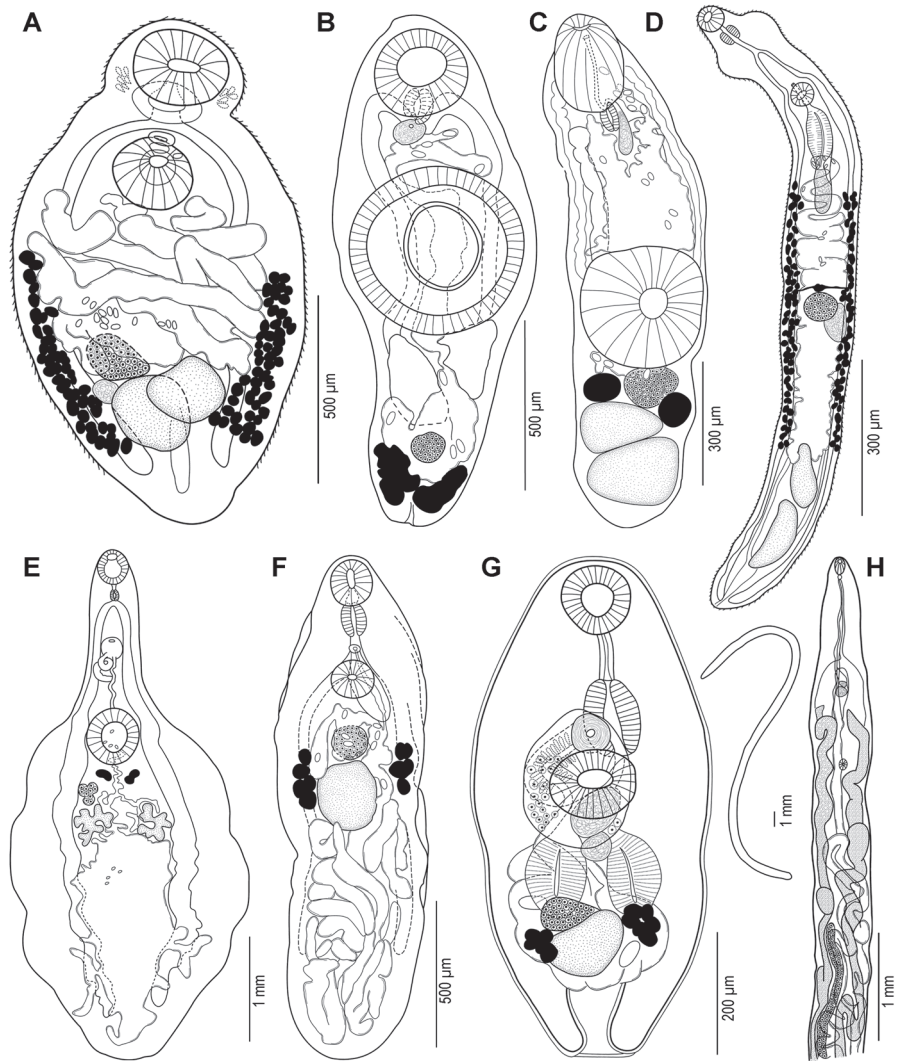


Fig. 4.5.4. Trematoda. **A.** *Neocladocystis congoensis* Manter et Pritchard, 1969 from *Parauchenoglanis monkei*; **B.** *Halipegus ctenopomi* Jones, 1982 from *Ctenopoma kingsleyae*; **C.** *Gonocerca phycidis* Manter, 1925 from *Urophycis chuss*; **D.** *Deropristis inflata* (Molin, 1859) from *Anguilla anguilla*; **E.** *Phyllodistomum bavuri* Boomker, 1984 from *Clarias gariepinus*; **F.** *Paralecithobotrys africanus* Manter et Pritchard, 1964 from *Pseudocrenilabrus philander*; **G.** *Saccocoelium obesum* Looss, 1902 from *Liza aurata*; **H.** *Nematobothrium labeonis* McClelland, 1955 from *Labeo coubie* or *L. horie* (host not specified). (Modified from Odhner 1902; Manter 1925; McClelland 1955; Boomker 1984; Blasco-Costa *et al.* 2009; A, B and F – holotypes illustrated by T. Scholz.)

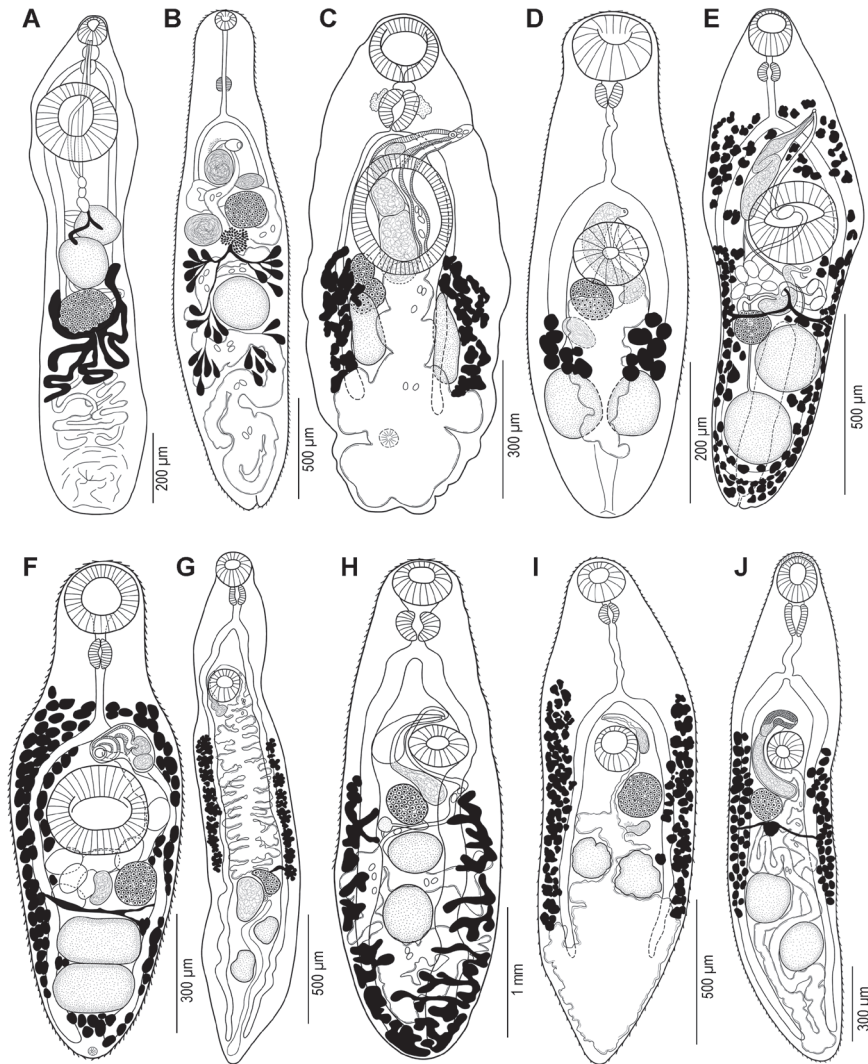


Fig. 4.5.5. Trematoda. **A.** *Ectenurus labeonis* (Fischthal et Kuntz, 1963) from *Labeo forskalii*; **B.** *Haplorchoides cahirinus* (Looss, 1896) from *Bagrus bajad*; **C.** *Heterorchis senegalensis* Vassiliadès et Richard, 1970 from *Protopterus annectens*; **D.** *Malawitrema staufferi* Bray et Hendrix, 2007 from *Clarias gariepinus*; **E.** *Nicolla gallica* (Dollfus, 1941) from *Cottus gobio*; **F.** *Plagioporus niloticus* Vercammen-Grandjean, 1960 from *Oreochromis niloticus*; **G.** *Thaparotrema botswanensis* Van Rensburg, Van As et King, 2013 from *C. gariepinus*; **H.** *Orientocreadium batrachoides* Tubangu, 1931 from *Clarias batrachus* or *Glossogobius giurus* (host not specified); **I.** *Astiotrema turneri* Bray, Van Oosterhout, Blais et Cable, 2006 from *Maylandia zebra*; **J.** *Glossidium lazerae* (Khalil, 1972) from *C. gariepinus*. (Modified from Looss 1899; Dollfus 1959; Vercammen-Grandjean 1960; Fischthal & Kuntz 1963; Vassiliadès & Richard 1970; Khalil 1972; Bray et al. 2006; Bray & Hendrix 2007; Jones & Bray 2008; Van Rensburg et al. 2013.)

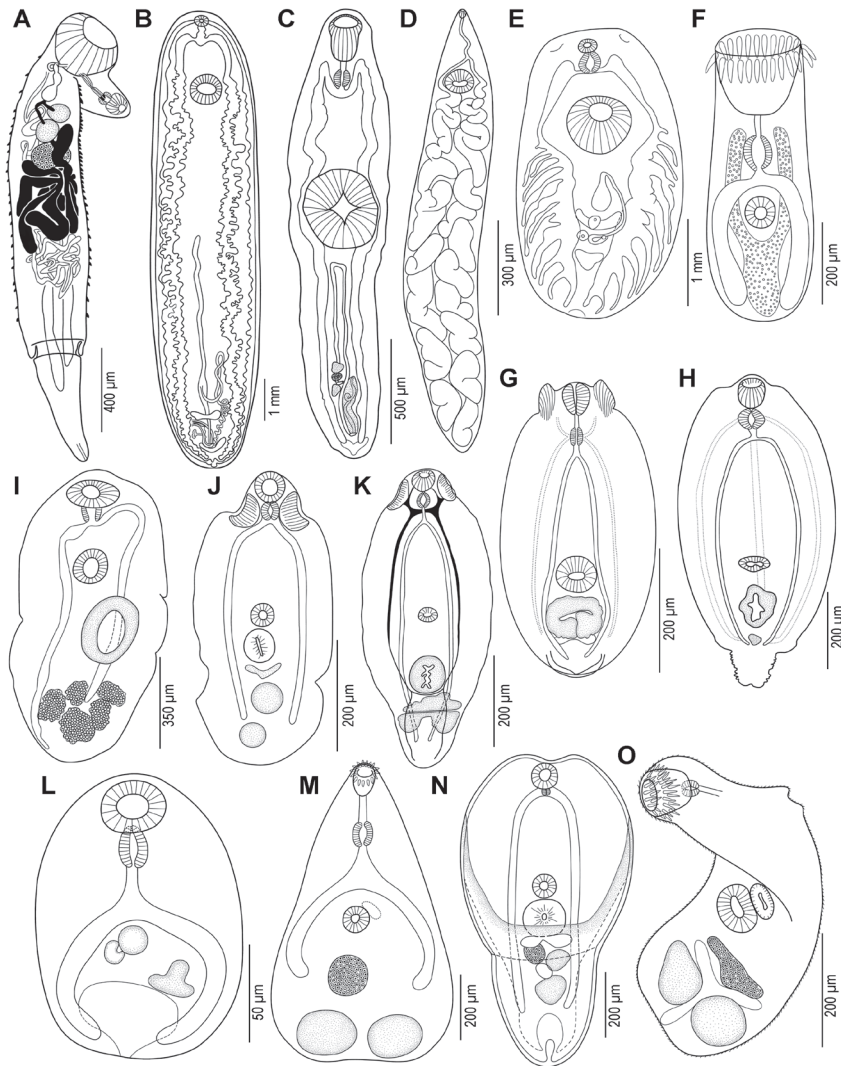


Fig. 4.5.6. Trematoda. **A.** *Dinurus gizae* Fischthal et Kuntz, 1963 from *Hydrocynus forskahlii*; **B.** *Clinostomoides brieni* Dollfus, 1950 from *Clarias gariepinus*; **C.** *Nephrocephalus bagriincapsulatus* (Wedl, 1861) from *Heterotis niloticus*; **D.** *Didymozoidae* gen. sp. from *H. forskahlii*; **E.** *Euclinostomum heterostomum* (Rudolphi, 1809) from *Coptodon zillii*; **F.** Cryptogonimidae gen. sp. (as *Metacercariae alestes* Fain, 1953) from *Alestes baremoze* or *C. gariepinus* (host not specified); **G.** *Diplostomum montanum* Zhokhov, 2014 from a cyprinid fish (host not specified); **H.** *Neodiplostomum* sp. from *C. gariepinus*; **I.** *Ornithodiplostomum* sp. from *C. gariepinus*; **J.** *Posthodiplostomoides leonensis* (Williams, 1967) from *Epiplatys* spp.; **K.** *Tylodelphys mashonensis* Beverley-Burton, 1963 from *C. gariepinus*; **L.** *Heterophyes* sp. from *Bagrus bajad*; **M.** *Pygidiopsis genata* Looss, 1907 from non-specified host; **N.** *Posthodiplostomum nanum* Dubois, 1937 from *Epiplatys spilargyreus*; **O.** *Centrocestus cuspidatus* (Looss, 1896) from *Gambusia affinis*. (Modified from Fain 1953; Beverly-Burton 1963; Fischthal & Kuntz 1963; Williams 1967a, b; Fischthal & Thomas 1972; Moravec 1977; Barson & Avenant-Oldewage 2006; Van Rensburg *et al.* 2013; Zhokhov 2014.)

Systematic survey of flukes (Trematoda) in African freshwater fishes

Trematodes identified at least to the genus level are ordered according to their families, which are listed alphabetically, as are their fish hosts. Identification keys for trematode families and genera are provided in the Keys to the Trematoda (Gibson *et al.* 2002; Jones *et al.* 2005; Bray *et al.* 2008). Type species and type hosts are highlighted in bold. The African country where the type locality lies is given if known. Fish names follow FishBase (Froese & Pauly 2017).

List of adult flukes (Trematoda) from African freshwater fishes

Subclass **Aspidogastrea** Faust et Tang, 1936

ASPIDOGASTRIDAE Poche, 1907

Aspidogaster Baer, 1827

Aspidogaster africanus Saoud, Mohamed et Abdel-Hamid, 1974 from *Chrysichthys nigrodigitatus*, *Labeobarbus bynni* [Fig. 4.5.2A]

Aspidogaster limacoides Diesing, 1834 from *Barbus* sp.

Subclass **Digenea** Carus, 1863

ALLOCREADIIDAE Stossich, 1903

Allocreadium Looss, 1900

Allocreadium aswanensis El-Naffar, Saoud et Hassan, 1984 from *Labeobarbus bynni* (Egypt)

Allocreadium engraulicypridis Khalil et Thurston, 1973 from *Rastrineobola argentea* (Uganda)

Allocreadium ghanensis Fischthal et Thomas, 1972 from *Synodontis batensoda*, ***Synodontis* sp.** (Ghana)

Allocreadium indistinctum Baer, 1959 from ***Barbus* sp.** (Democratic Republic of the Congo)

Allocreadium mazoensis Beverly-Burton, 1962 from ***Clarias gariepinus*** (Zimbabwe), *Enteromius camptacanthus*, *E. paludinosus*, *E. trimaculatus*, *Haplochromis teegelaari*, *Labeobarbus marequensis* [Fig. 4.5.2B]

Allocreadium sudanensis Saoud, Abdel-Hamid et Ibrahim, 1974 from ***Labeobarbus bynni*** (Sudan)

Allocreadium voltanum Thomas, 1957 from ***Brycinus macrolepidotus*** (Black Volta River)

APOCREADIIDAE Skrjabin, 1942

Trematobrien Dollfus, 1950

Trematobrien haplochromios Dollfus, 1950 from **Pseudocrenilabrus philander** (Democratic Republic of the Congo) [Fig. 4.5.2C]

APOROCOTYLIDAE Odhner, 1912

Sanguinicola Plehn, 1905

Sanguinicola chalmersi Odhner, 1924 from **Auchenoglanis occidentalis** (Sudan), *Synodontis schall* [Fig. 4.5.2D]

Sanguinicola clarias Imam, Marzouk, Hassan et Itman, 1984 from **Clarias gariepinus** (Egypt)

CALLODISTOMIDAE Poche, 1926

Callodistomum Odhner, 1902

Callodistomum diaphanum Odhner, 1902 from *Ctenopoma kingsleyae*, **Polypterus bichir** (Sudan), *P. endlicheri* [Fig. 4.5.2E]

Cholepotes Odhner, 1910

Cholepotes ovofarctus (Odhner, 1902) from *Synodontis schall*, **Synodontis sp.** (Sudan) [Fig. 4.5.2F]

CEPHALOGONIMIDAE Looss, 1899

Emoleptalea Looss, 1900

Emoleptalea exilis (Looss, 1899) from **Bagrus bajad** (Egypt) [Fig. 4.5.2G]

Emoleptalea nwanedi King, Smit, Baker et Luus-Powell, 2018 from *Schilbe intermedius* (South Africa)

Emoleptalea rifaati (Ramadam, Saoud et Taha, 1987) from **Synodontis schall**, **S. serratus** (type host not explicitly mentioned) (Egypt)

Emoleptalea synodontidos Dollfus, 1950 from **Synodontis notatus** (Democratic Republic of the Congo)

Emoleptalea sp. from *Nothobranchius furzeri*, *N. kadleci*

Masenia Chatterji, 1933

Masenia bangweulensis (Beverly-Burton, 1962) from *Clarias gariepinus*, **C. ngamensis** (Zambia), *Heterobranchus isopterus*

Masenia ghanensis (Fischthal et Thomas, 1968) from *Clarias gariepinus*, *Heterobranchus isopterus*, **H. longifilis** (Ghana) [Fig. 4.5.3A]

Masenia proteropora (Thomas, 1958) from **Clarias anguillaris** (Ghana)

Masenia synodontis (Khalil et Thurston, 1973) from **Synodontis victoriae** (Uganda)

CLADORCHIIDAE Fiscoeder, 1901

Basidiodiscus Fischthal et Kuntz, 1959

Basidiodiscus ectorchis Fischthal et Kuntz, 1959 from *Mormyrus kannume*, *Synodontis batensoda*, *S. clarias*, **S. schall** (Egypt) [Fig. 4.5.3B]

Brevicaecum McClelland, 1957

Brevicaecum niloticum McClelland, 1957 from ***Citharinus citharus*** (Sudan) [Fig. 4.5.3C]

Panamphistomum Manter et Pritchard, 1964

Panamphistomum benoiti Manter et Pritchard, 1964 from *Clarias gariepinus*, ***Pseudocrenilabrus philander*** (Democratic Republic of the Congo) [Fig. 4.5.3D]

Sandonia McClelland, 1957

Sandonia sudanensis McClelland, 1957 from *Bagrus docmak*, ***Distichodus nefasch***, *D. rostratus*, *Synodontis batensoda*, *S. budgetti*, *S. clarias*, *S. membranaceus*, *S. nigrita*, *S. ocellifer*, **S. schall** (type host not explicitly mentioned; Sudan), *S. sorex*, *S. vermiculatus*, *Synodontis* sp. [Fig. 4.5.3E]

CRYPTOGONIMIDAE Ward, 1917

Acanthostomum Looss, 1899

Acanthostomum absconditum (Looss, 1901) from ***Bagrus bajad***, *B. docmak* (Egypt) [Fig. 4.5.3F]

Acanthostomum gymnarchi (Dollfus, 1950) from ***Gymnarchus niloticus*** (Sudan)

Acanthostomum spiniceps (Looss, 1896) from ***Bagrus bajad*** (Egypt), *B. docmak*, *B. filamentosus*, *Chrysichthys nigrodigitatus*

Brientrema Dollfus, 1950

Brientrema malapteruri Dollfus, 1950 from *Distichodus lusosso*, ***Malapterurus electricus*** (Democratic Republic of the Congo) [Fig. 4.5.3G]

Neocladocystis Manter et Pritchard, 1969

Neocladocystis congoensis Manter et Pritchard, 1969 from ***Parauchenoglanis monkei*** (Cameroon) [Fig. 4.5.4A]

Neocladocystis tanganyikae (Prudhoe, 1951) from **unidentified cichlid** (Democratic Republic of the Congo)

Siphodera Linton, 1910

Siphodera ghanensis Fischthal et Thomas, 1968 from ***Chrysichthys nigrodigitatus*** (Ghana), *Hydrocynus brevis*, *Lutjanus goreensis* [Fig. 4.5.3H]

DEROGENIDAE Nicoll, 1910

Halipegus Looss, 1899

Halipegus ctenopomi Jones, 1982 from ***Ctenopoma kingsleyae*** (Senegal) [Fig. 4.5.4B]

DEROPRISTIDAE Cable et Hunninen, 1942

Deropristis Odhner, 1902

Deropristis inflata (Molin, 1859) from *Anguilla anguilla* [Fig. 4.5.4D]

DIDYMOZOIDAE Poche, 1907

Nematobothrium van Beneden, 1858

Nematobothrium labeonis McClelland, 1955 from ***Labeo coubie***, *L. forskalii*, ***L. horie*** [type host not explicitly mentioned], *L. niloticus* (Sudan) [Fig. 4.5.4H]

Nematobothrium sp. from *Labeo coubie*, *L. senegalensis*

GONOCERCIDAE Skrjabin et Guschanskaja, 1955

Gonocerca Manter, 1925

Gonocerca phycidis Manter, 1925 from *Clarias gariepinus* [Fig. 4.5.4C]

GORGODERIDAE Looss, 1899

Phyllodistomum Braun, 1899

Phyllodistomum bavuri Boomker, 1984 from ***Clarias gariepinus*** (South Africa) [Fig. 4.5.4E]

Phyllodistomum ghanense Thomas, 1958 from *Ctenopoma kingsleyae*, ***Mastacembelus nigromarginatus*** (Ghana)

Phyllodistomum linguale Odhner, 1902 from ***Gymnarchus niloticus*** (Egypt)

Phyllodistomum spatula (Odhner, 1902) from ***Bagrus bajad*** (Egypt), *B. docmak*

Phyllodistomum spatulaeforme (Odhner, 1902) from ***Malapterurus electricus*** (Egypt)

Phyllodistomum symmetrorchis Thomas, 1958 from ***Auchenoglanis occidentalis*** (Ghana), *Bagrus bajad*

Phyllodistomum cf. *symmetrorchis sensu* Cutmore, Miller, Curran, Bennett et Cribb, 2013 from *Clarias gariepinus*

Phyllodistomum tana Zhokhov, 2010 from ***Clarias gariepinus*** (Ethiopia)

Phyllodistomum vanderwaali Prudhoe et Hussey, 1977 from ***Clarias gariepinus*** (South Africa)

HAPLOPORIDAE Nicoll, 1914

Paralecithobotrys Freitas, 1948

Paralecithobotrys africanus Manter et Pritchard, 1964 from ***Pseudocrenilabrus philander*** (Democratic Republic of the Congo) [Fig. 4.5.4F]

- Saccocoelium* Looss, 1902
Saccocoelium obesum Looss, 1902 from *Chelon ramada*, *Mugil cephalus* [Fig. 4.5.4G]
- HEMIURIDAE Looss, 1899*
- Dinurus* Looss, 1907
Dinurus gizae Fischthal et Kuntz, 1963 from ***Hydrocynus forskahlii*** (Egypt) [Fig. 4.5.6A]
Ectenurus Looss, 1907
Ectenurus labeonis (Fischthal et Kuntz, 1963) from ***Labeo forskalii*** (Egypt) [Fig. 4.5.5A]
- *The marine genus *Lecithochirium* Lühe, 1901 is not included because reports of *L. magnicaudatum* Fischthal et Kuntz, 1963 from *Labeo forskalii* and *L. musculus* Looss, 1907 from *Heterotis niloticus* are doubtful and apparently represent accidental infections.
- HETEROPHYIDAE Leiper, 1909
Haplorchoides Chen, 1949
Haplorchoides cahirinus (Looss, 1896) from ***Bagrus bajad*** (Egypt), *B. docmak*, *B. meridionalis*, *Clarias gariepinus* [Fig. 4.5.5B]
- MACRODEROIDIDAE McMullen, 1937
Malawitrema Bray et Hendrix, 2007
Malawitrema staufferi Bray et Hendrix, 2007 from *Bagrus meridionalis*, ***Clarias gariepinus*** (Malawi) [Fig. 4.5.5D]
- OPECOELIDAE Ozaki, 1925
Nicolla Wiśniewski, 1933
Nicolla gallica (Dollfus, 1941) from *Anguilla anguilla* [Fig. 4.5.5E]
Plagioporus Stafford, 1904
Plagioporus niloticus Vercammen-Grandjean, 1960 from *Anguilla anguilla*, ***Oreochromis niloticus*** (Democratic Republic of the Congo) [Fig. 4.5.5F]
- OPISTHORCHIIDAE Looss, 1899
Thaparotrema Gupta, 1955
Thaparotrema botswanensis Van Rensburg, Van As et King, 2013 from ***Clarias gariepinus*** (Botswana) [Fig. 4.5.5G]
Thaparotrema piscicola (Odhner, 1902) from ***Gymnarchus niloticus*** (Sudan)
- ORIENTOCREADIIDAE Yamaguti, 1958
Orientocreadium Tubangui, 1931

Orientocreadium batrachoides Tubangui, 1931 from *Clarias anguillaris*, *C. gariepinus*, *C. ngamensis* [Fig. 4.5.5H]

Orientocreadium indicum Pande, 1934 from *Clarias gariepinus*, *Heterobranchus longifilis*

Genera *incertae sedis* in the superfamily Plagiorchioidea (*sensu lato*)

Astiotrema Looss, 1899

Astiotrema impletum (Looss, 1899) from ***Tetraodon lineatus*** (Egypt)

Astiotrema lazeri El-Naffar, Saoud et Hassan, 1984 from ***Clarias gariepinus*** (Egypt)

Astiotrema reniferum (Looss, 1898) from *Bagrus docmak*, *Clarias gariepinus*

Astiotrema turneri Bray, Van Oosterhout, Blais et Cable, 2006 from *Labeotropheus trewavasae*, *Maylandia emmiltos*, ***M. zebra*** (Malawi), *Melanochromis vermivorus* [Fig. 4.5.5I]

Glossidium Looss, 1899

Glossidium lazerae (Khalil, 1972) from ***Clarias gariepinus*** (Sudan) [Fig. 4.5.5J]

Glossidium pedatum Looss, 1899 from ***Bagrus bajad***, ***B. docmak*** (type host not explicitly mentioned) (Egypt), *Clarias gariepinus*

Heterorchis Baylis, 1915

Heterorchis crumenifer Baylis, 1915 from ***Protopterus aethiopicus*** (Uganda), *P. annectens*, *Protopterus* sp.

Heterorchis protopteri Thomas, 1958 from ***Protopterus annectens*** (Ghana)

Heterorchis senegalensis Vassiliadès et Richard, 1970 from ***Protopterus annectens*** (Senegal) [Fig. 4.5.5C]

List of metacercariae of flukes (Trematoda) from African freshwater fishes

Note: Due to the simple morphology of larval stages, the existence of morphologically similar species and the lack of knowledge on trematode life cycles, reliable identification of larval stages to the species level is usually impossible based only on morphological characteristics. As a result, some morphology-based identification of metacercariae reported from freshwater fishes in Africa may be misidentifications. Molecular techniques have proven to be efficient for identification and elucidation of the life cycles of parasites and should be applied in future studies.

CLINOSTOMIDAE Lühe, 1901

Clinostomoides Dollfus, 1950

Clinostomoides brieni Dollfus, 1950 from *Clarias gariepinus* [Fig. 4.5.6B]

Clinostomum Leidy, 1856

Clinostomum chrysichthys Dubois, 1930 from *Chrysichthys auratus*

Clinostomum complanatum (Rudolphi, 1819) from *Chrysichthys nigrodigitatus*, *Coptodon zillii*, *Enteromius multilineatus*, *Oreochromis niloticus*, *Sarotherodon galilaeus*

Clinostomum macrosomum Jaiswal, 1957 from *Clarias gariepinus*, *Oreochromis niloticus*

Clinostomum tilapiae Ukoli, 1966 from *Chromidotilapia guntheri*, *Coptodon zillii*, *Cyprinus carpio*, *Hemichromis fasciatus*, *Oreochromis mossambicus*, *O. niloticus*, *Pelmatolapia mariae*, *Sarotherodon galilaeus*, *S. melanotheron*

Clinostomum vandehorsti Ortlepp, 1935 from *Marcusenius macrolepidotus*, *Schilbe mystus*

Clinostomum sp. from *Amphilius uranoscopus*, *Chiloglanis pretoriae*, *Citharinus citharus*, *Clarias gariepinus*, *Coptodon zillii*, *Ctenopoma kingsleyae*, *Epiplatys* sp., *Haplochromis obliquidens*, *Hemichromis fasciatus*, *Labeo coubie*, *Labeobarbus beso*, *Oreochromis leucostictus*, *O. mossambicus*, *O. niloticus*, *Oreochromis* sp., *Sarotherodon galilaeus*, *Schilbe intermedius*, *Synodontis eupterus*, *S. nigrita*, *S. schall*, *Tilapia* sp.

Euclinostomum Travassos, 1928

Euclinostomum ardeolae El-Naffar et Khalifa, 1981 from *Oreochromis niloticus*

Euclinostomum clarias (Dubois, 1930) from *Clarias angolensis*

Euclinostomum dollfusi Fischthal et Kuntz, 1963 from *Clarias gariepinus*

Euclinostomum heterostomum (Rudolphi, 1809) from *Chromidotilapia kingsleyae*, *Clarias gariepinus*, *Clarias* sp., *Coptodon zillii*, *Oreochromis mossambicus*, *Sarotherodon melanotheron*, *Tilapia* sp. [Fig. 4.5.6E]

Nephrocephalus Odhner, 1902

Nephrocephalus bagriincapsulatus (Wedl, 1861) from *Auchenoglanis occidentalis*, *Bagrus* sp., *Clarias anguillaris*, *Heterotis niloticus* [Fig. 4.5.6C]

CRYPTOGONIMIDAE Ward, 1917

Cryptogonimidae gen. sp. (as Metacercariae alestes Fain, 1953) from *Alestes baremoze*, *Clarias gariepinus* [Fig. 4.5.6F]

CYATHOCOTYLIDAE Mühling, 1898

Prohemistomum Odhner, 1913

Prohemistomum vivax (Sonsino, 1892) from *Oreochromis niloticus*, *Schilbe mystus*

DIDYMOZOIDAE Poche, 1907

Didymozoidae gen. sp. from *Hydrocynus forskahlii* [Fig. 4.5.6D]

DIPLOSTOMIDAE Poirier, 1886

- Diplostomum* von Nordmann, 1832
- Diplostomum garrae* Zhokhov, 2014 from ***Garra dembecha*** (Ethiopia)
- Diplostomum heterobranchi* (Wedl, 1861) from *Clarias gariepinus*
- Diplostomum longicollis* Zhokhov, 2014 from ***Enteromius humilis***, ***Garra dembecha*** (type host not specified) (Ethiopia)
- Diplostomum magnicaudum* El-Naffar, 1979 from *Oreochromis niloticus*
- Diplostomum montanum* Zhokhov, 2014 from ***Enteromius humilis***, ***Garra dembecha***, ***Labeobarbus beso***, ***L. gorgorensis*** (type host not specified) (Ethiopia) [Fig. 4.5.6G]
- Diplostomum tilapiae* Zhokhov, 2014 from ***Oreochromis niloticus*** (Ethiopia)
- Diplostomum* sp. from *Clarias gariepinus*, *Enteromius humilis*, *Garra dembecha*, *Oreochromis mossambicus*, *Synodontis nigrita*
- Dolichorchis* Dubois, 1961
- Dolichorchis tregenna* (Nazmi Gohar, 1932) from *Clarias gariepinus*
- Neodiplostomum* Railliet, 1919
- Neodiplostomum* sp. from *Clarias gariepinus* [Fig. 4.5.6H]
- Ornithodiplostomum* Dubois, 1936
- Ornithodiplostomum* sp. from *Clarias gariepinus* [Fig. 4.5.6I]
- Posthodiplostomoides* Williams, 1969
- Posthodiplostomoides leonensis* (Williams, 1967) from *Epiplatys sexfasciatus*, *E. spilargyreus* [Fig. 4.5.6J]
- Posthodiplostomum* Dubois, 1936
- Posthodiplostomum nanum* Dubois, 1937 from *Coptodon zillii*, *Enteromius humilis*, *Epiplatys sexfasciatus*, *E. spilargyreus*, *Garra dembecha*, *Hemichromis fasciatus*, *Heterobranchus longifilis* [Fig. 4.5.6N]
- Tylodelphys* Diesing, 1850
- Tylodelphys grandis* Zhokhov, Morozova et Tessema, 2010 from ***Clarias gariepinus*** (Ethiopia)
- Tylodelphys mashonensis* Beverley-Burton (1963) from *Clarias gariepinus*, *C. ngamensis* [Fig. 4.5.6K]
- Tylodelphys* sp. from *Clarias gariepinus*, *Coptodon zillii*, *Cyprinus carpio*, *Micropterus salmoides*, *Oreochromis leucostictus*
- Diplostomidae gen. sp. from *Clarias gariepinus*, *Pseudocrenilabrus philander*, *Tilapia sparrmanii*

ECHINOCHASMIDAE Odhner, 1910

Echinochasmus Dietz, 1909

Echinochasmus liliputans (Looss, 1896) from *Oreochromis niloticus*

HETEROPHYIDAE Leiper, 1909

Centrocestus Looss, 1899

Centrocestus cuspidatus (Looss, 1896) from *Gambusia affinis* [Fig. 4.5.6O]

Haplorchis Looss, 1899

Haplorchis sp. from *Oreochromis niloticus*

Heterophyes Cobbold, 1866

Heterophyes aequalis Looss, 1902 from *Oreochromis niloticus*

Heterophyes heterophyes (von Siebold, 1852) from *Oreochromis niloticus*

Heterophyes sp. from *Bagrus bajad* [Fig. 4.5.6L]

Pygidiopsis Looss, 1907

Pygidiopsis genata Looss, 1907 from *Oreochromis niloticus*, *Synodontis batensoda* [Fig. 4.5.6M]

Stellantchasmus Onji et Nishio, 1915

*Stellantchasmus pseudocirratu*s (Witenberg, 1929) from *Oreochromis niloticus*

Stictodora Looss, 1899

Stictodora sawakinensis Looss, 1899 from *Oreochromis niloticus*

PROTERODIPILOSTOMIDAE Dubois, 1936

Pseudoneodiplostomum Dubois, 1936

Pseudoneodiplostomum thomasi (Dollfus, 1935) from *Clarias anguillaris*

STRIGEIDAE Railliet, 1919

Apatemon Szidat, 1928

Apatemon barbusi Zhokhov, Miretskaya, Pugacheva et Tessema, 2008 from *Enteromius humilis*, *E. pleurogramma*, ***E. tanapelagius*** (Ethiopia), *Labeobarbus acutirostris*, *L. dainellii*, *L. gorguari*, *L. intermedius*, *L. nedgia*, *L. beso*

Apatemon tilapiae Zhokhov, Miretskaya, Pugacheva et Tessema, 2008 from ***Oreochromis niloticus*** (Ethiopia)

Apatemon sp. from *Nothobranchius furzeri*

Ichthyocotylurus Odening, 1969

Ichthyocotylurus sp. from *Garra dembecha*

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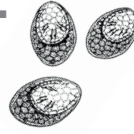
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Chapter 4.6.

CESTODA



Tomáš SCHOLZ & Roman KUČHTA

Tapeworms (Cestoda) – basic characteristics, life cycles, classification and principal diagnostic features

- parasitic flatworms (Platyhelminthes: Neodermata)
- about 5,000 species classified in 19 orders
- obligate endoparasites usually of the digestive system of all groups of vertebrates
- body (strobila) dorsoventrally flattened, usually composed of proglottids (“segments”)
- attachment organs (bothria, bothridia, suckers) on the anterior end called scolex (may be absent)
- digestive tract (intestine) absent
- body surface with hair-like structures called microtriches (absorption of nutrients and attachment)
- all African species hermaphroditic, with well-developed vitellarium (vitelline follicles)
- indirect life cycles (1-2 intermediate hosts: copepods, amphipods, oligochaetes, fishes) [Fig. 4.6.1]
- causative agents of human fish-borne diseases (e.g., broad fish tapeworm) – not in Africa

The classification of cestodes is based on well-defined orders (19 in total at present – Caira & Jensen 2017). They are characterised mainly by the morphology of the scolex (the number and type of attachment organs such as paired bothria and bothridia or four muscular suckers – see Figs 4.6.2B, 4.6.5A) and the morphology of the reproductive organs such as the structure of vitelline follicles (diffuse in the cortex, in lateral bands or compact), position of gonads (in the cortex or medulla), egg morphology, structure of the uterus, etc. (e.g., Fig. 4.6.5B; see Khalil *et al.* 1994 for keys to the orders, families and genera of cestodes, and Caira & Jensen 2017 for updated information on all cestodes).

Generic classification and species identification is based on the size and shape of the scolex and its attachment organs such as suckers and apical organs (it may be muscular, *i.e.*, resembling suckers, or glandular, *i.e.*, comprising gland cells), on proglottid morphology, especially the size, position and shape of gonads (e.g., shape, relative position and size of the terminal genitalia, number of testes, extent of vitelline follicles, shape of the uterus and the number of its lateral diverticula, etc.), size and shape of the eggs, morphology of excretory canals, and many other characteristics.

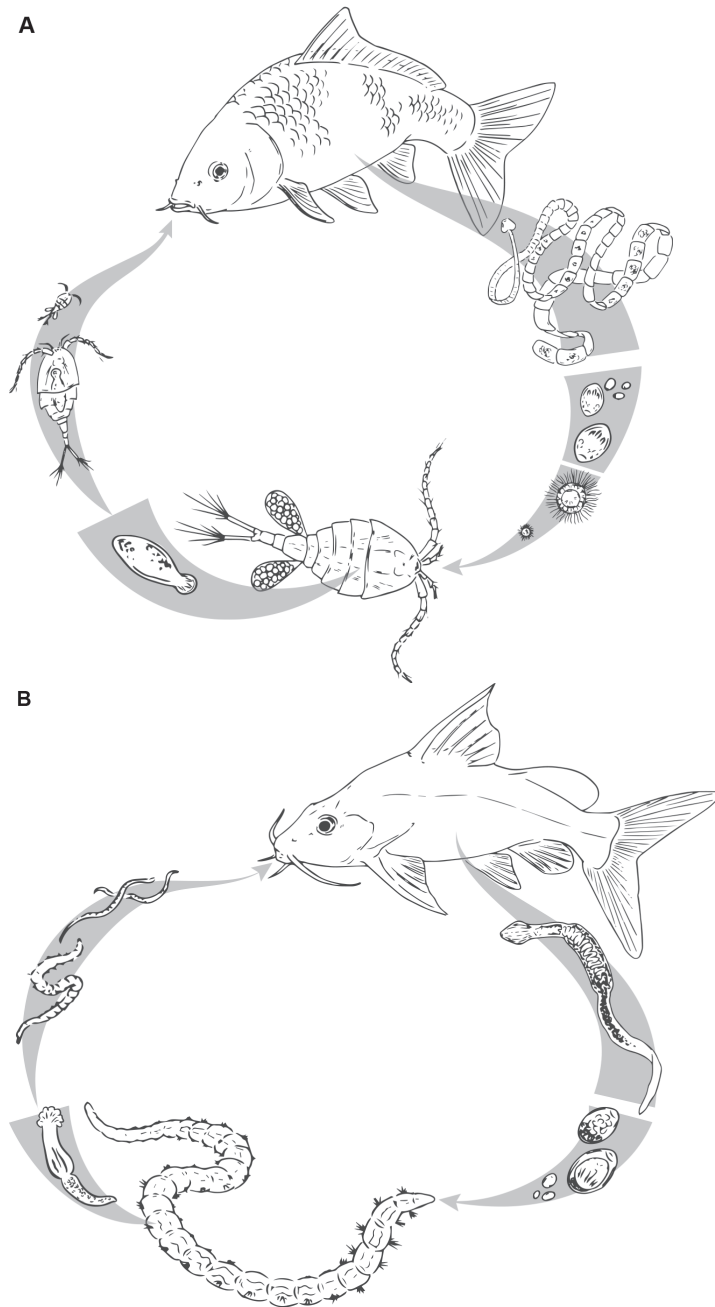


Fig. 4.6.1. Life cycles of cestodes. **A.** *Schyzocotyle acheilognathi* (Yamaguti, 1934); copepods serve as intermediate hosts; **B.** *Wenyonia virilis* Woodland, 1923; naids serve as intermediate hosts. (Illustrations by M. Luo.)

Key to the orders of tapeworms (Cestoda)

Adults which contain fully developed genital organs and eggs if gravid occur almost exclusively in the intestinal lumen, only *Tetracampus ciliotheca* is also reported to occur in the gall bladder. Larvae called metacestodes, which include plerocercoids and plerocerci, are parenteral, *i.e.*, outside the intestinal lumen except for some tiny larvae of the Gryporhynchidae. Metacestodes do not have fully developed genital organs including eggs and they occur in the mesenteries, intestinal wall, gall bladder and liver.

- 1 (2) Strobila monozoic (with one genital complex per strobila) [Fig. 4.6.2A].....3
- 2 (1) Strobila polyzoic (proglottised with several genital complexes per strobila) [Fig. 4.6.2B]7
- 3 (4) Strobila without scolex or attachment organ; adults in body cavity [Fig. 4.6.2A].....**Amphilinidea**
- 4 (3) Strobila with scolex [Fig. 4.6.3A]..... 5
- 5 (6) Scolex unarmed, without suckers [Fig. 4.6.3E]; adults in intestine**Caryophyllidea**
- 6 (5) Scolex armed with hooks [Fig. 4.6.6A]; larvae in internal organs**Cyclophyllidea** (Gryporhynchidae)
- 7 (8) Scolex with two bothria or attachment grooves [Fig. 4.6.2E].....9
- 8 (7) Scolex with four suckers [Fig. 4.6.4A]; adults in intestine.....**Onchoproteocephalidea** (formerly Proteocephalidea)
- 9 (10) Large worms with weakly developed scolex [Fig. 4.6.5D]; larvae free in body cavity.....**Diphyllobothriidea**
- 10 (9) Scolex with two bothria, armed with hooks or not [Fig. 4.6.2D]; adults in intestine.....**Bothriocephalidea**

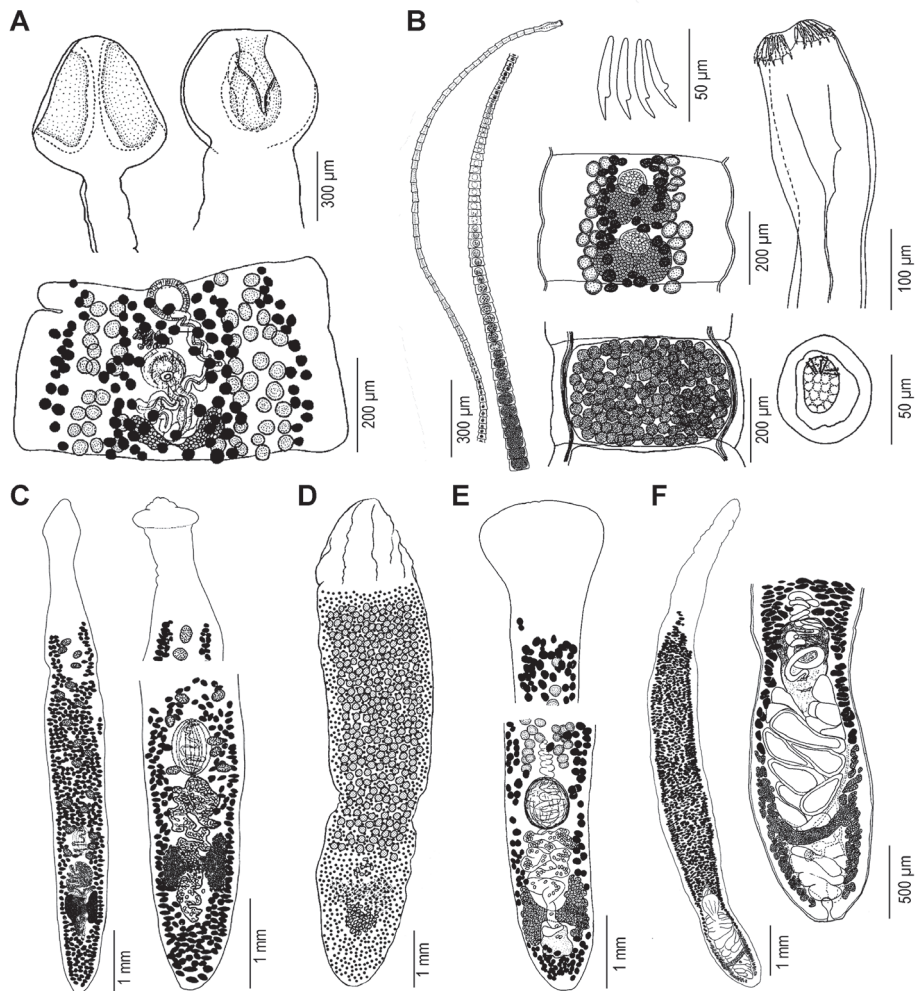


Fig. 4.6.3. Cestoda (Bothriocephalidea and Caryophyllidea). **A.** *Schyzocotyle acheilognathi* (Yamaguti, 1934) from *Cyprinus carpio*; **B.** *Tetracampos ciliotheca* Wedl, 1861 from *Clarias anguillaris*; **C.** *Atractolytocestus huronensis* Anthony, 1958 from *C. carpio*; **D.** *Lytocestoides tanganyikae* Baylis, 1928 from a cichlid; **E.** *Khawia armeniaca* (Cholodkovsky, 1915) from *Arabibarbus grypus*; **F.** *Lytocestus marcuseni* Troncy, 1978 from *Hippopotamyrus harringtoni*. (Modified from Woodland 1937; Troncy 1978; Scholz et al. 2011a; Kuchta et al. 2012.)

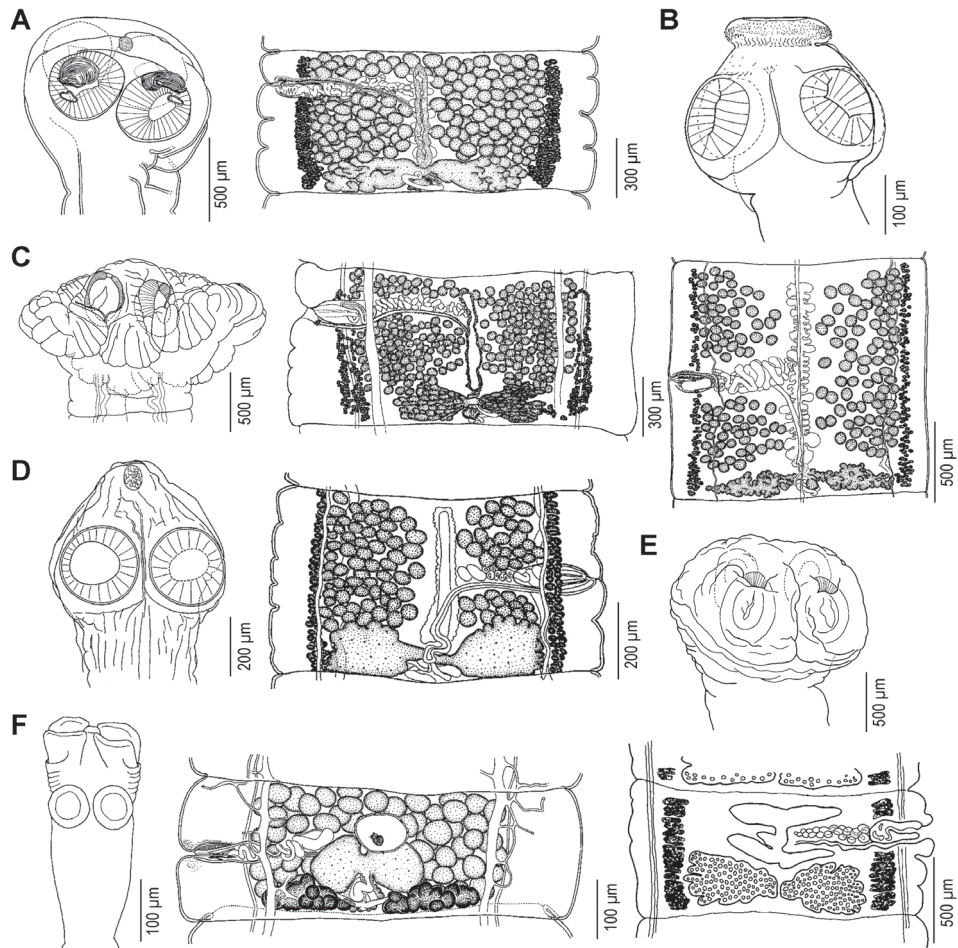


Fig. 4.6.4. Cestoda (Onchoproteocephalidea). **A.** *Barsonella lafoni* de Chambrier, Scholz, Beletew et Mariaux, 2009 from *Clarias gariepinus*; **B.** *Electrotaenia malopteruri* (Fritsch, 1886) from *Malapterurus electricus*; **C.** *Corallobothrium solidum* Fritsch, 1886 from *M. electricus*; **D.** *Proteocephalus synodontis* Woodland, 1925 from *Synodontis schall*; **E.** *Marsypocephalus tanganyikae* (Fuhrmann et Baer, 1925) from *C. gariepinus*; **F.** *Sandonella sandoni* (Lynsdale, 1960) from *Heterotus niloticus*. (Modified from Fuhrmann and Baer 1925; de Chambrier *et al.* 2004, 2008, 2009, 2011; Scholz *et al.* 2011b.)