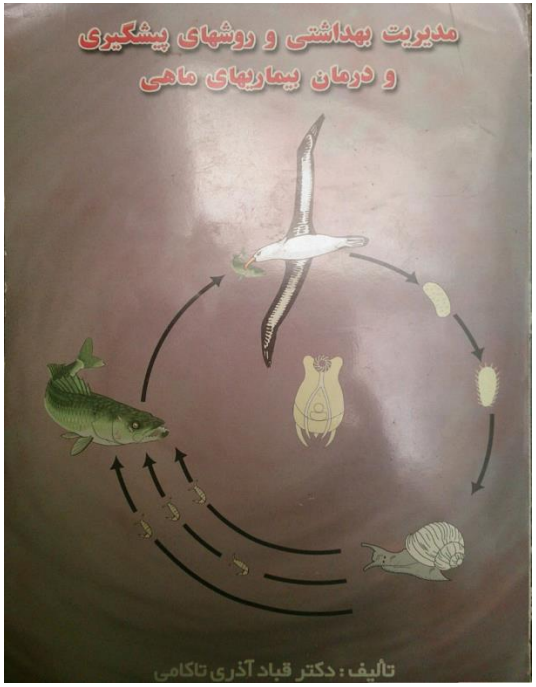

به نام خداوند جان و خرد

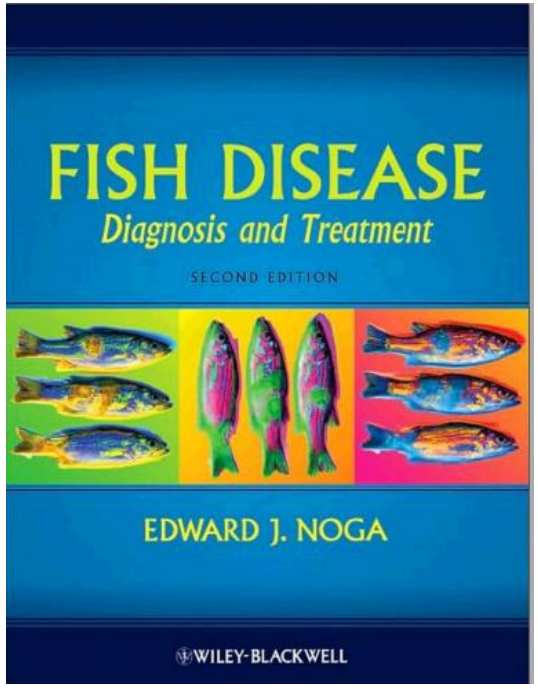
بهداشت و بیماری‌های آبزیان

- **منابع:**

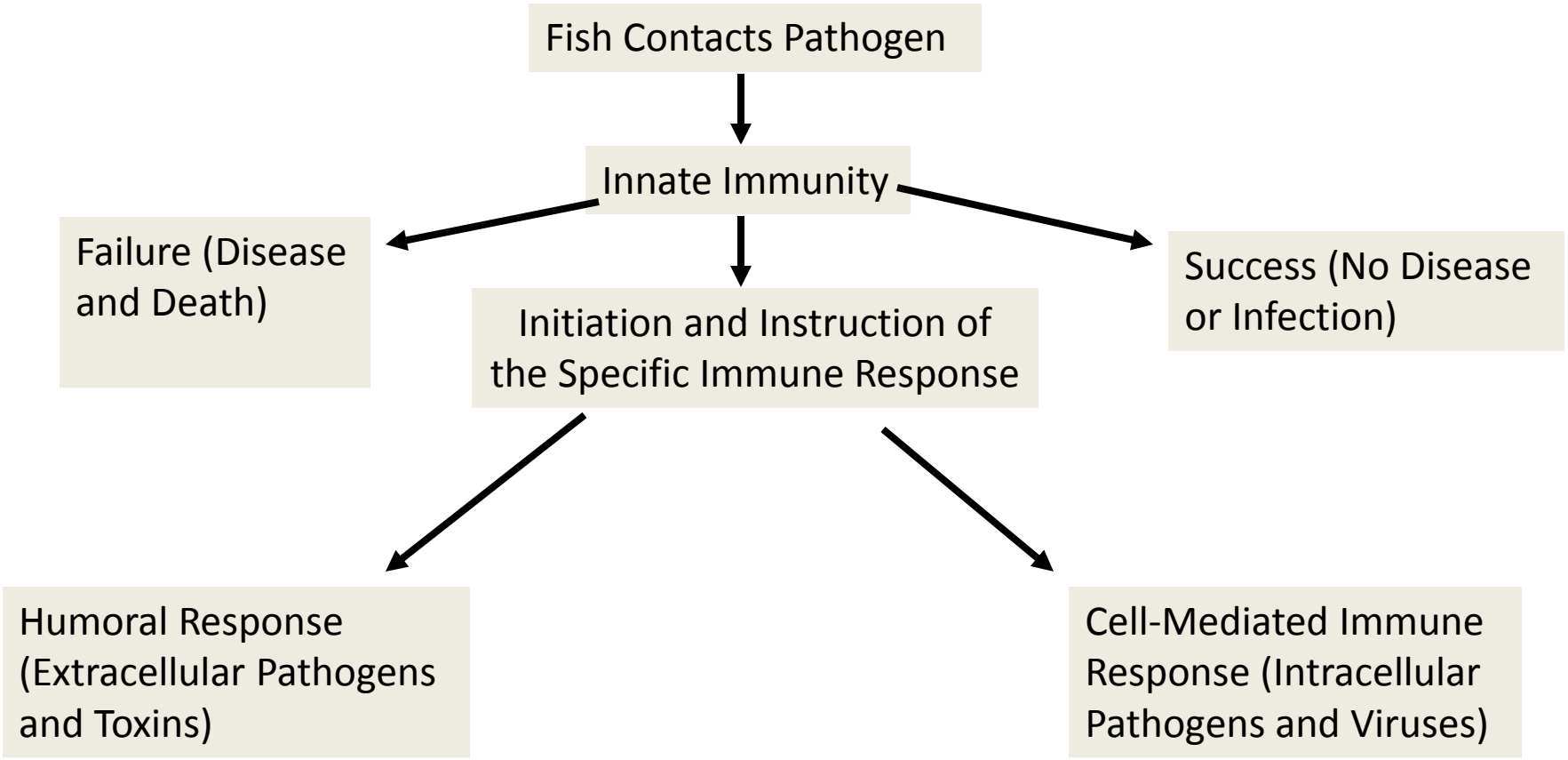
۱) مدیریت بهداشتی و روش‌های پیشگیری و درمان بیماری‌های ماهی (دکتر قباد آذری تاکامی)

۲) Fish Disease (Diagnosis & Treatment), Second Edition, Edward J. Noga





Response of Fish Following an Encounter with a Pathogen



Natural Immunity and Disease Resistance

- **Mucus and skin:** natural barriers, has molecules with immune actions:
  - Lysozyme
  - Complement
  - Natural antibodies (Ab)
  - Specific antibodies tentatively reported in mucus. mucus immunoglobulin elevated after exposure to bacteria.

Natural Immunity and Disease Resistance

Non-specific immune cells

- **Monocytes and tissue macrophages**: most important cells in immune response, produce cytokines, primary cells involved in phagocytosis and first killing of pathogens upon first recognition and subsequent infection.

- **Neutrophils**: primary cells in early stages of inflammation, neutrophils produce cytokines to recruit immune cells to damaged or infected area; neutrophils are phagocytic and kill bacteria by extracellular mechanisms

- **Natural killer cells**: use receptor binding to target cells and lyse them; important in parasitic and viral immunity.

Natural Immunity and Disease Resistance

Nonspecific Humoral Molecules:

Molecule	Composition	Mode of Action
Lectins	Specific sugar-binding proteins	Recognition, precipitation, agglutination
Lytic enzymes	Catalytic proteins lysozyme, etc.	Hemolytic and antibacterial activity
Transferrin/lactoferrin	Glycoprotein	Iron binding
Ceruloplasmin	Acute-phase protein	Copper binding
C-reactive protein	Acute-phase protein	Activation of complement
Interferon	protein	Resistance to viral infection

Natural Immunity and Disease Resistance

1. **Phagocytosis:** most primitive of defense mechanisms, occurs in stages
   - Movement by chemotaxis (directional) or chemokinesis (non-d) of phagocytes in response to foreign object
   - Attachment via lectins.
   - Engulfment of the foreign agent (simple movement into the phagocyte)
   - Killing and digestion

Natural Immunity and Disease Resistance

2. Inflammation:

3. Complement: consists of 20 or more chemically different serum proteins + glycoproteins having enzyme function originally named "complement" because it was considered a biological substance *complementing* the action of antibody.

- **Action:** clears antigenic molecules, immune complexes, participates in inflammation and phagocytosis

Fish Immune System

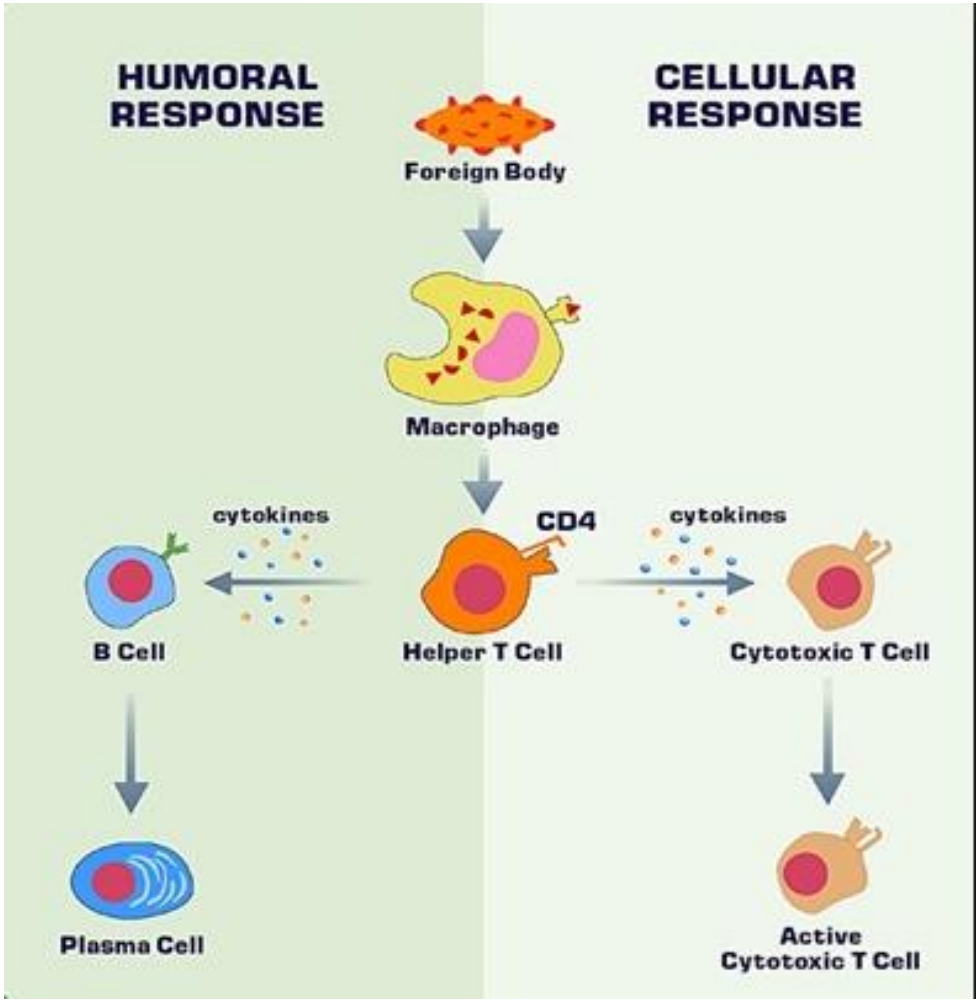
- Most important immunocompetent organs: thymus, kidney (head, trunk), spleen and liver
- **Thymus:** develops T-lymphocytes (helpers, killers; similar to other vert's)
- **Kidney:** important in both immunity and hematopoiesis, site of blood cell differentiation
  - Early immune response handled by entire kidney
  - With maturity, anterior used for immune response; posterior for blood filtration, urinary activities
  - Blood flows slowly through kidney and antigens are "trapped" or exposed to reticular cells, macrophages, lymphocytes
  - Anterior is where "memory" occurs.

Fish Immune System

- **Spleen:** secondary to kidney, involved in immune reactivity and blood cell formation, contains lymphocytes and macrophages

- **Liver:** could be involved in production of components of the complement cascade, important in resistance; not real clear

Immune Response



Humoral Immunity in Fish

- The antibody response to foreign antigens
- Fish posses B-cells (surface immunoglobulin-positive cells), similar to mammals in structure.
- Surface IgM of B-cells serves as receptor for antigen recognition and is of same specificity as the antibody molecule that will be produced.
- Unlike crustaceans, fish possess immunologic memory.
- Their primary and memory response both use the same IgM molecule, with eight antigen binding sites, a potent activator of complement

Cell-Mediated Immunity in Fish

- Used to eliminate intracellular pathogens (e.g., bacteria, virus, parasites).
- Relies on contact of the foreign invader with the subsequent presentation of an antigen having the same major histocompatability complex (MHC I or II) to T-helper cells.
- Once T-helper cells are stimulated, the produce cytokines that result in stimulation of effector cells (cytotoxic lymphocytes) or macrophages
- Cytokines stimulate aforementioned cells and also recruit new cells to the area, activate them

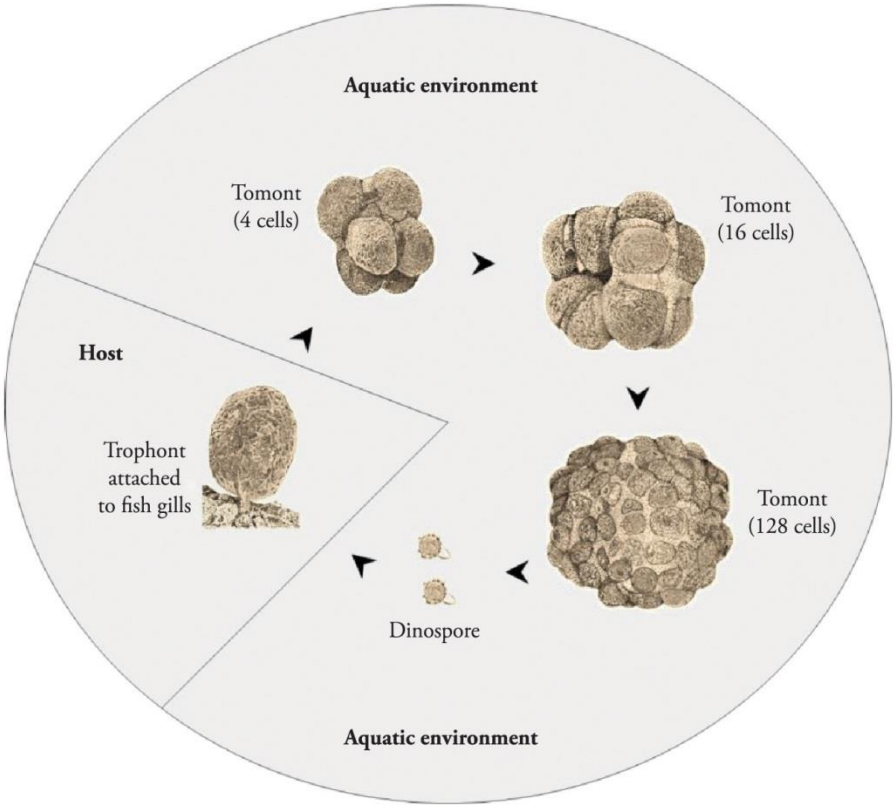
Factors Influencing Disease Resistance and Immune Response of Fish

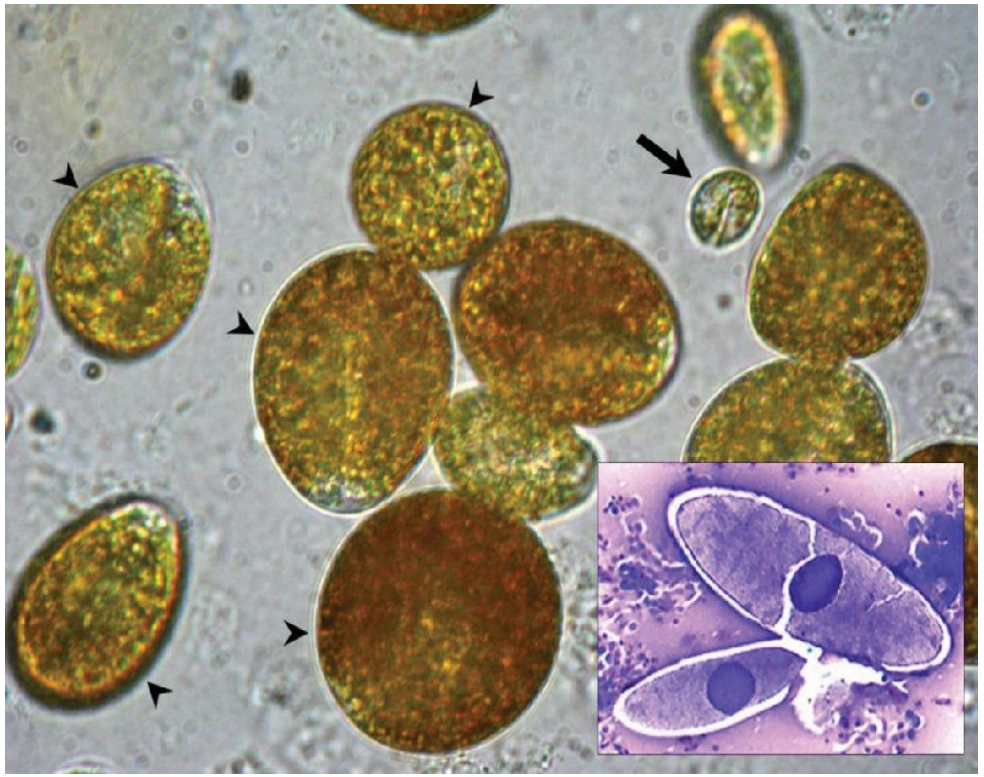
General	Specific
Genetics	Individuals may exhibit differences in innate resistance and acquired immunity
Environment	Temperature, season, photoperiod
Stress	Water quality, pollution, density, handling and transport, breeding cycles
Nutrition	Feed quality and quantity, nutrient availability, use of immunostimulants, antinutritional factors in feeds
Fish	Age, species or strains
Pathogen	Exposure levels, type (parasite, bacterial, viral), virulence

[1]From Shoemaker et al.,2001. Immunity and disease resistance in fish. In: Nutrition and Fish Health (Ed.: Lim, C., Webster, C.D.). Food Products Press, NY. Pgs 149-162.

Stress

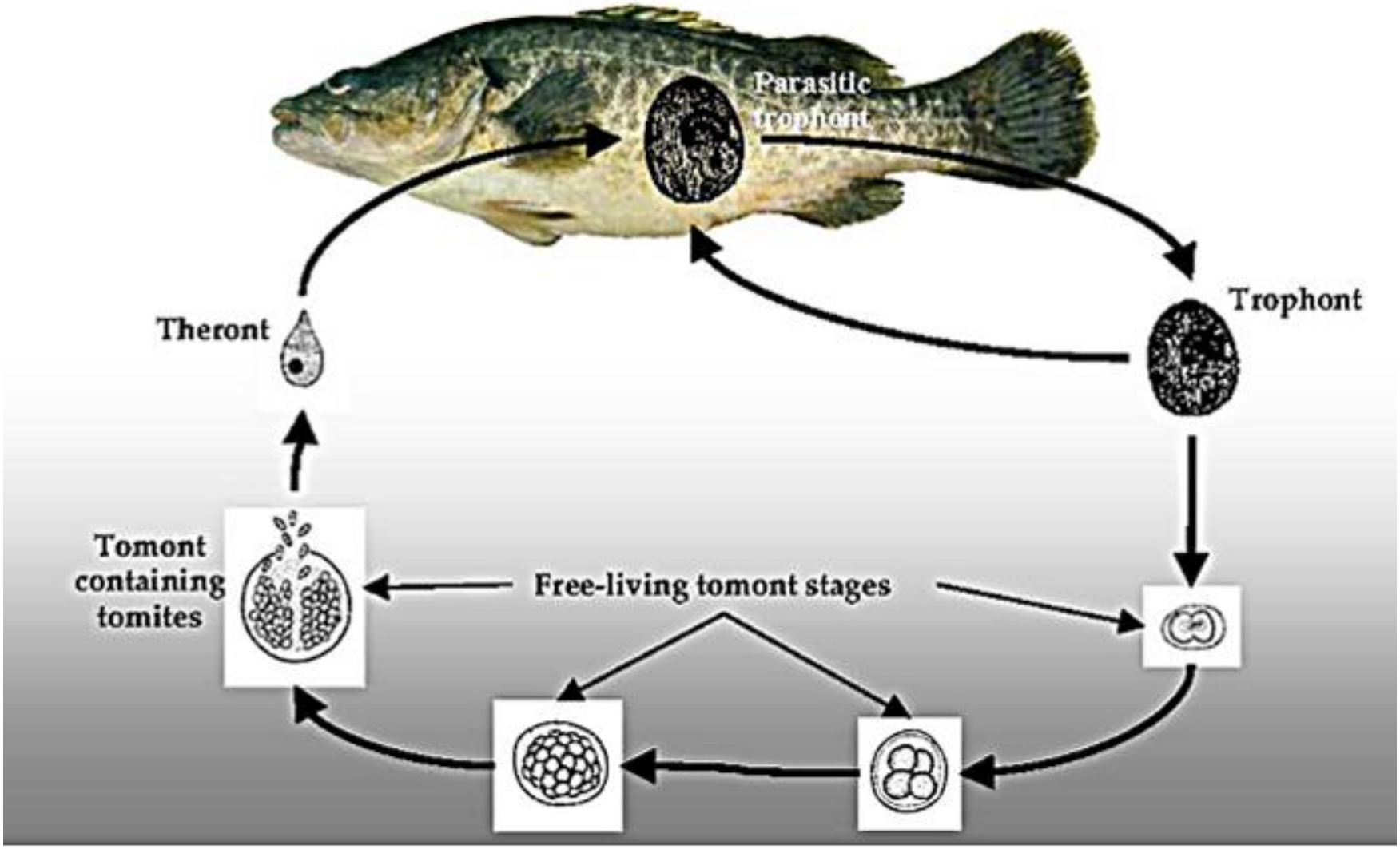
Nutrition





Piscinoodinium pillulare from gill scraps of tambaqui *Colossoma macropomum*. Pear-shaped trophonts, rounded (arrowheads) and one dinospore (arrow). In detail, two parasites stained in Giemsa exhibiting oval to rounded nucleus with the absence of micronucleus.

Protozoa Life Cycle



Piscinoodiniosis (Freshwater Velvet Disease)

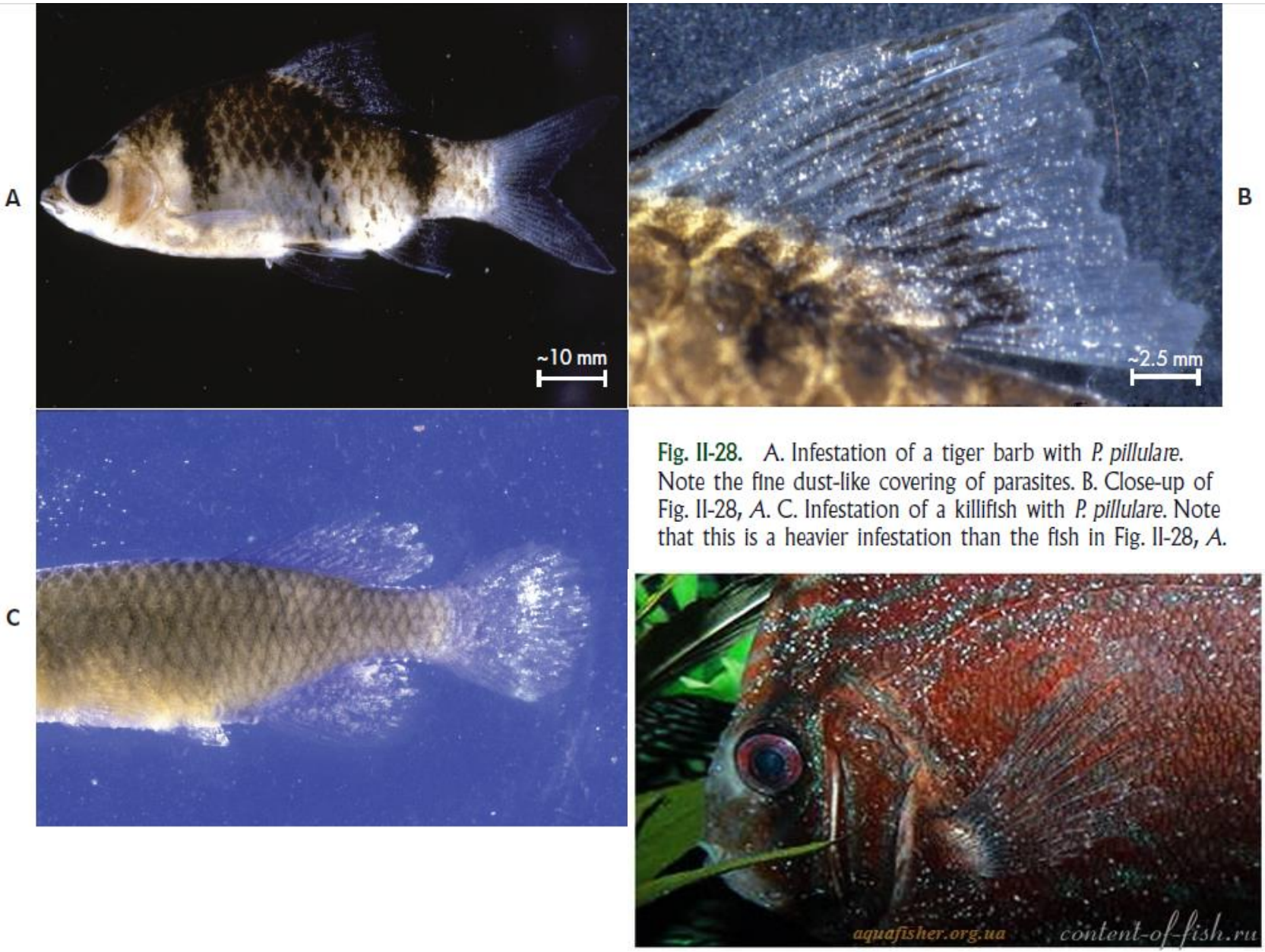
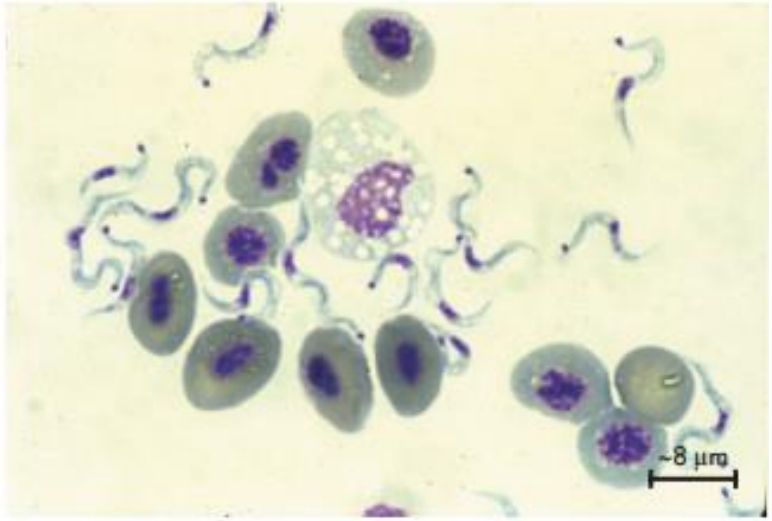
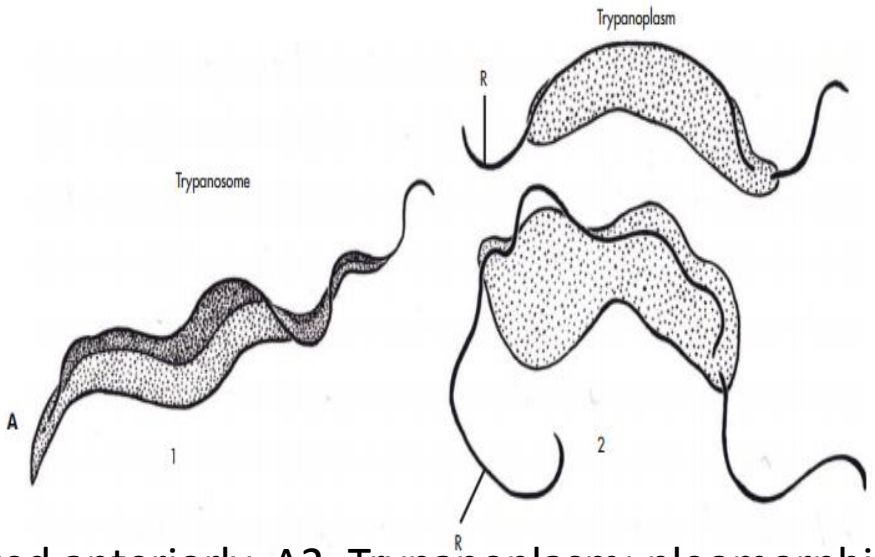


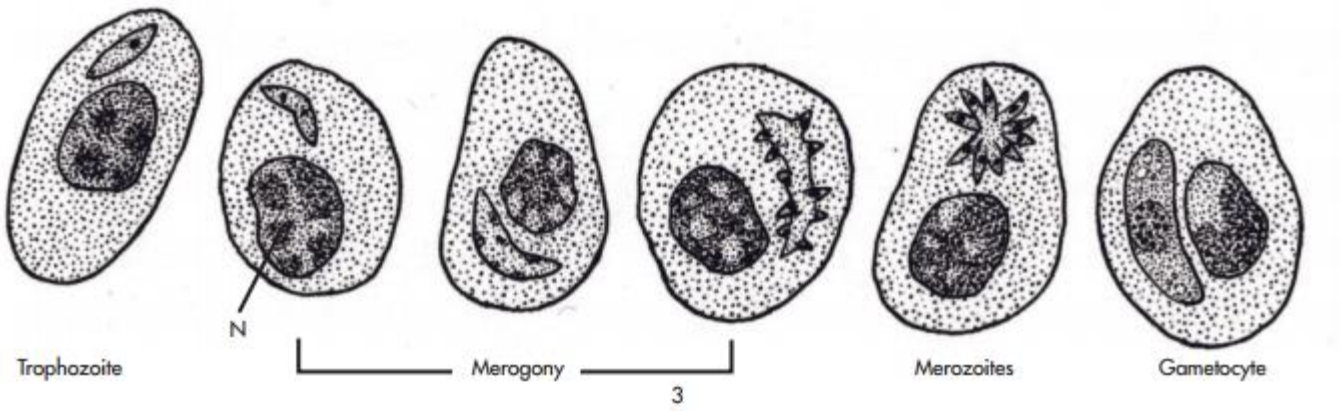
Fig. II-28. A. Infestation of a tiger barb with *P. pillulare*. Note the fine dust-like covering of parasites. B. Close-up of Fig. II-28, *A*. C. Infestation of a killifish with *P. pillulare*. Note that this is a heavier infestation than the fish in Fig. II-28, *A*.

Trypanosomatids





A1. Trypanosomes: shape; single flagellum directed anteriorly. A2. Trypanoplasm: pleomorphic shape; two flagella, one directed anteriorly, the other (R = recurrent flagellum) directed posteriorly. The recurrent flagellum forms a characteristically wide, wavy, undulating membrane; these organisms are highly similar to Cryptobia .



Ichthyobodosis (Costiasis)

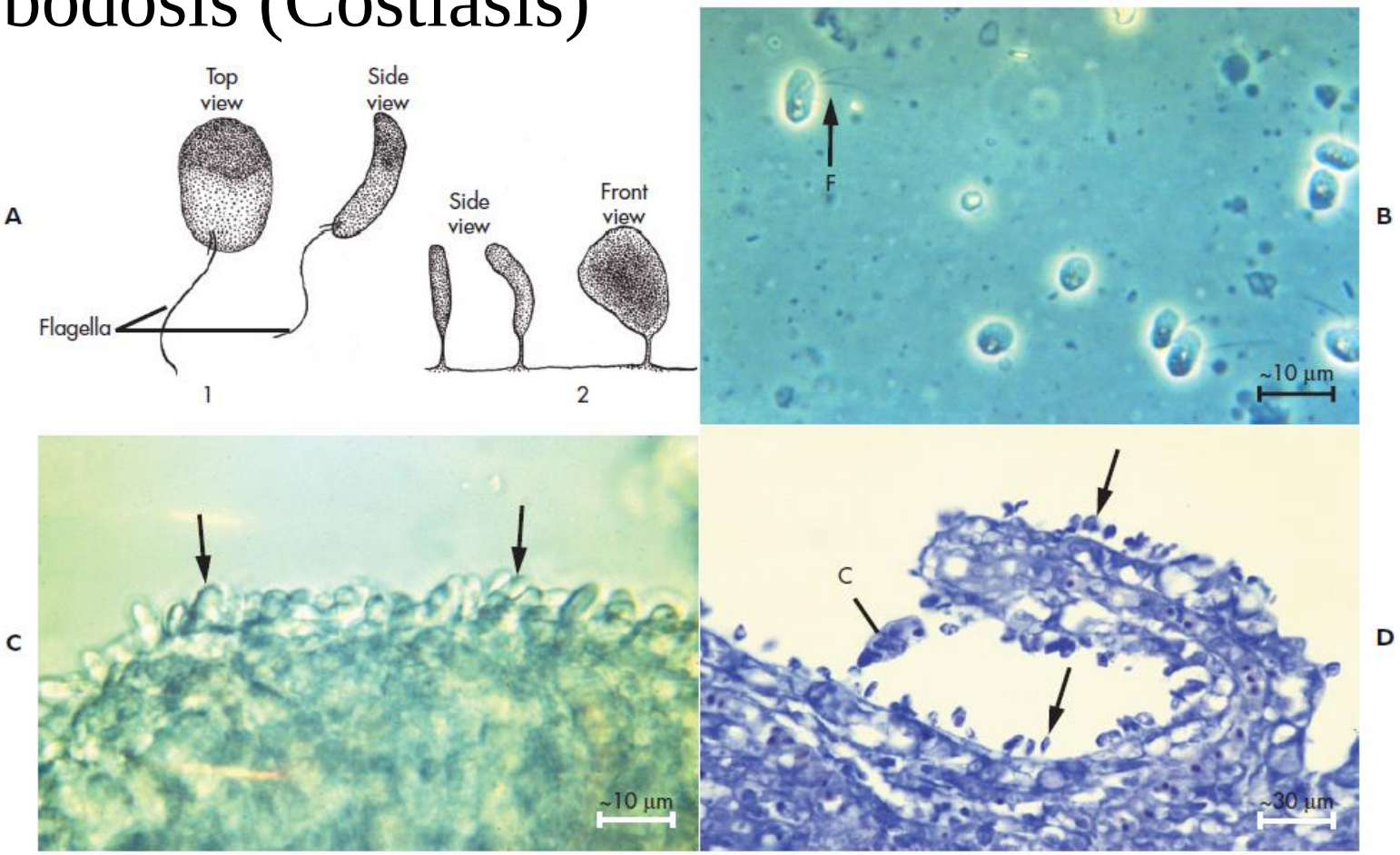


Fig. II-29. A. *Ichthyobodo*. Diagrams with key characteristics: (*1*) Free-swimming stage: size (~5–8 × 10–15 µm); slightly asymmetrical; oval body on top view; flattened, crescent shape on side view; single or paired flagella directed posterolaterally. (*2*) Attached stage: pyriform shape; flagella are not easily seen when attached. B. Wet mount of the free-swimming stage of *I. necator*. *F* = flagellum. C. Wet mount of many *Ichthyobodo* (*arrows*) attached to the gill epithelium. D. Histological section of gill with a heavy *I. necator* infestation (*arrows*). Note the pyriform, dorsoventrally flattened shape on side view. A larger, unrelated ciliate (*C*) is also present. Giemsa. (*B* and *C* photographs courtesy of G. Hoffman.).

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Cryptobiosis

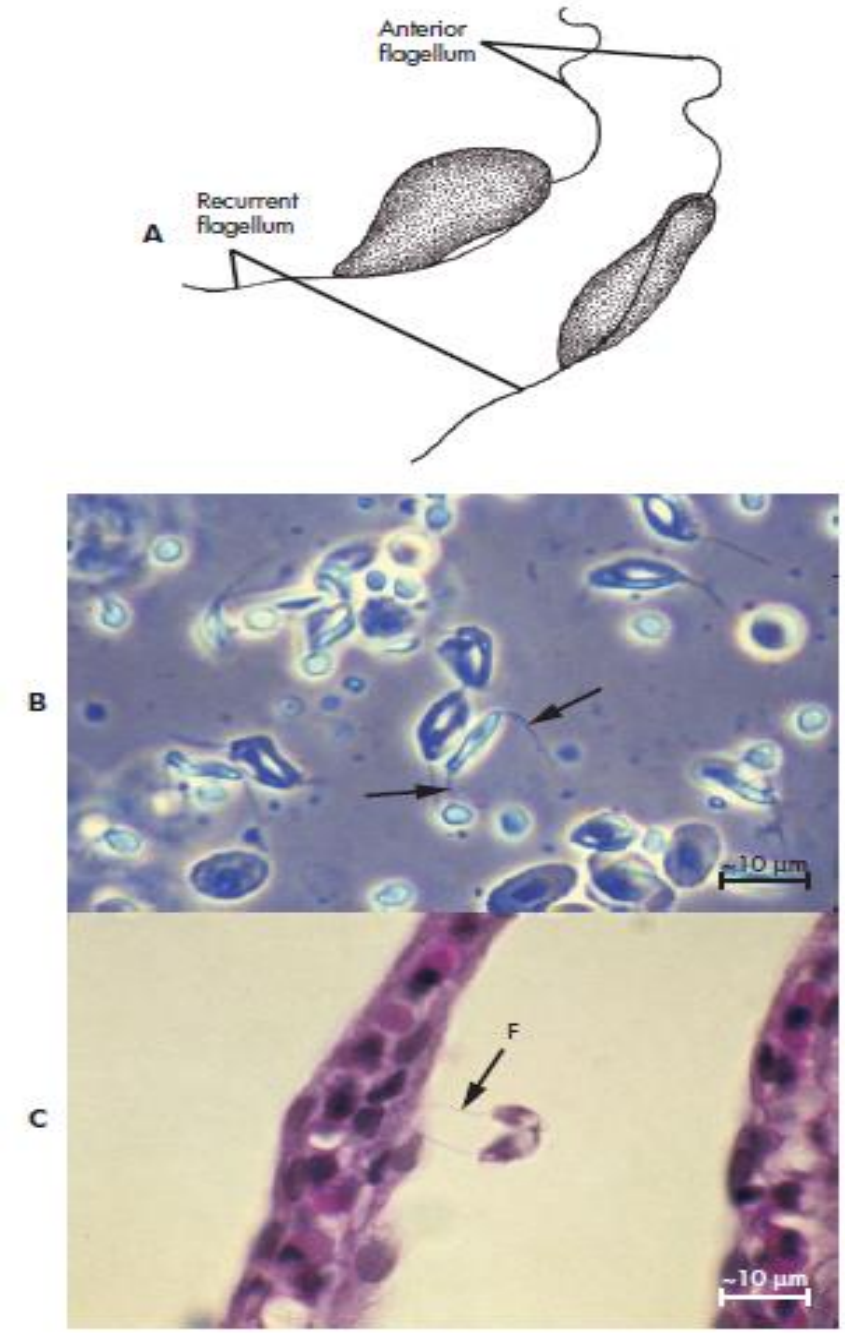


Fig. II-30. A. *Cryptobia*. Diagram with key characteristics: size (~10–20 × ~3–6 µm); pleomorphic shape; two flagella (one directed anteriorly and the other [recurrent flagellum] directed posteriorly). The recurrent flagellum sometimes forms a short, undulating membrane (see *Trypanoplasma*). B. Wet mount of *Cryptobia eilatica* from the gills of European sea bass. Note the two flagella (*arrows*), directed anteriorly and posteriorly. C. Histological section of two cryptobids from striped bass attached to a gill secondary lamella by their recurrent flagellum (*F*). Hematoxylin and eosin. (*B* photograph courtesy of A. Diamant; *C* photograph by L. Khoo and E. Noga.)

Hexamitosis

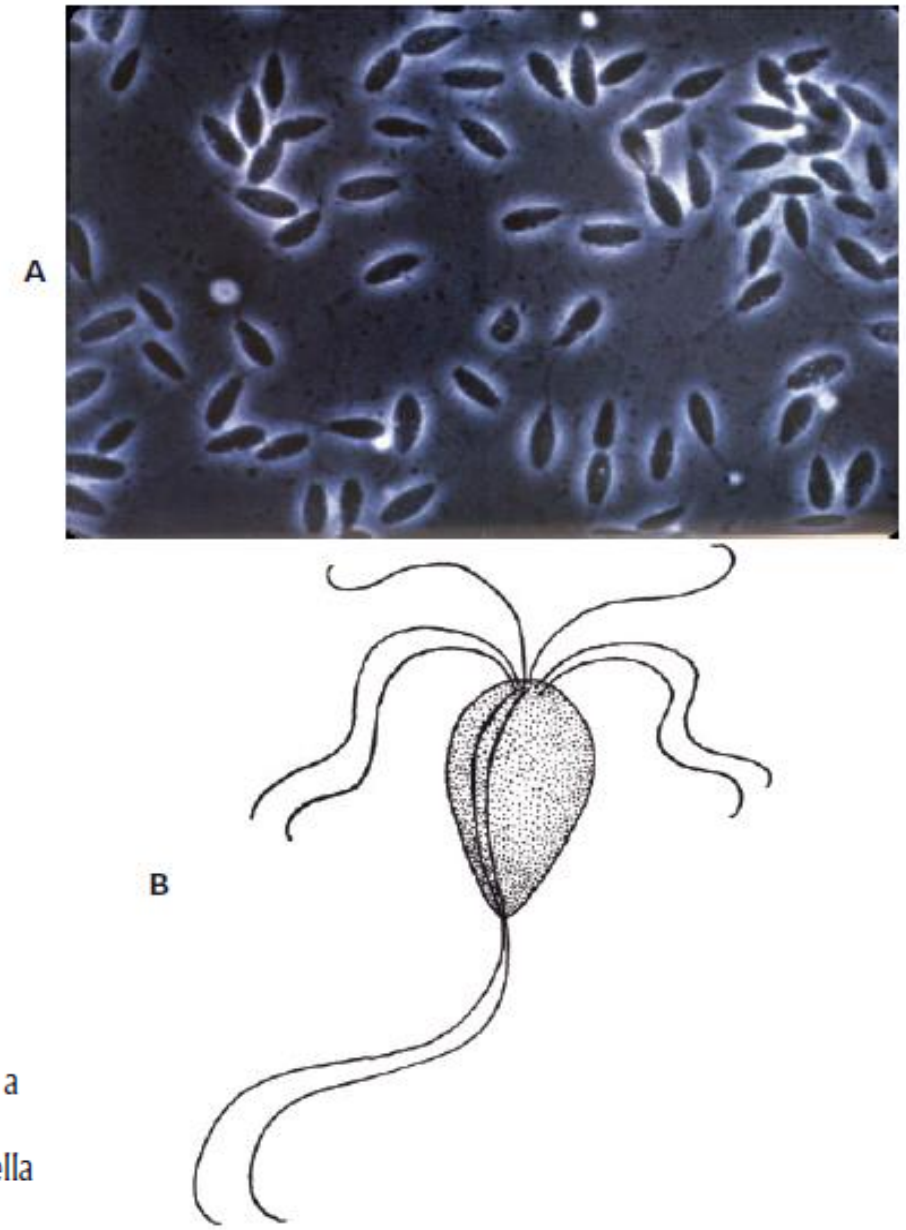
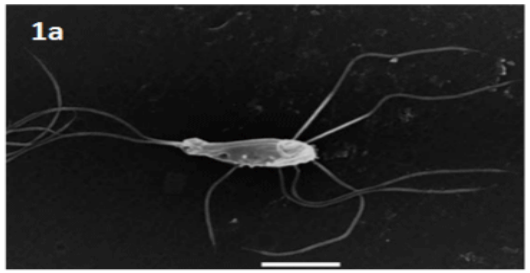


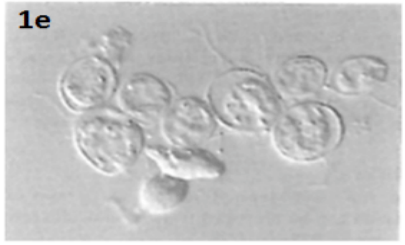
Fig. II-73. A. Wet mount of diplomonads. B. Diagram of a typical diplomonad flagellate with diagnostic features: size (from 5 to 20μm long, excluding the flagella); eight flagella (three pairs anteriorly, one pair posteriorly); pyriform to ellipsoidal to egg-shape to tapering body. (*A* from Hoffman and Meyer 1974.)



Ingestion by a fish host and excystment

Trophozoite

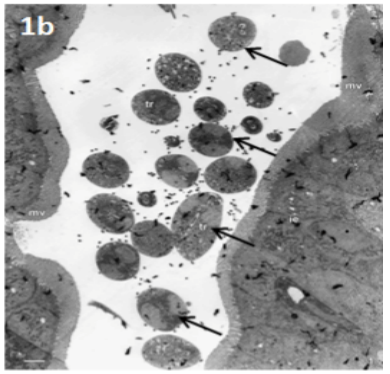
Asexual reproduction by longitudinal binary fission



Cyst

Lifecycle of *Spironucleus* spp.

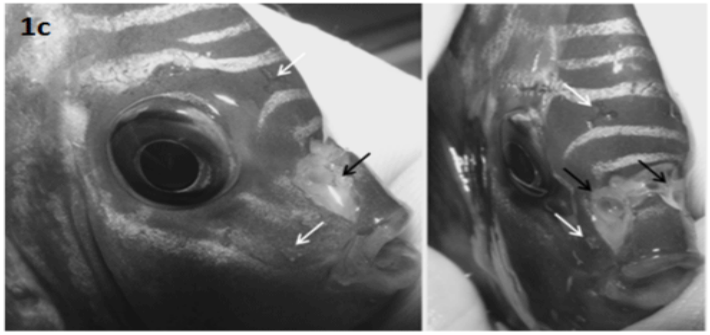
Intestinal colonization

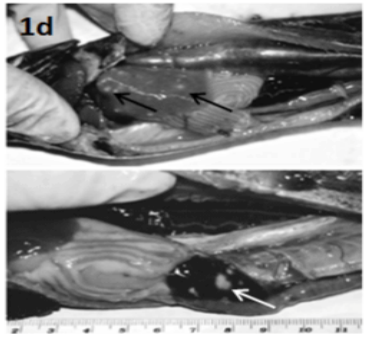


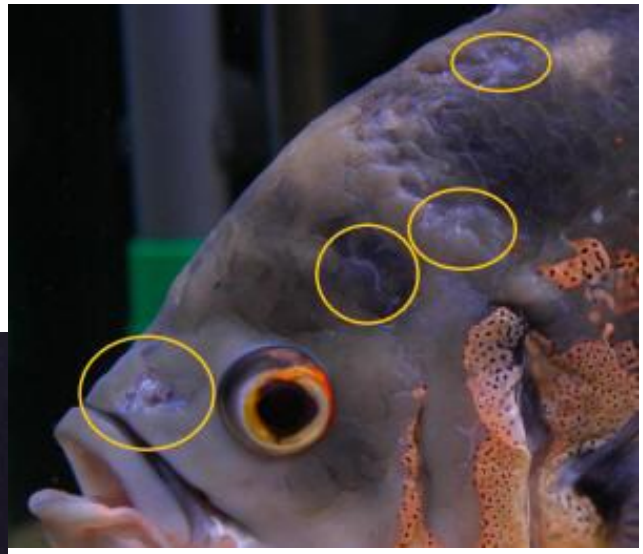
Encystment and release into water body

Systemic infection

Invasion of the intestinal mucosa







Parasitic Disaeses

- **2) Phylum Ciliophora (مژه داران)**

Ichthyophthiriosis (Ich Infection)

Fig. II-20. A. *Ichthyophthirius multifiliis* life cycle. *a* = trophonts; *b* = dividing tomont; *c* = tomites/theronts. B. Close-up view of a bluegill with ich. Note that the parasite nodules (*arrows*) protrude slightly above the skin surface. C. Channel catfish with a heavy ich infection.

Ich Infection

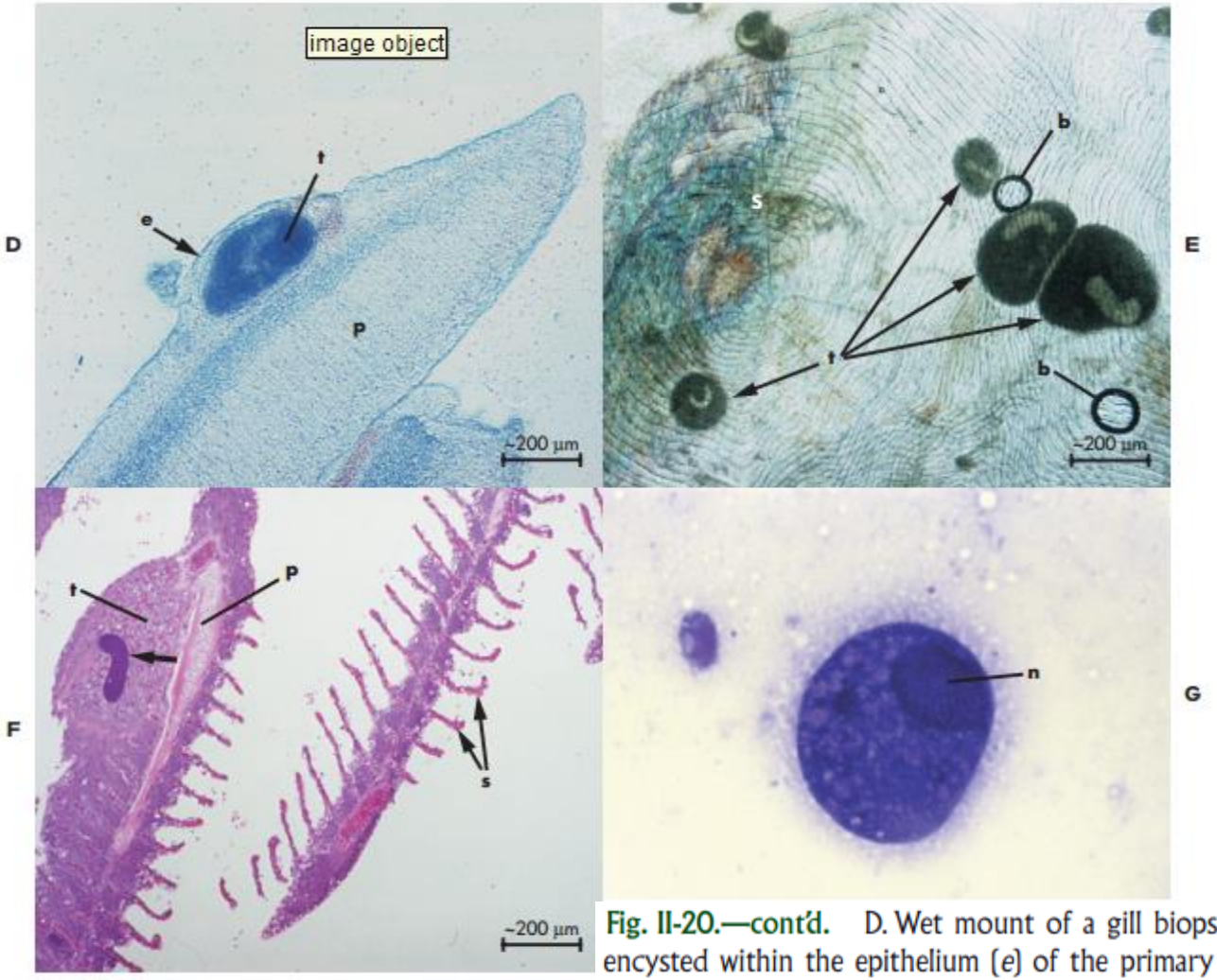


Fig. II-20.—cont'd. D. Wet mount of a gill biopsy showing *I. multifiliis* trophont (*t*) encysted within the epithelium (*e*) of the primary lamella (*p*). E. Wet mount of a skin scraping showing *I. multifiliis* trophonts (*t*). Key features include the size variation of the pleomorphic parasites and the C-shaped macronucleus. *s* = fish scale; *b* = air bubble. F. Histological section through trophont (*t*). Note the macronucleus (*arrow*): the C shape is not apparent in every section through a parasite. *p* = primary gill lamella; *s* = secondary gill lamellae. Multiple trophonts at the same site might be due to multiplication while in the fish (Ewing et al. 1988). G. Stained smear of an *I. multifiliis* trophont. Note that the nucleus (*n*) is not C-shaped in this immature individual. In larger individuals, the nucleus is usually not visible on a stained smear. Modified Wright's. (*A* figure by B. Davison-DeGraves and E. Noga; *C* photograph by R. Bullis and E. Noga; *F* photograph courtesy of L. Khoo.)

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Chilodonellosis

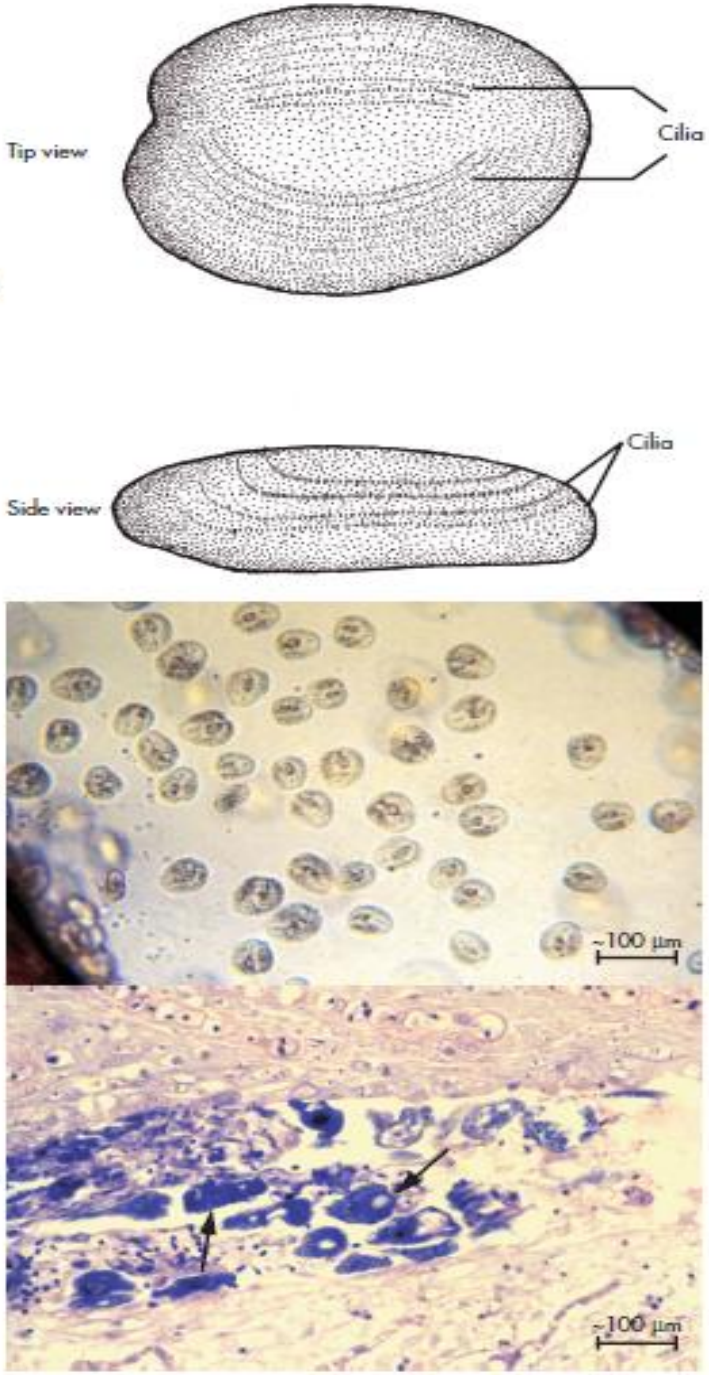

Fig. II-23. A. *Chilodonella*. Diagram of key characteristics: size (usually ~40–60 µm long); bands of cilia; when viewed from above (*top view*), oval-to-heart-shape, with notched anterior end; parasites are a flattened shape when viewed from the side (*side view*). B. Wet mount of *Chilodonella ciprini*. C. Histological section of gill with *Chilodonella* (*arrows*). Giemsa. (*B* photograph courtesy of G. Hoffman.)

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Trichodinosis

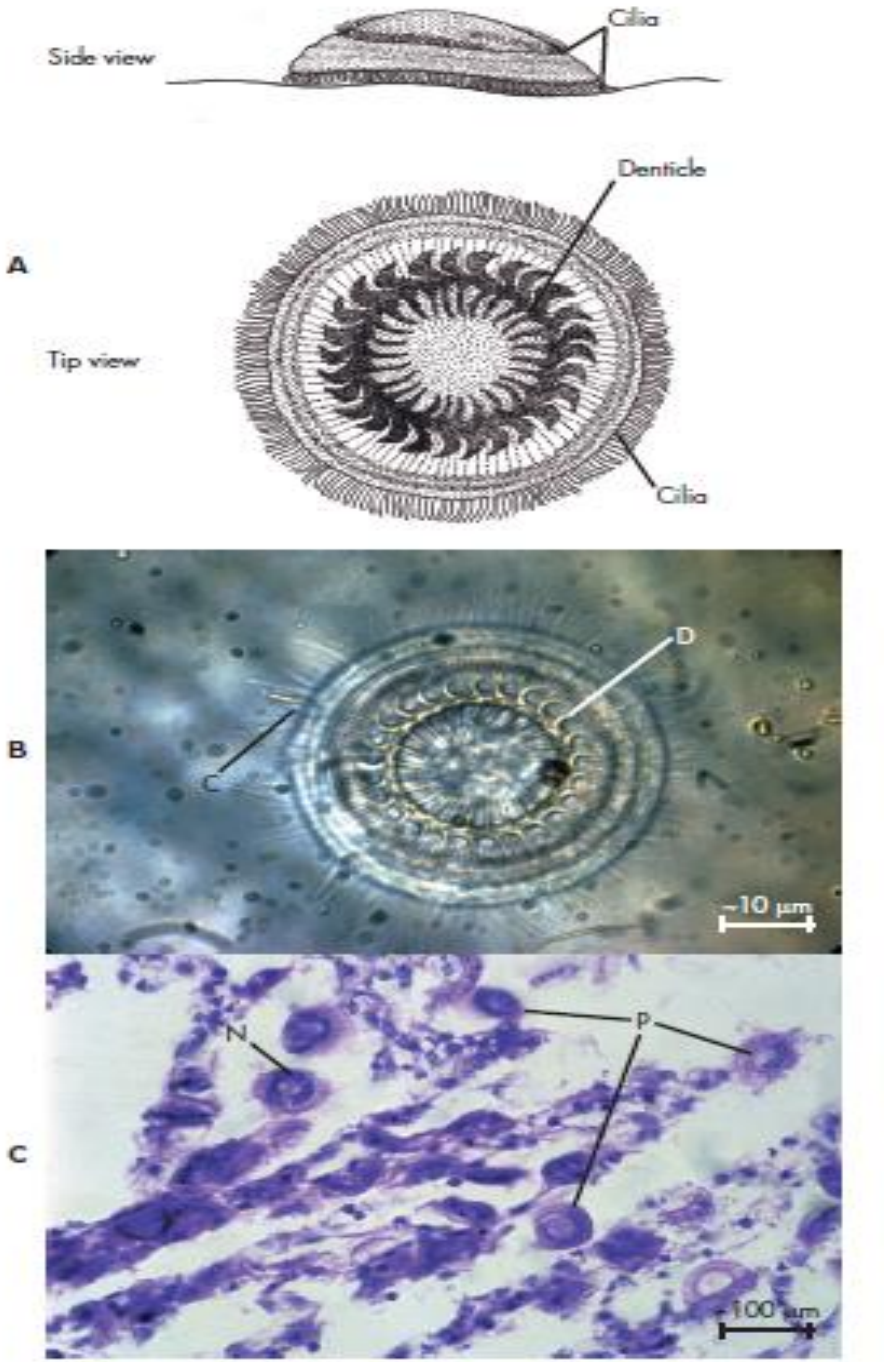

Fig. II-22. A. Diagram of a typical trichodinid parasite with key characteristics: size (15–120 µm, usually 40–60 µm in diameter); cilia for locomotion; round shape when seen from top of parasite (dorsally); and ring with hook-like denticles. B. Wet mount of a typical trichodinid parasite. *C* = cilia; *D* = denticle. C. Histological section through the gill of a goldfish with a heavy trichodinid infestation. Parasites (*P*) can be recognized by their round shape from above. *N* = nucleus. (*B* photograph courtesy of F. Meyer.)

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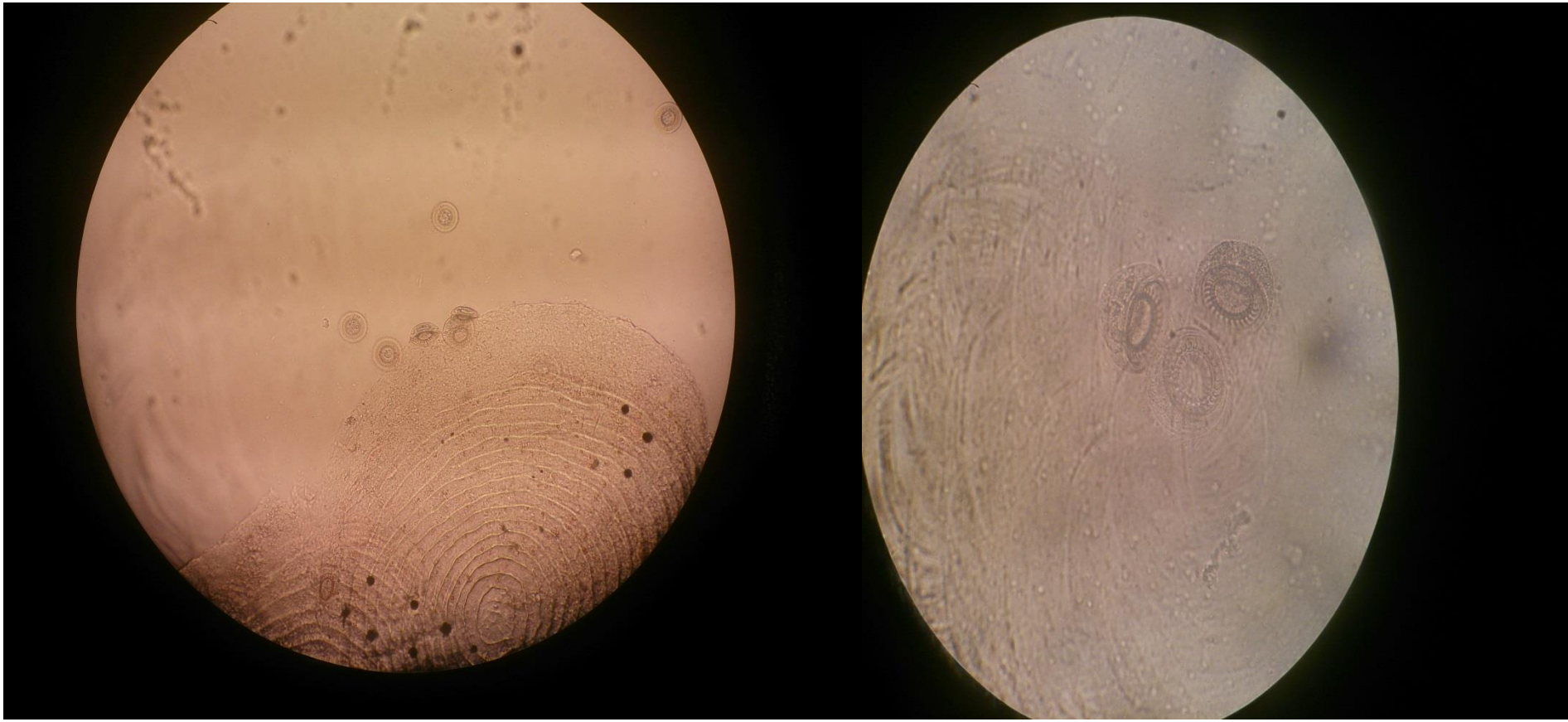
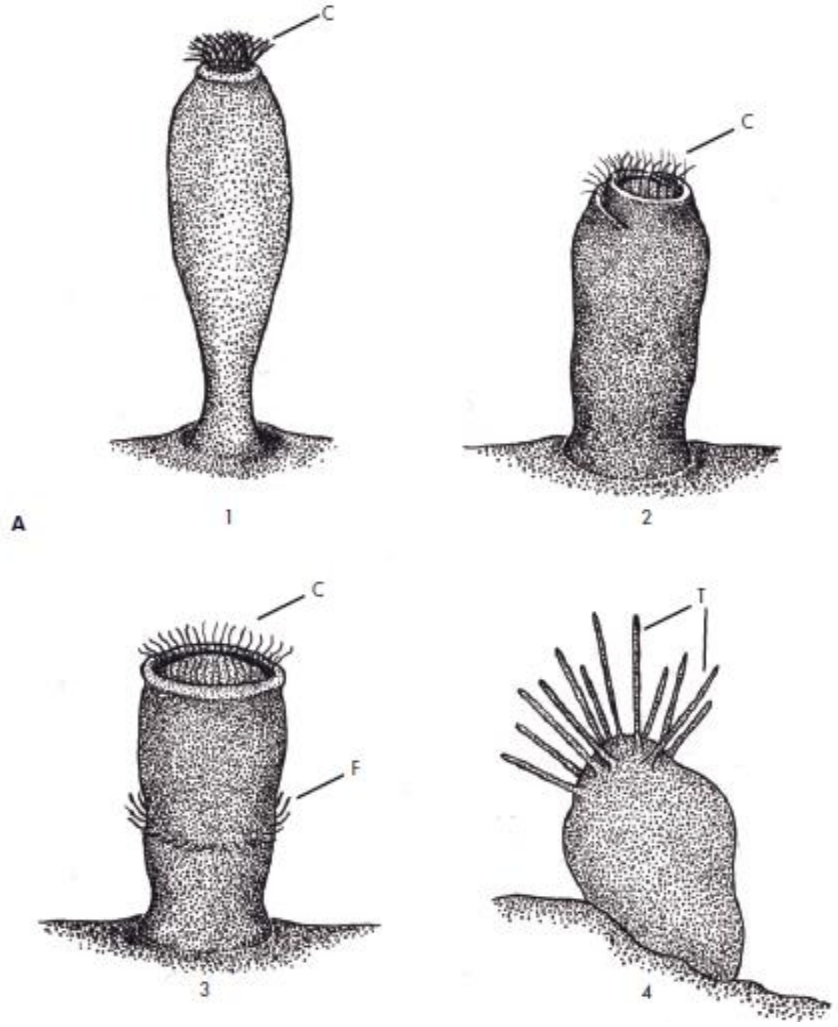


Sessilina



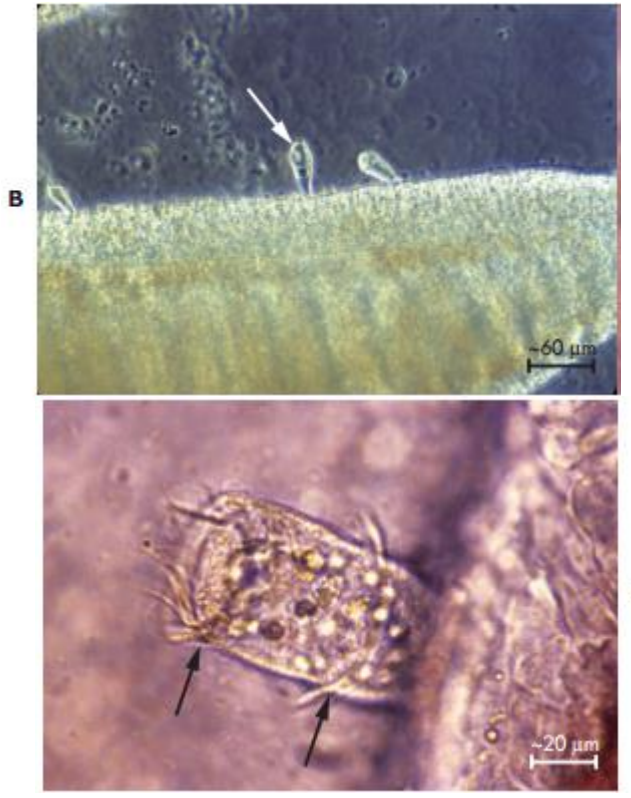
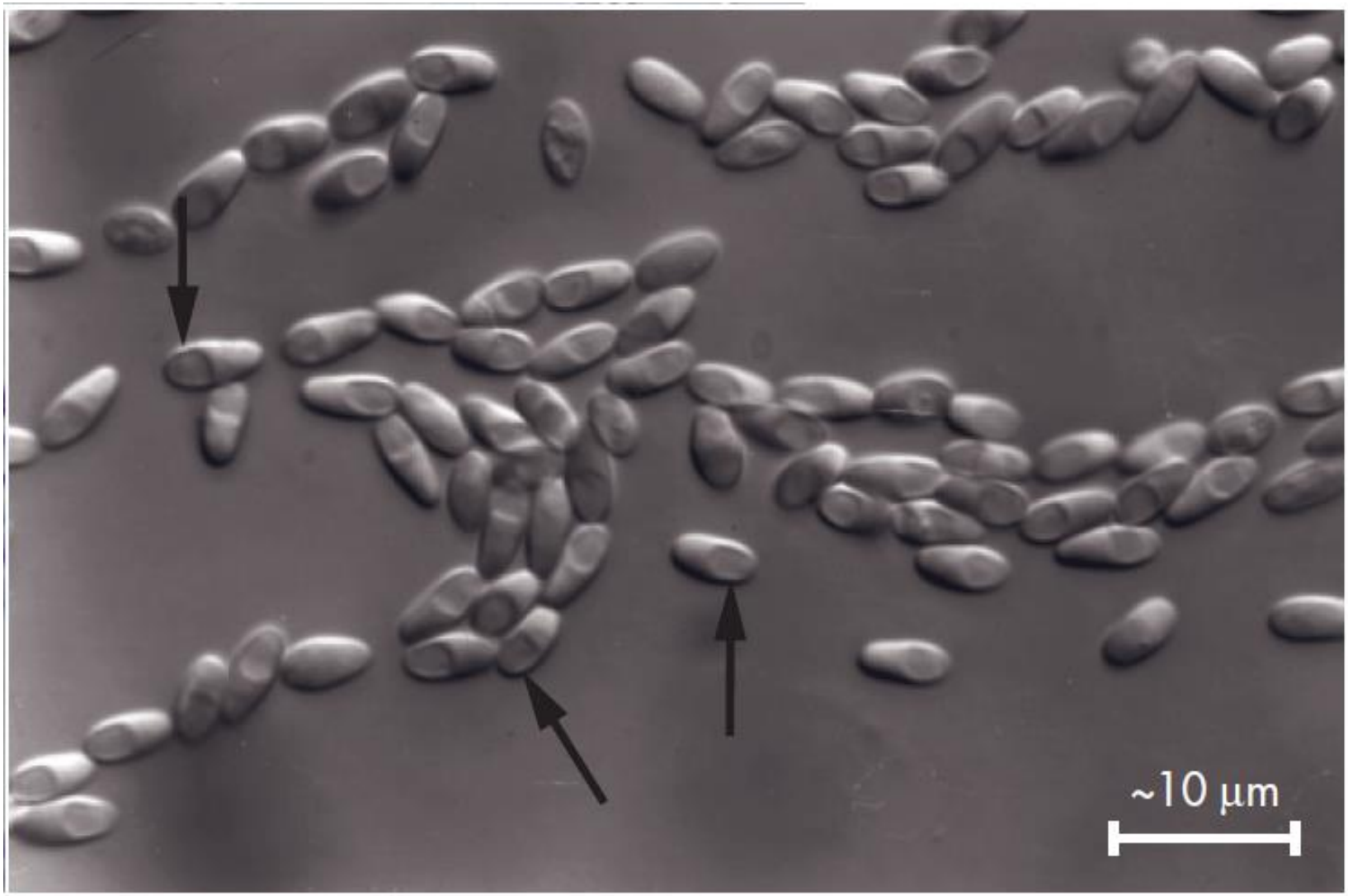


Fig. II-32. A. Sessile, solitary, ectocommensal ciliates. Diagrams with key characteristics (*C* = cilia). Most range from ~40 to 100 µm. All except *Capriniana* may occur on skin or gills: (*1*) *Apiosoma* (66 species); elongated body; only oral cilia; freshwater; (*2*) *Riboscyphidia* (~18 species): cylindrical to conical body; only oral cilia; freshwater or marine; (*3*) *Ambiphrya* (4 species): cylindrical to conical body; oral cilia; permanent, motionless, equatorial, ciliary fringe (*F*); freshwater; (*4*) *Capriniana piscium:* variable size (usually 40–110 × 25–70 µm); pleomorphic shape; feeding tubes (*T*); body adhered to secondary lamella of gill. B. Wet mount of *Apiosoma* (formerly *Glossatella*) infestation (*arrow*). Note the vase shape. C. Wet mount of *Ambiphrya* (formerly *Scyphidia*). Note the oral and aboral cilia (*arrows*).

Parasitic Disaeses

- 3) Phylum Sporzoa (هاگداران)
- 4) Microsporidia
- 5) Myxosporidia

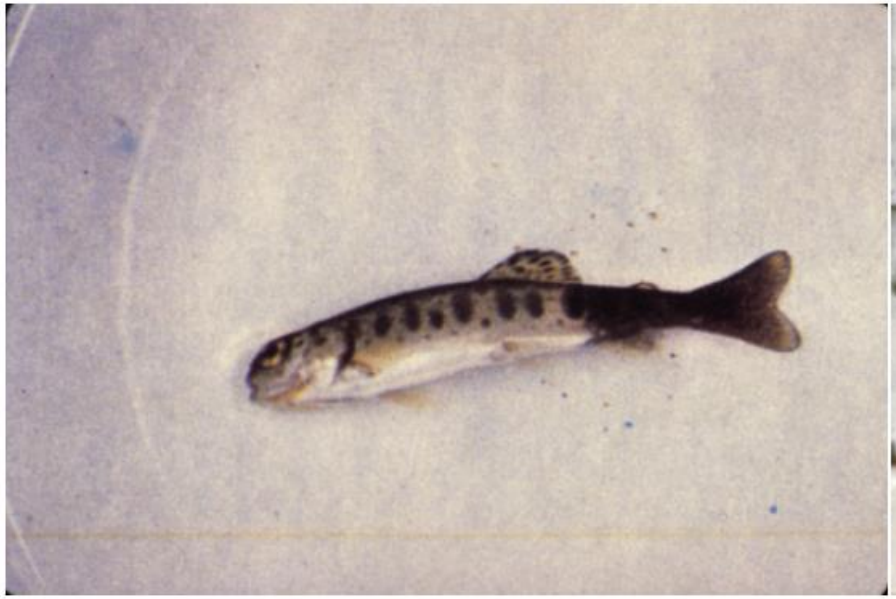


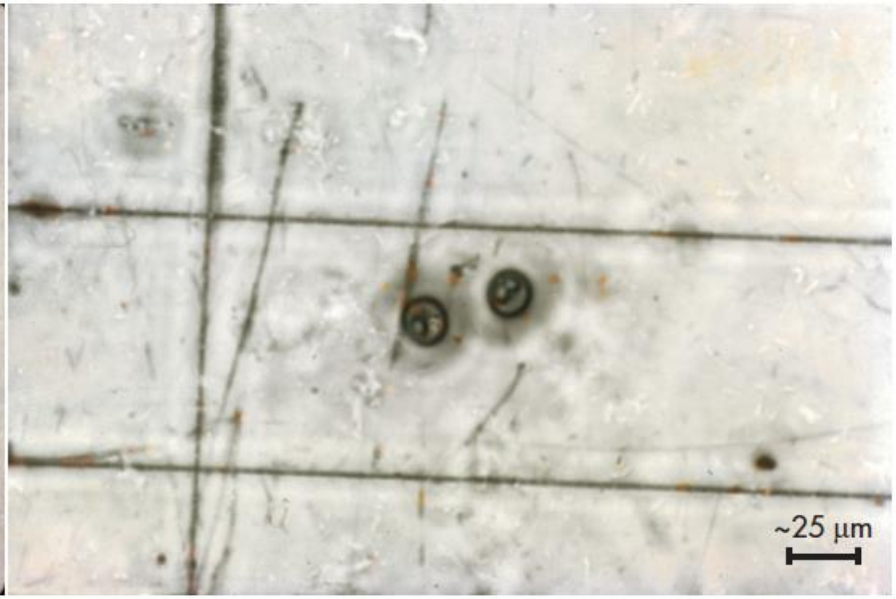
E

E. Individual microsporidian spores.

Myxosomiasis

A





B

Fig. II-68. A. Rainbow trout with whirling disease. Black tail. B. Wet mount of cartilage digest from a fish with whirling disease, showing the characteristic spores that are almost round in front view, with two pyriform polar capsules. (*A* and *B* photographs courtesy of G. Hoffman.)

Parasitic Disaeses

- 2- Parasitic Metazoa (انگلهای پریاخته)
- 1) Platyhelminthes (کرمهای پهن)
- 1- Cestoda (کرمهای نواری)

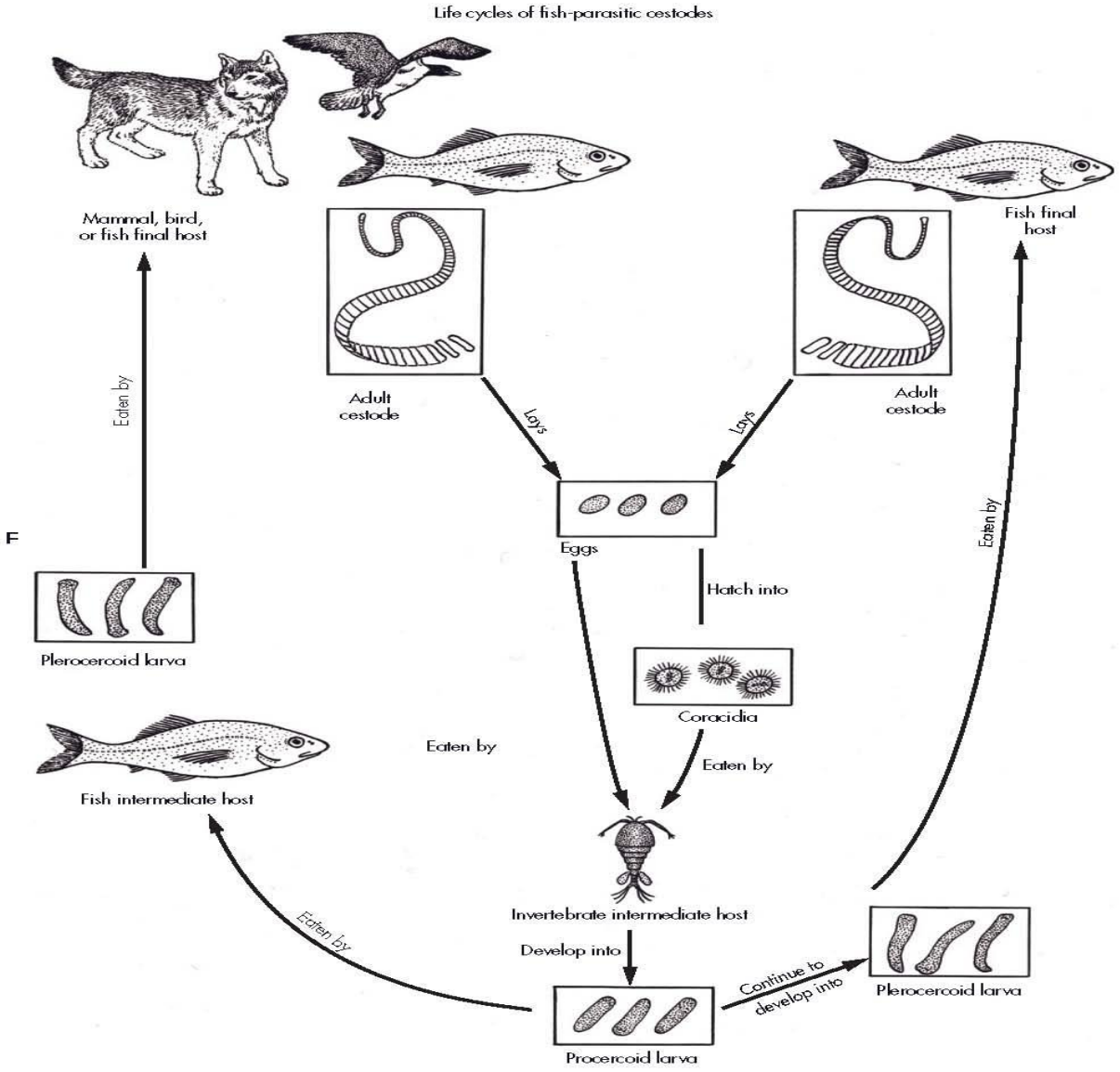
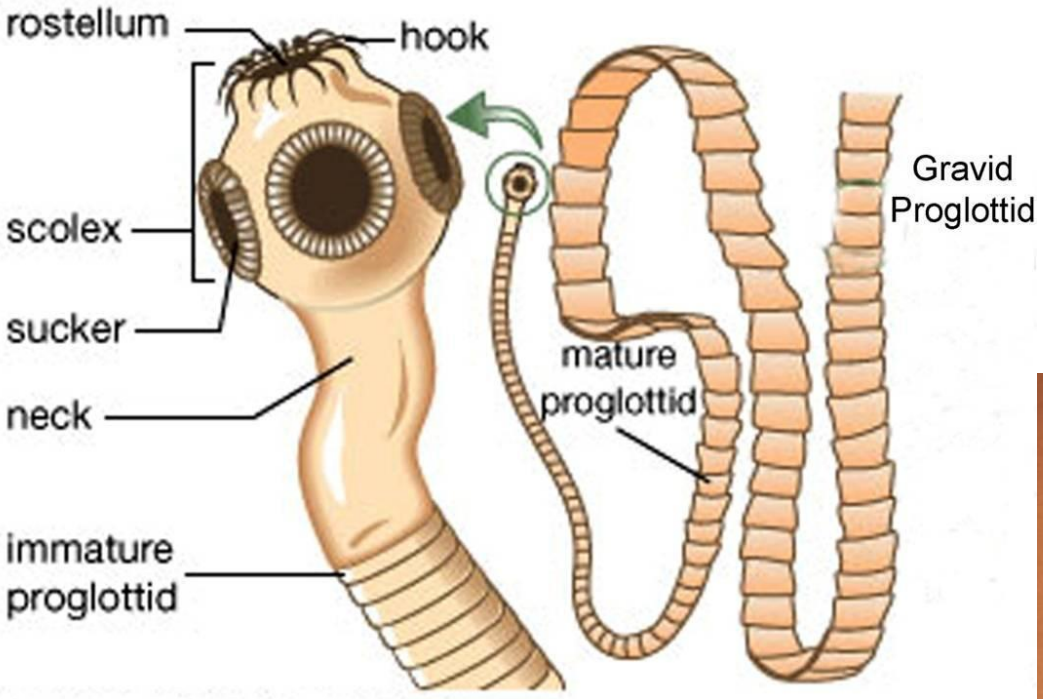


Fig. 11-61.—cont'd. F. Life cycles of cestodes infecting fish.

Continued.

Scolex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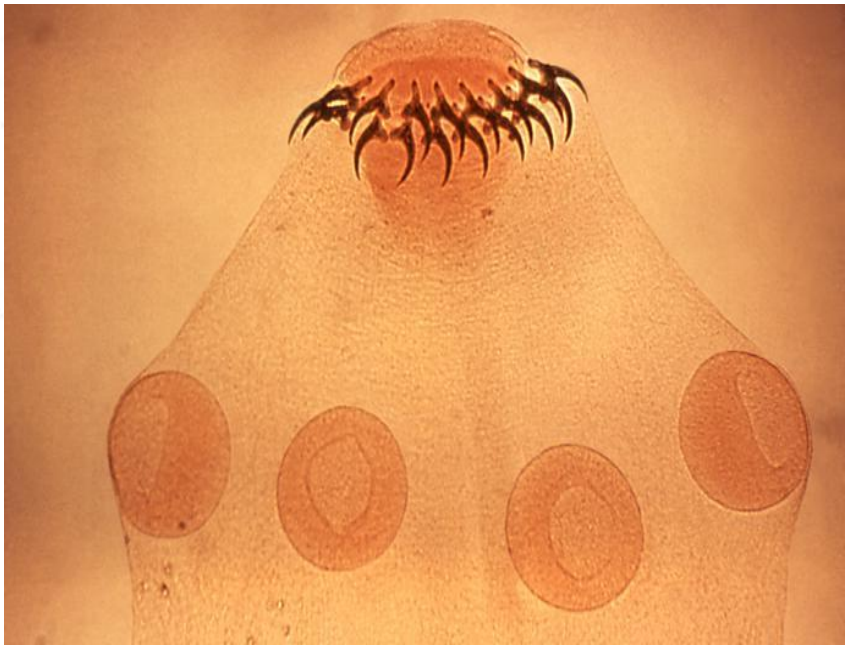
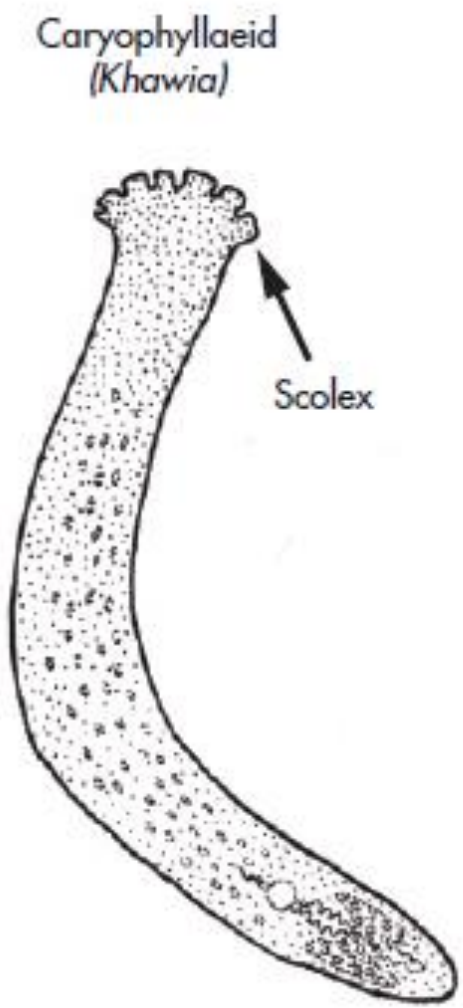
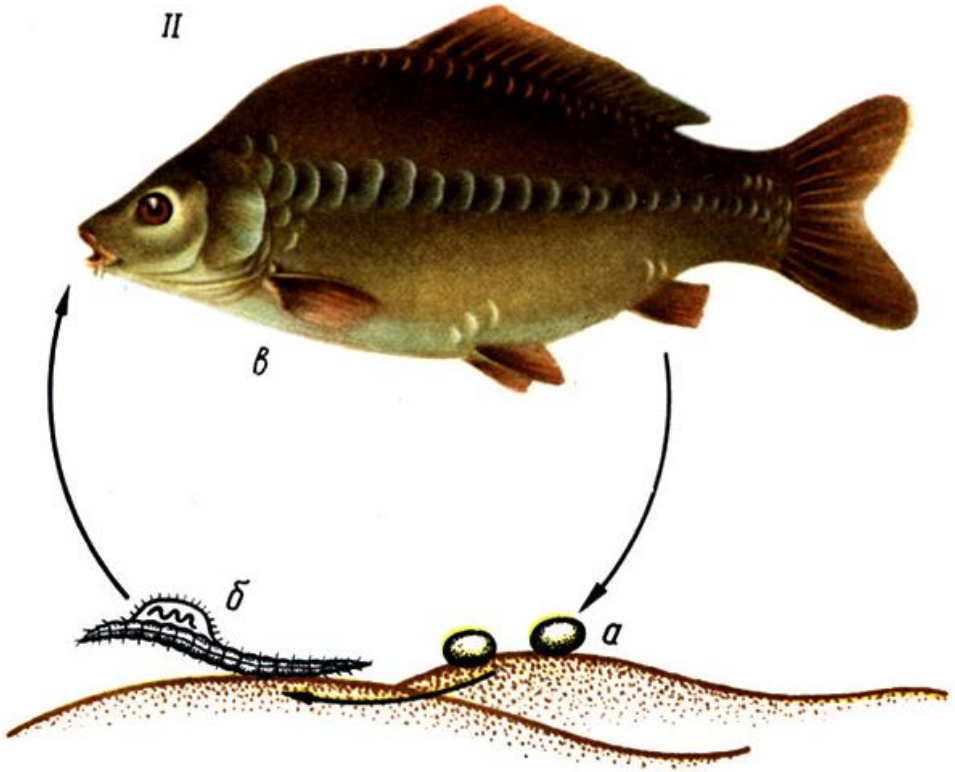


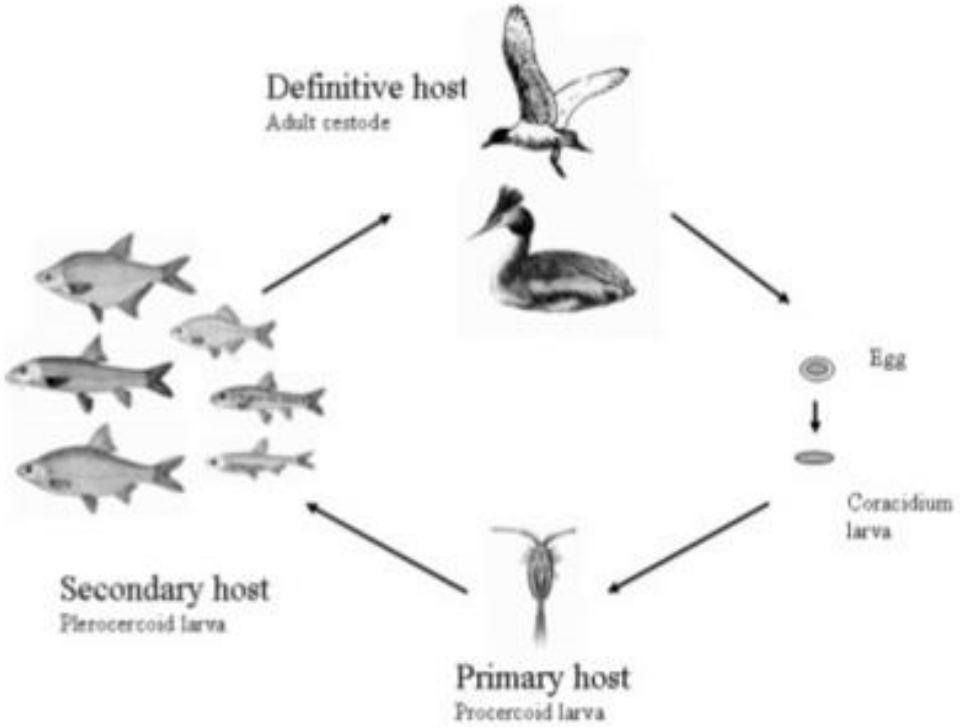
Khawiose





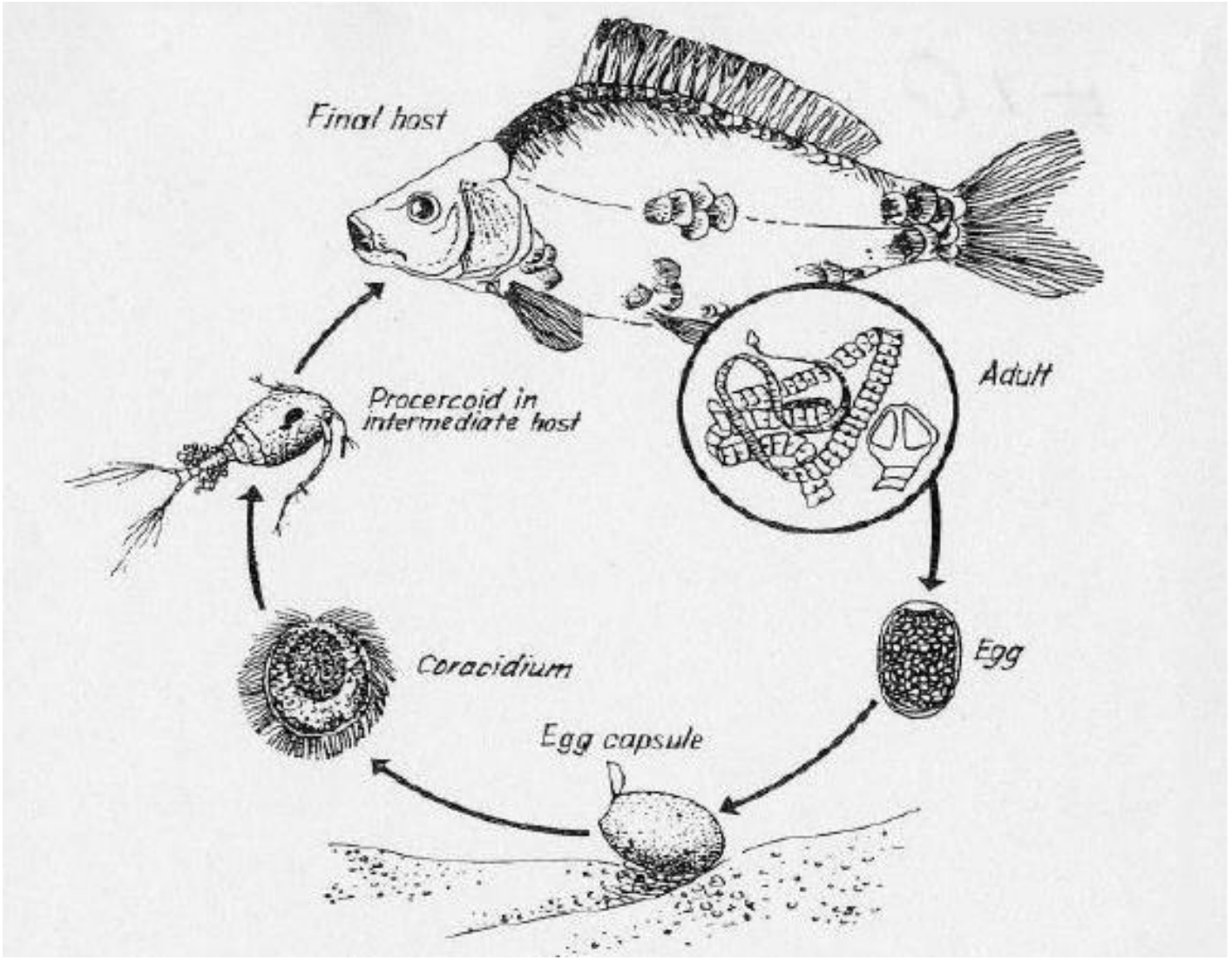
Ligula intestinalis

Ligula intestinalis

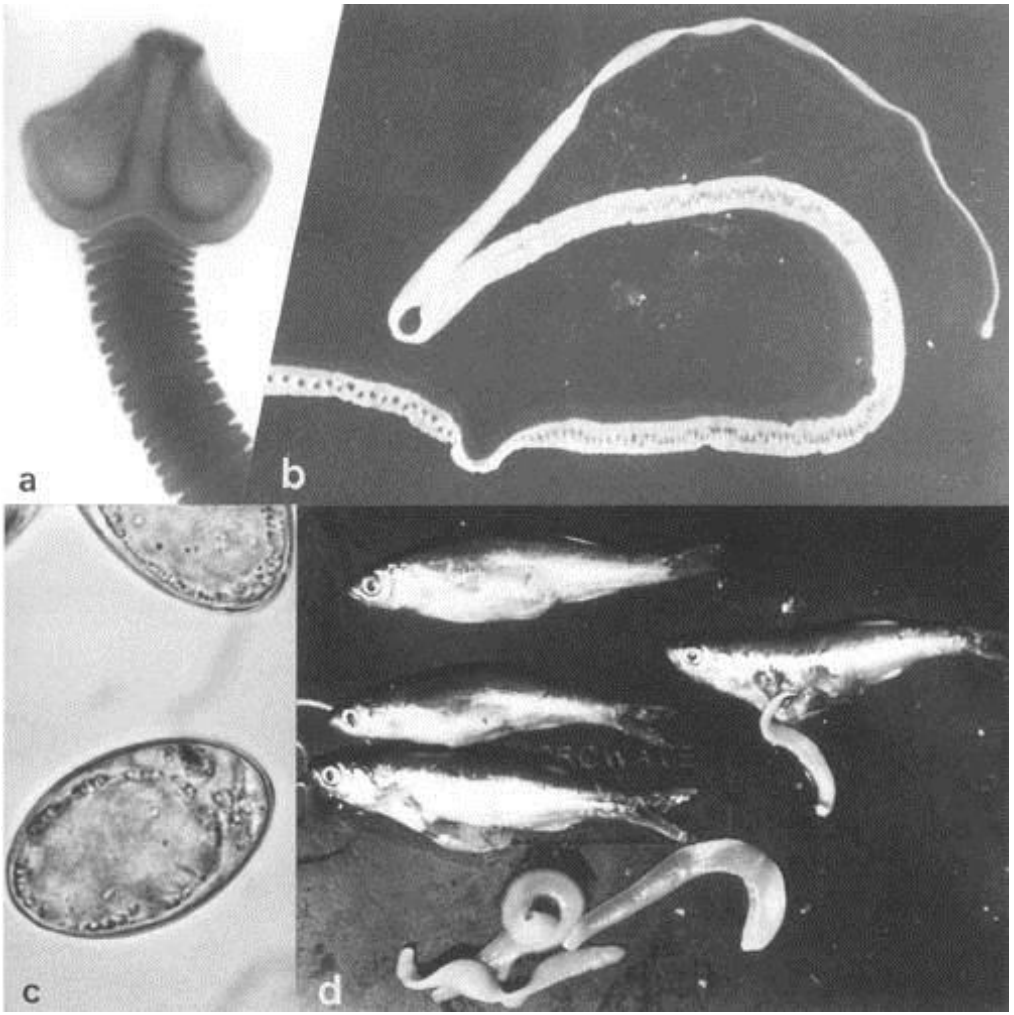


Trypanorhyncha

Bothriocephalus Life Cycle



Bothriocephalus



Parasitic Disaeses

- 2- Termatoda (کرمهای برگی شکل)

*2-1- Monogenea

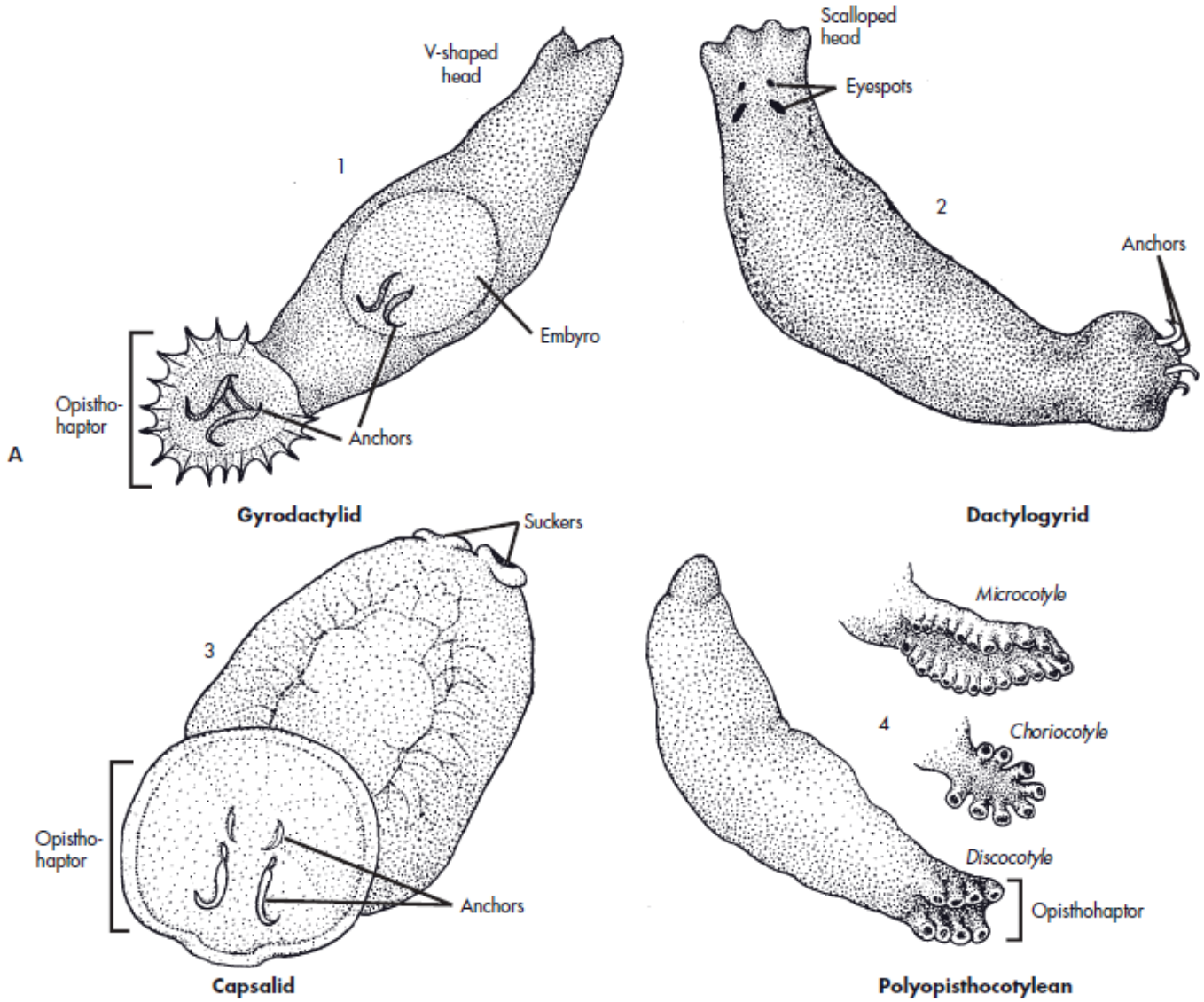
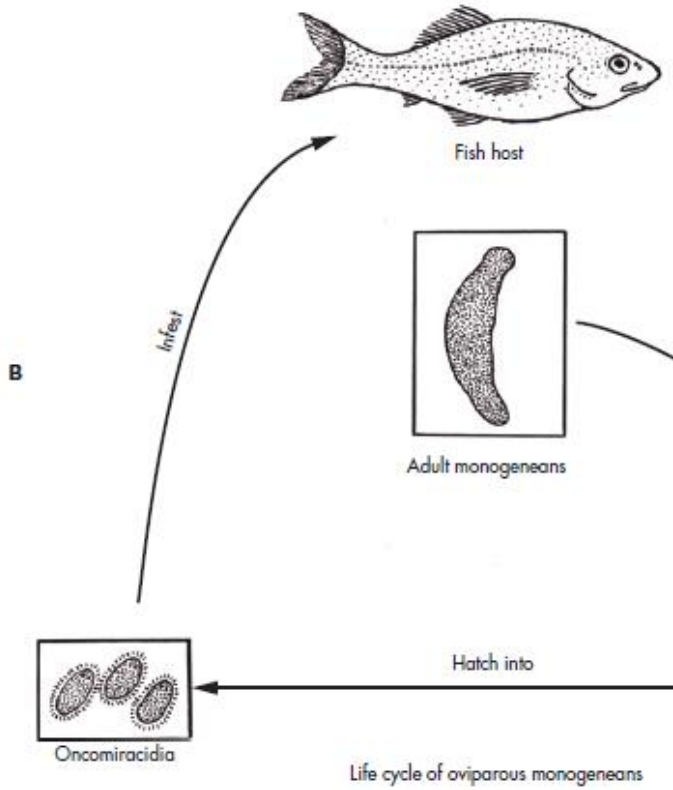
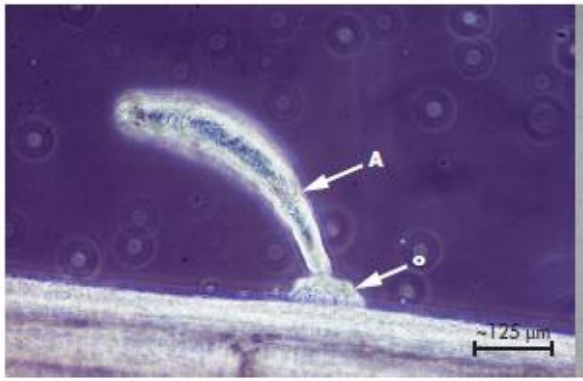


Fig. II-17. Diagrams of major types of monogeneans affecting cultured fish, including key diagnostic features. A_1. Gyrodactylid type. Note size (0.3–1 mm), V-shaped head, lack of eyespots, developing embryo with anchors, single pair of anchors. A_2. Dactylogyrid type. Note size (to 2 mm), scalloped head, one or more pairs of eyespots, ovary without embryo, 1–2 pair of anchors; primarily on gills. A_3. Capsalid type. Note size (often >4 mm), anchors; some also have anterior suckers. A_4. Polyopisthocotylean type. Note clamps and lack of anchors on various opisthohaptors.

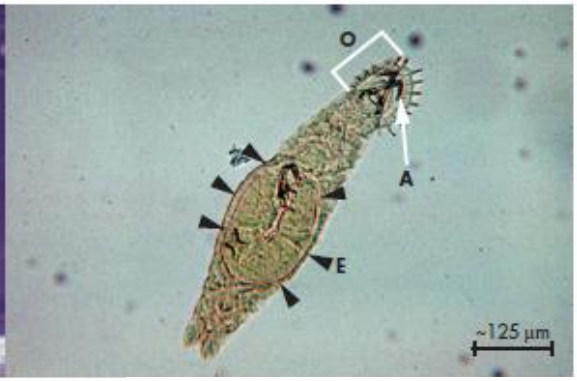
- Movie\Fluke\FlukeMovieDrJohnsonDotCom.wmv



B

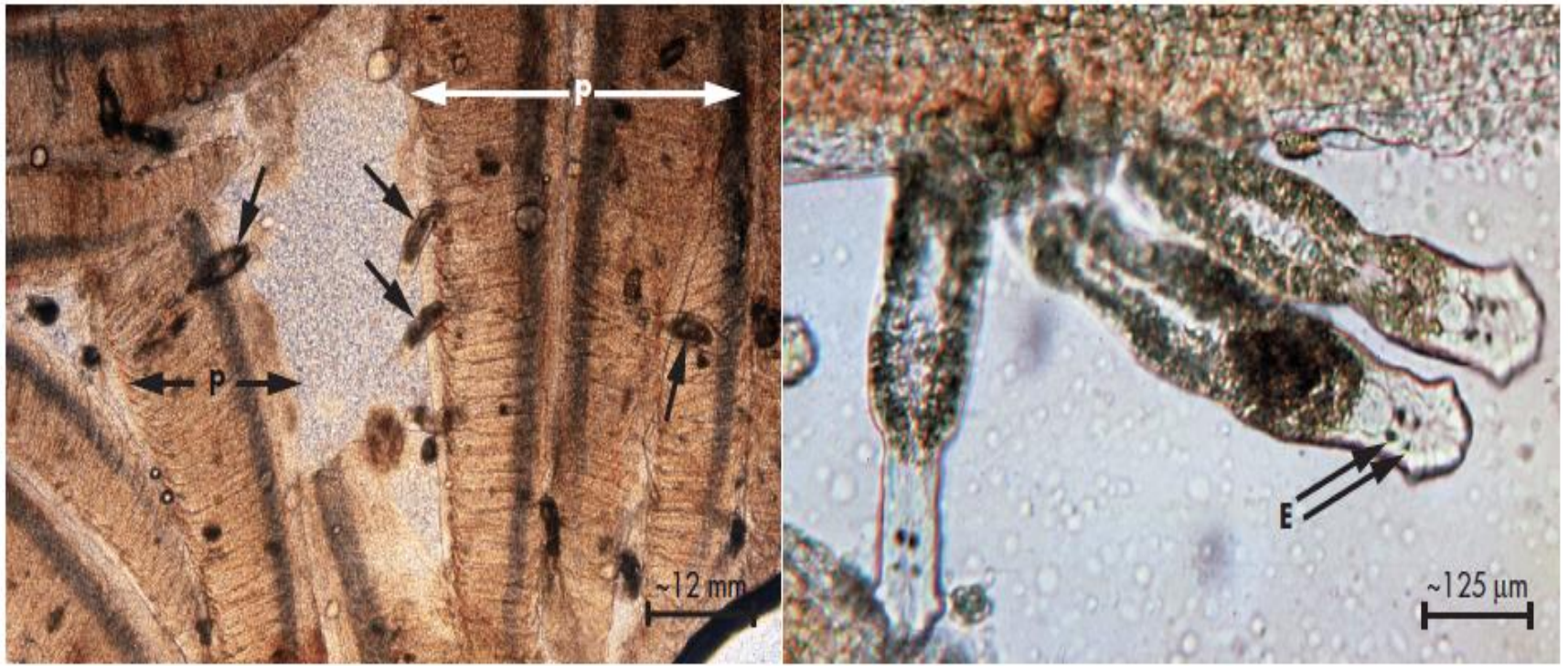


C



D

Fig. II-17.—cont'd. B. Life cycle of oviparous monogeneans. C. Wet mount of a gyrodactylid monogenean attached to goldfish fin (*F*). *O* = opisthohaptor; *A* = anchors of embryo's opisthohaptor. D. Wet mount of a typical monopisthocotylean monogene (*Gyrodactylus*). Key identifying features include size, worm-like appearance, and anchors (*A*). Note the embryo (*E, arrows*), which differentiates it from oviparous monopisthocotyleans. *O* = opisthohaptor.



E. Wet mount of a heavy dactylogyrid (Cleidodiscus) infestation (arrows) of channel catfish gills. P = primary lamella. F. Wet mount of a typical dactylogyrid monogenean (Cleidodiscus) attached to gill.

Parasitic Disaeses

- * 2-2- Digenea

Digenea Life cycle

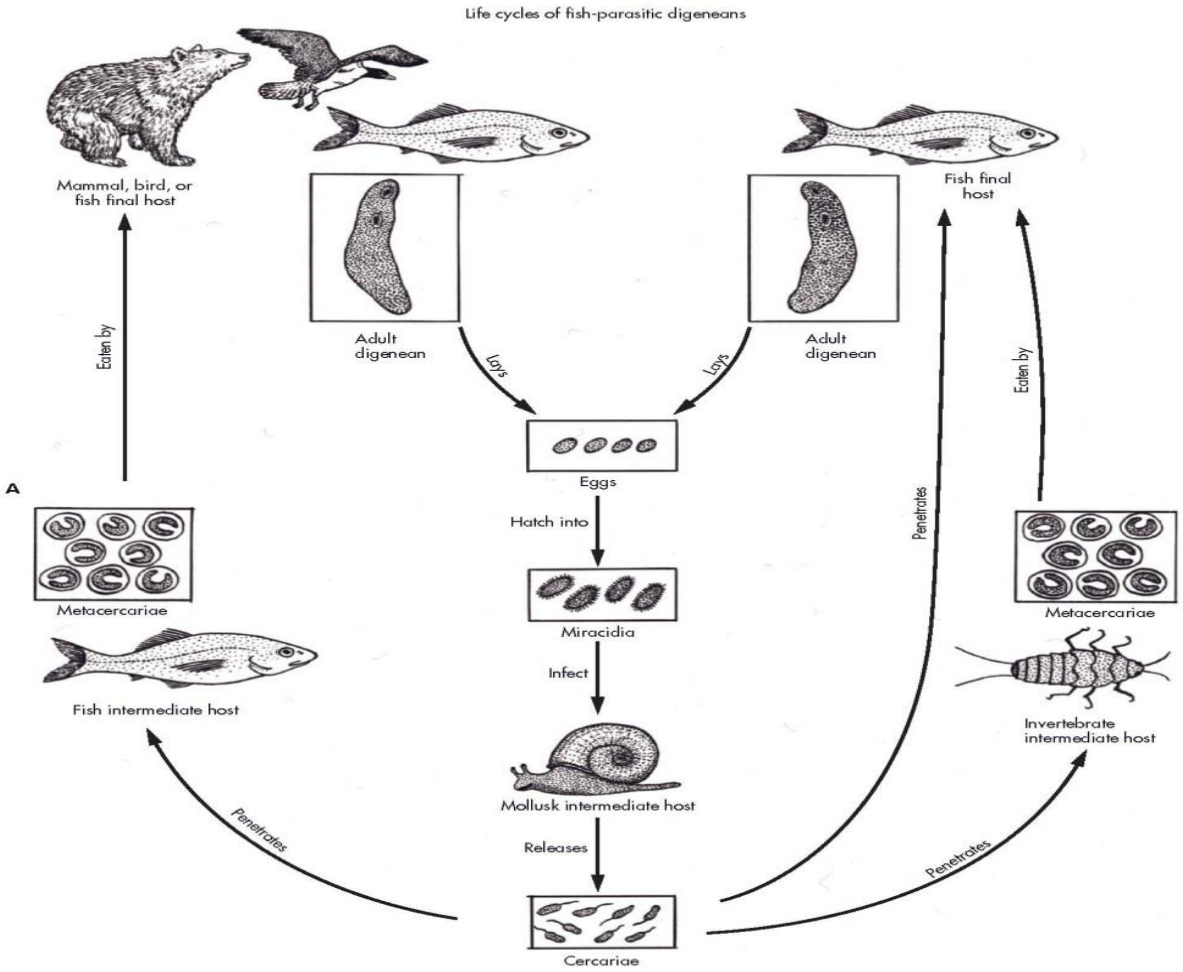
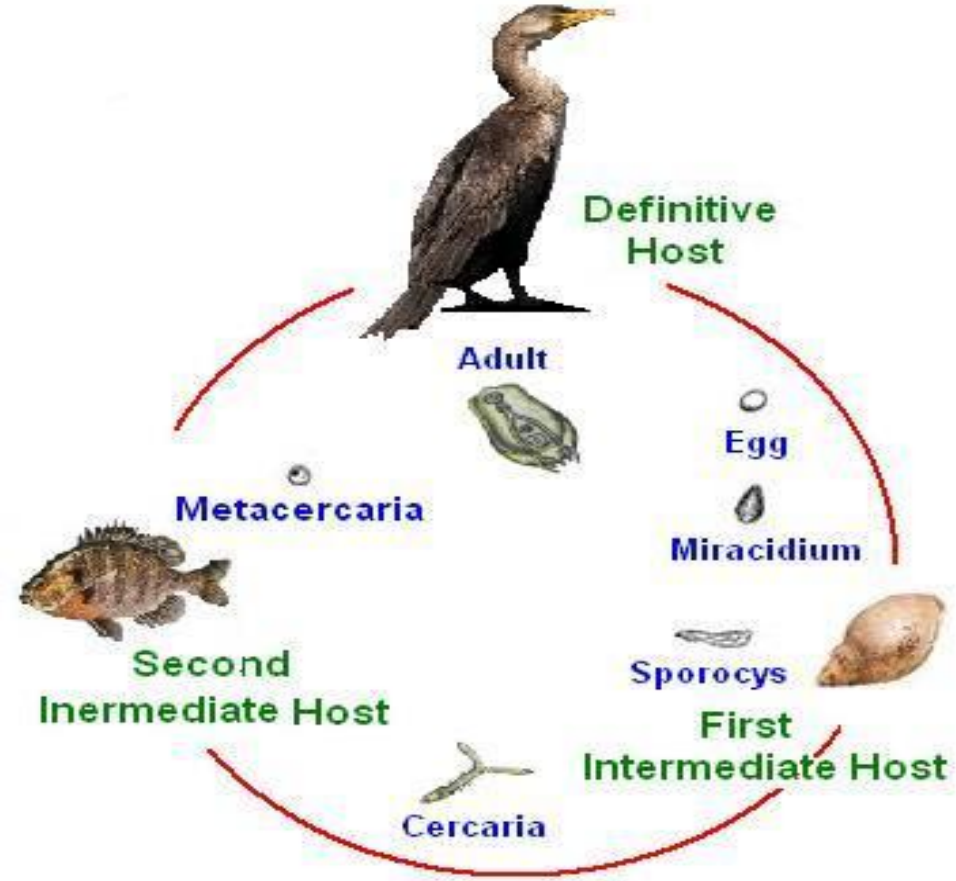


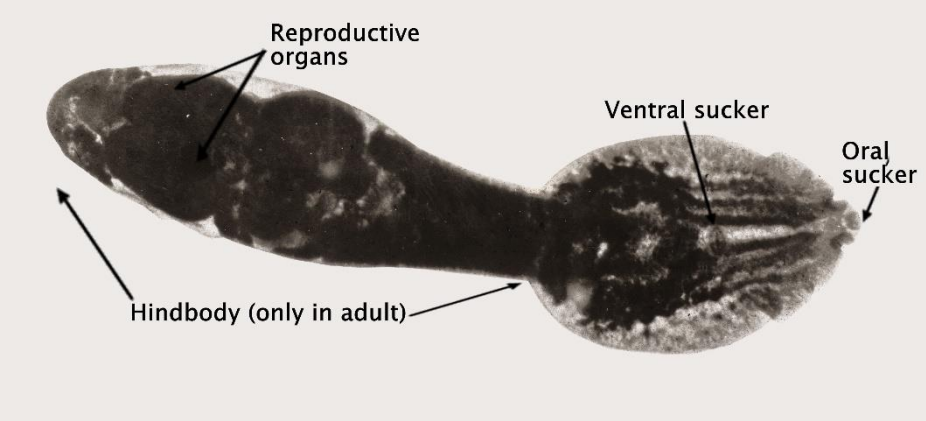
Fig. II-58. A. Life cycles of digeneans infecting fish.

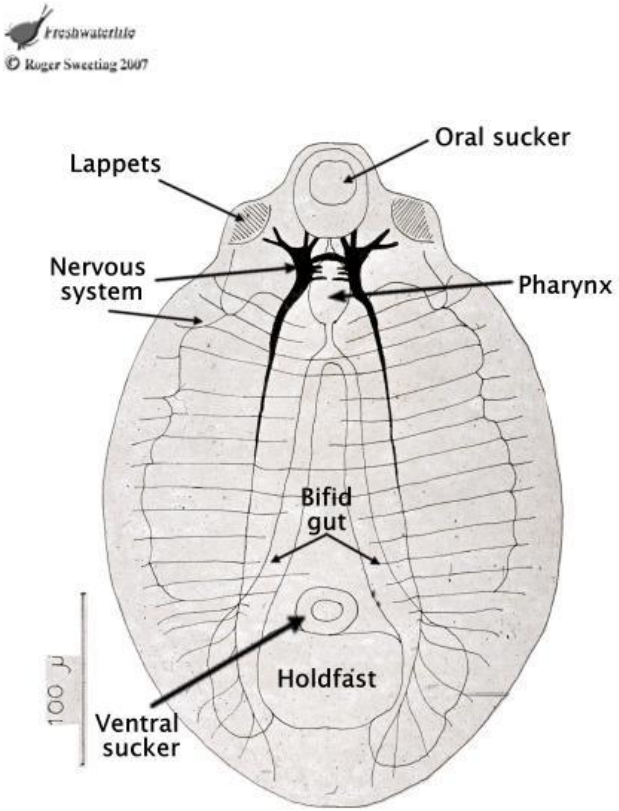
Continued.

Diplostomum spathaceum Life cycle

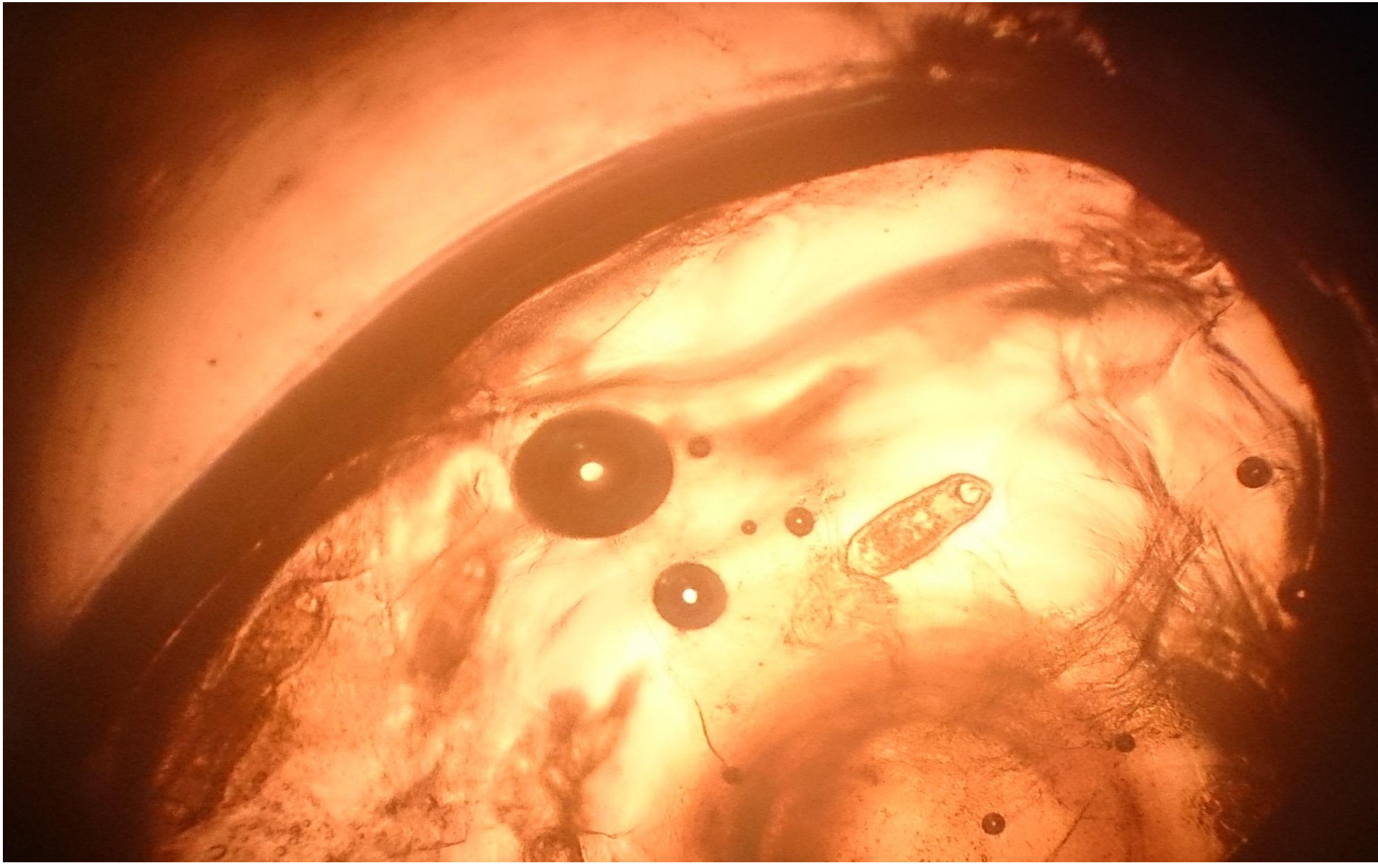


Diplostomum spathaceum

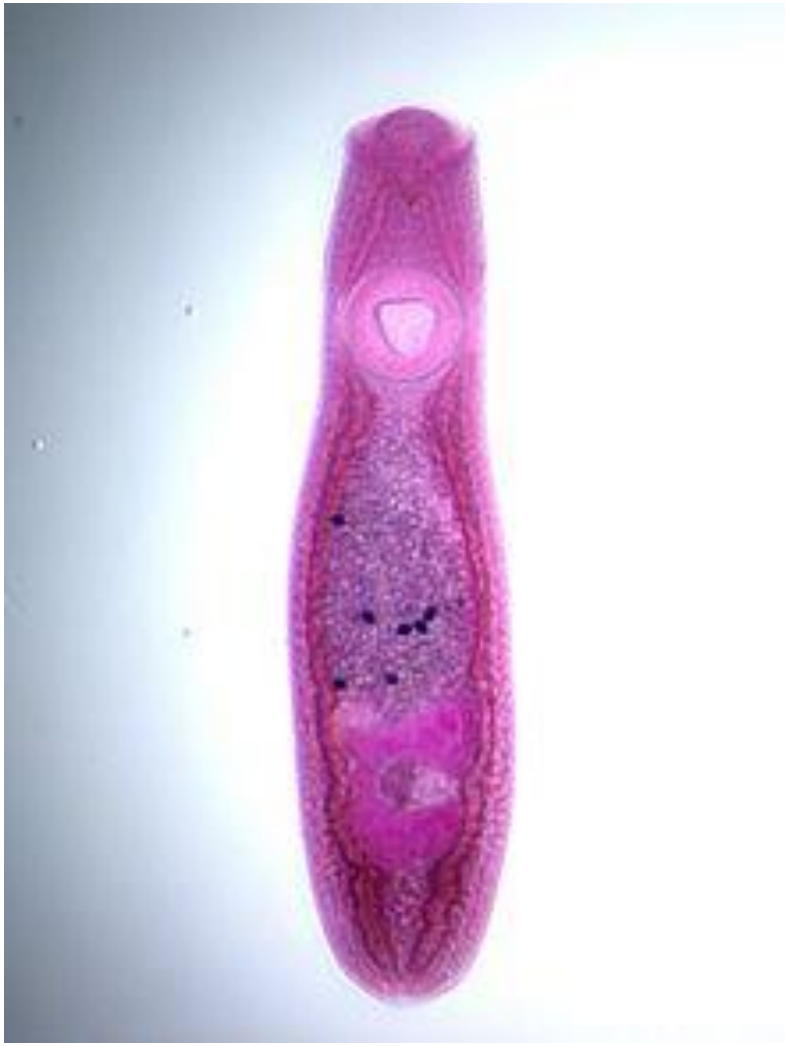




Diplostomum spathaceum



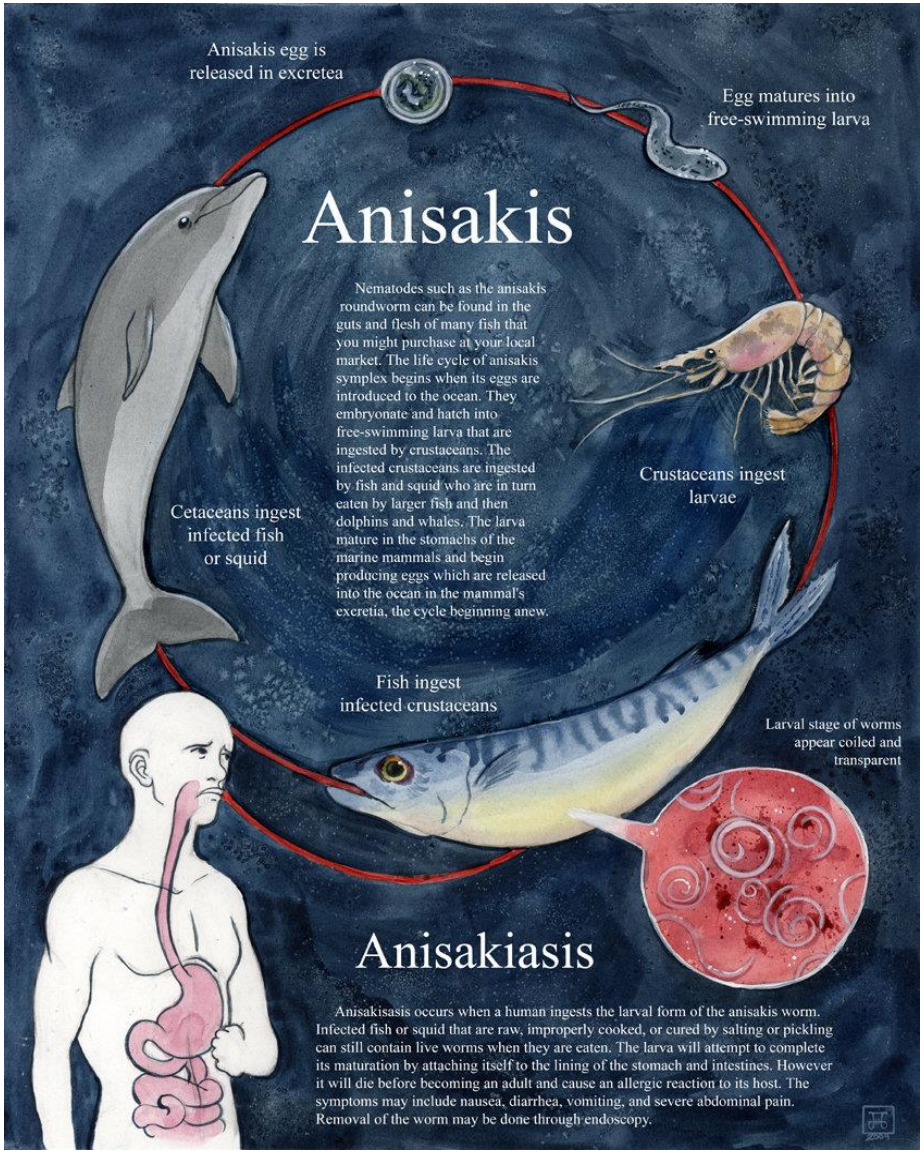
Clinostomum



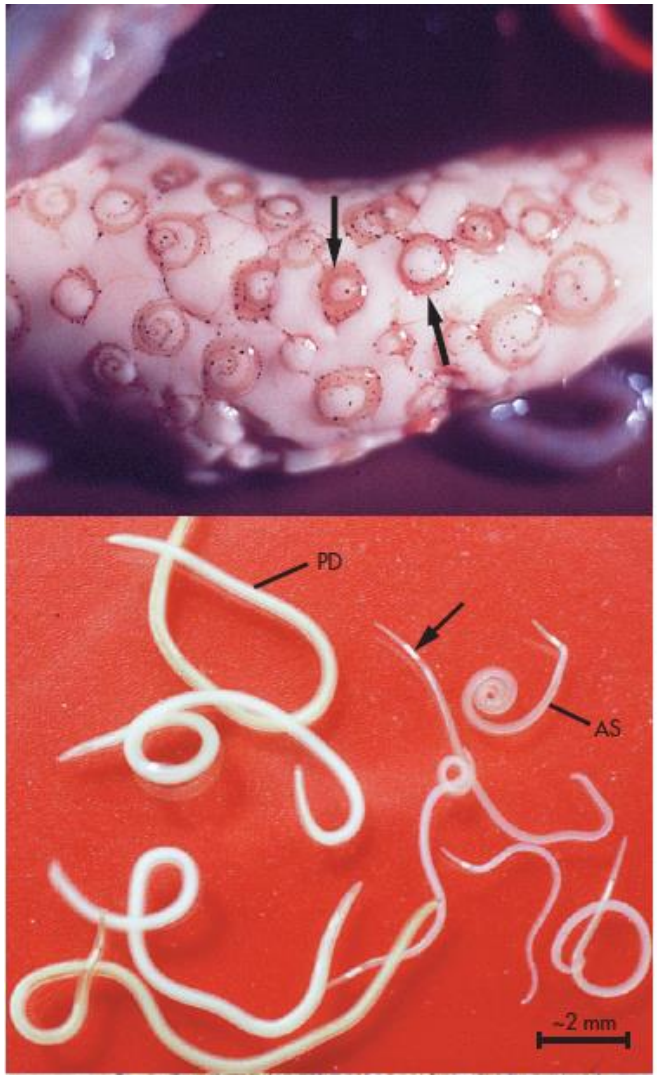
Posthodipllostomum

2) Nematode/Round worm

- Anisakis



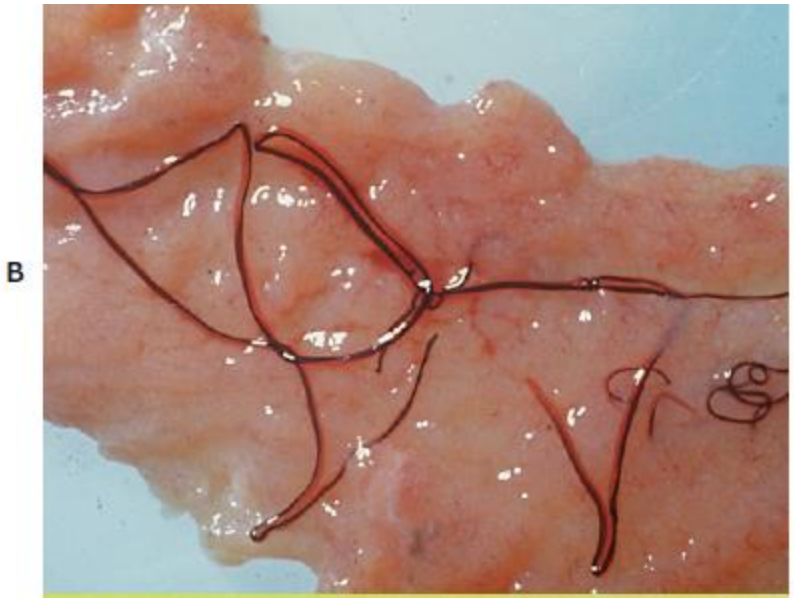
Anisakis

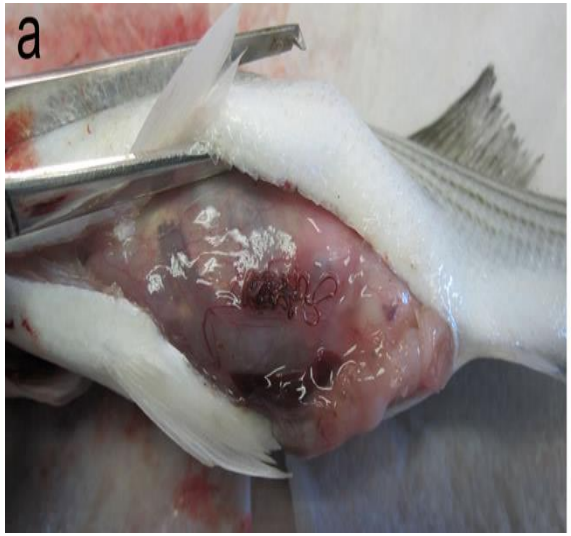


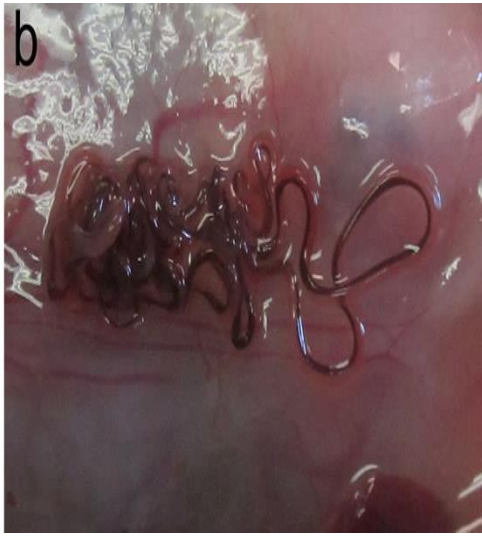
C. Liver of Atlantic cod with encysted, anisakid, nematode larvae. Each larva (arrows) is curled and in a capsule.

Anisakis simplex (AS)

Philometra





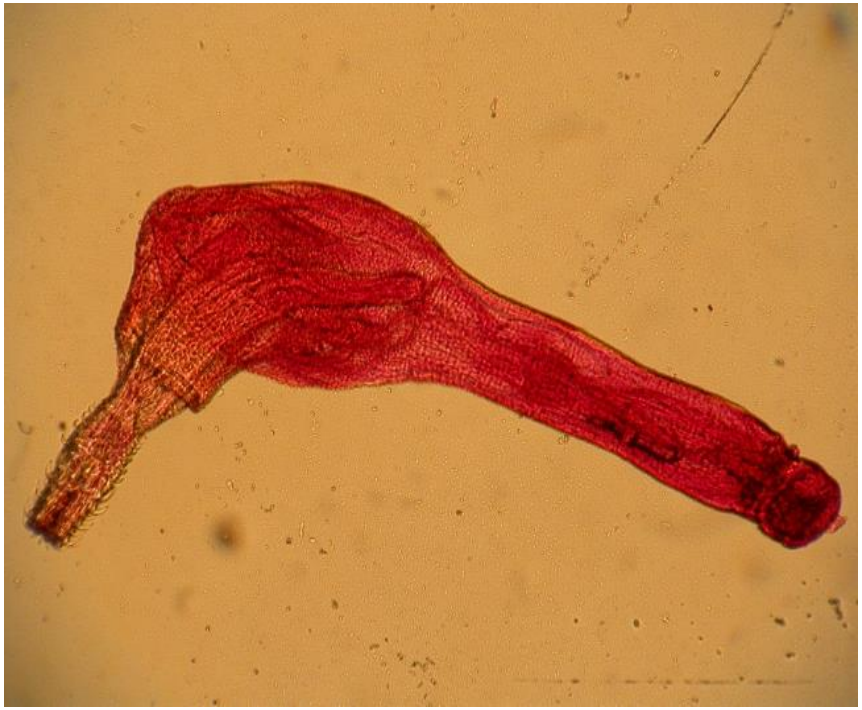


- Adult red worm (Philometra sp.)

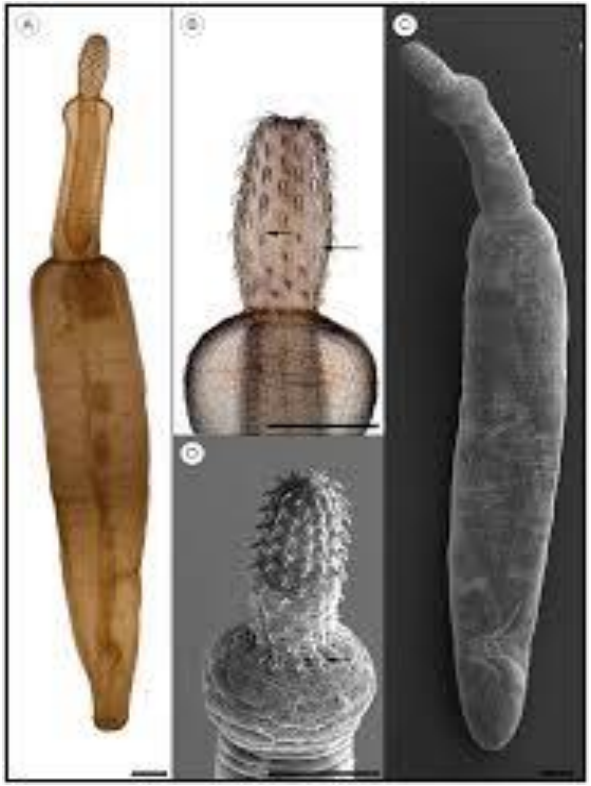
Parasitic Disaeses

- 3) Acanthocephala (کرمهای سرخاردار)

Acanthocephala



Corynosoma



Pomphorhynchus

Movie\Acanthocephala\Acanocephal.mp4

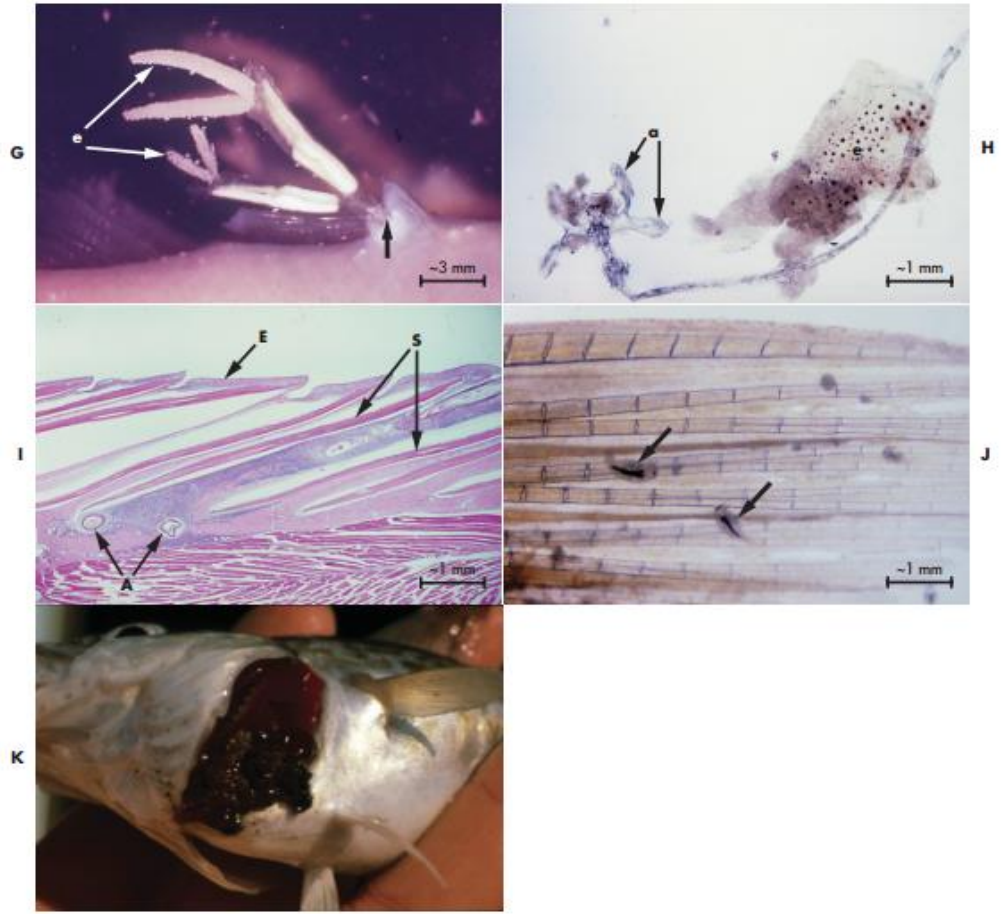
4) Annelida (کرمهای حلقوی)

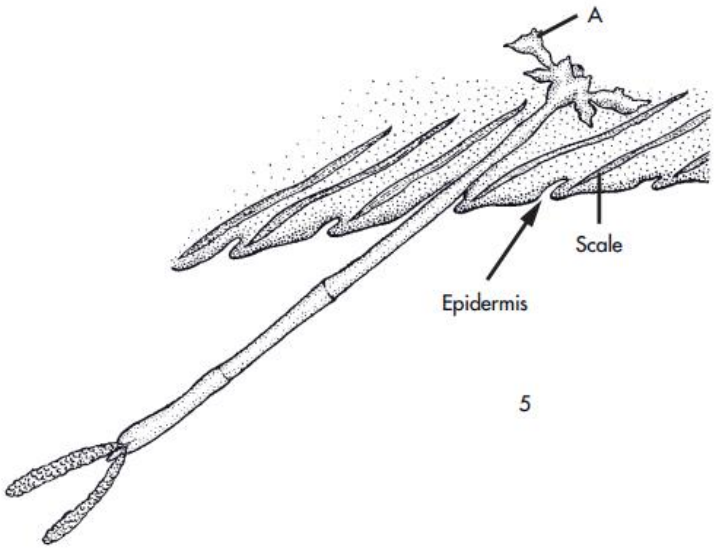
- *Piscicola geometra*

Parasitic Disaeses

- 1- Crustacea (سخت پوستان)
- 2- Glochida نرم تن دو کفه ای گلوچیدا
- 3- Polypodium (انگل مرجانی شکل)
- 4- Lampery

Lernaea

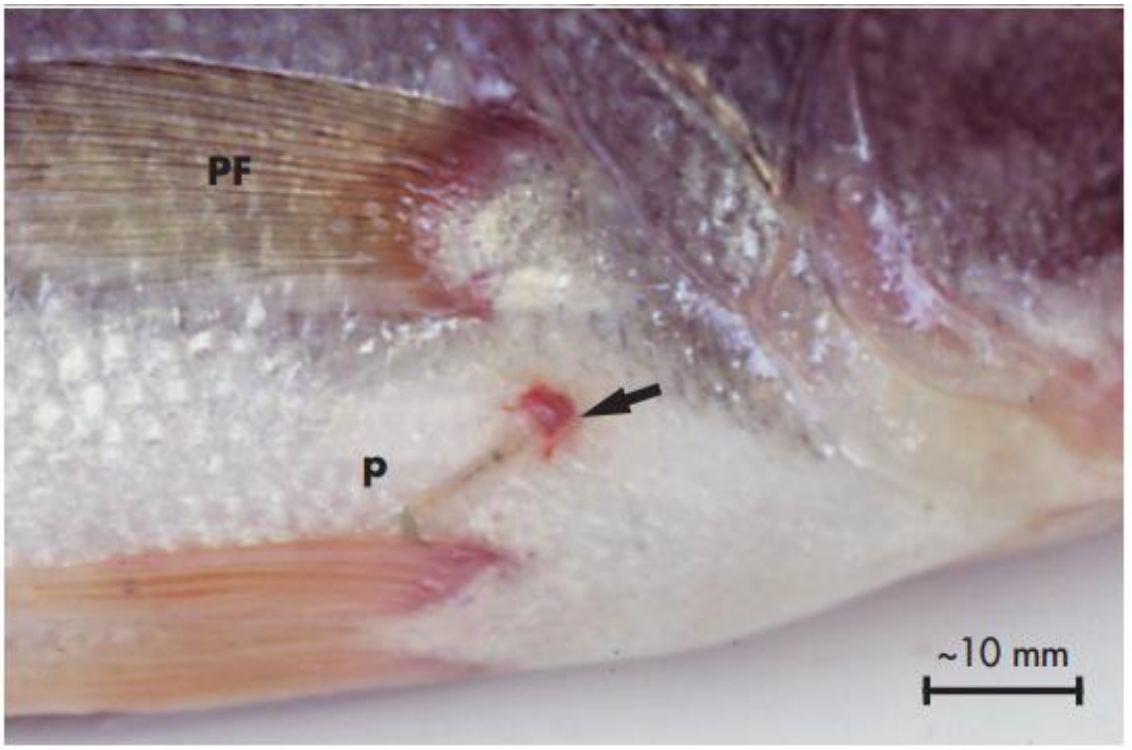




Lernaeid type: mature female (~5 – 25mm), long thin body, vestigal appendages, head with anchors (A).

Fig. II-14.—cont'd. G. Close-up view of two anchor worms (*Lernaea cyprinacea*), which enter the fish at the *arrow*. *E* = egg sacs. H. Wet mount of a skin scraping with an immature *Lernaea cruciata* female. *A* = anchors. *E* = host epithelium. I. Histological section through an immature *Lernaea cruciata* female. Only anchors (*A*) are visible in this plane of section. The parasite penetrates between two scales (*S*), inciting inflammation. *E* = epithelium. Hematoxylin and eosin. J. Copepodid infestation (*Lernaea cyprinacea; arrows*) on the fin of a goldfish. K. *Lernaeocera branchialis*, a pennellid, attached to and penetrating the base of the branchial cavity of an Atlantic cod. (D_1 photograph courtesy of T. Wenzel; D_2 photograph courtesy of A. Pike; *E* and *K* photographs by H. Möller; *G* photograph by G Hoffman.)

Lernaea



F

F. Anchor worm (Lernaea cruciata) infection of a largemouth bass. The head of the parasite is embedded under the skin while the body (P) with egg sacs protrudes. Note the hemorrhage (arrow) where the parasite enters the fish. PF = pectoral fin.

Argulus

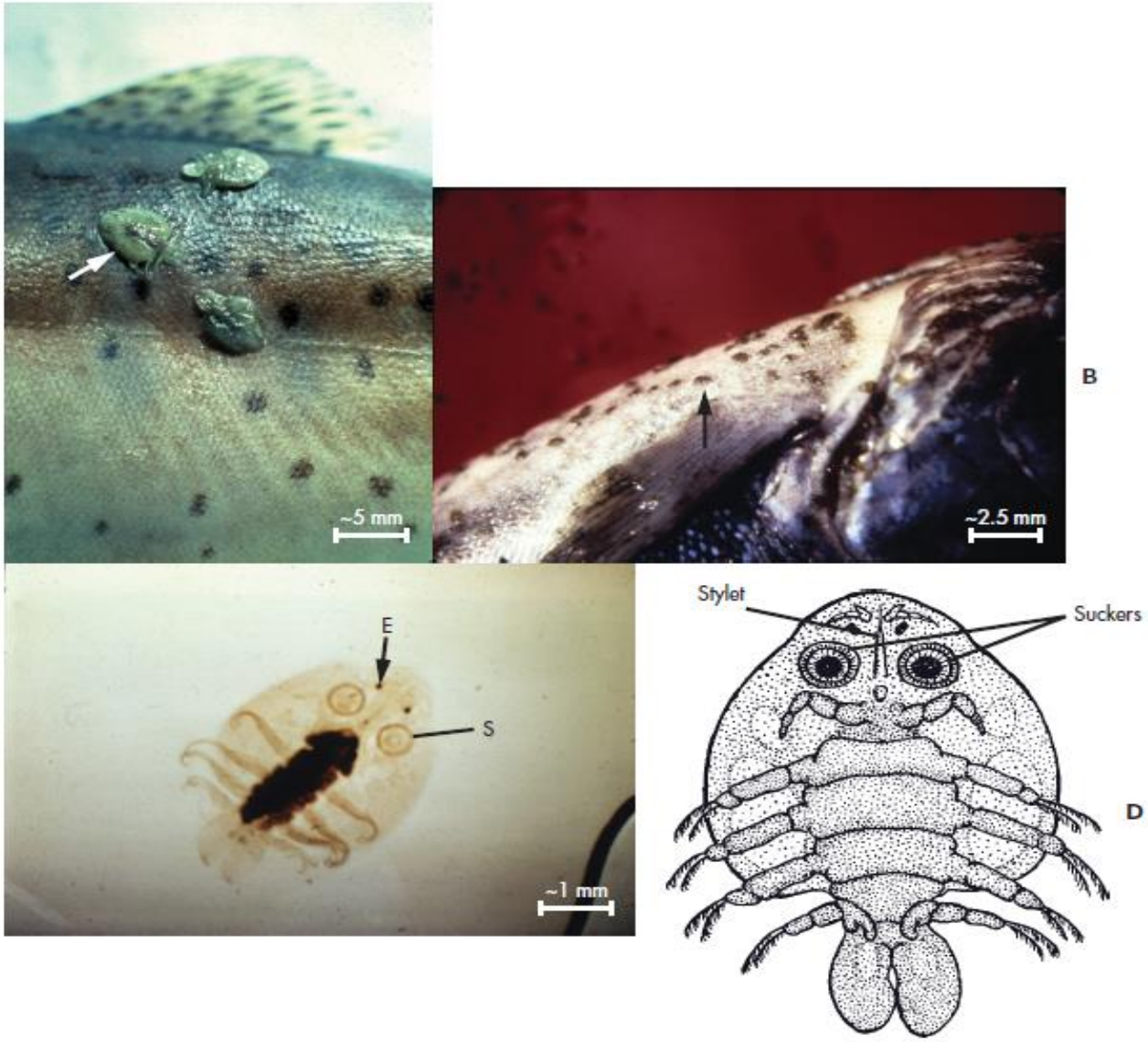


Fig. II-15. A and B. Branchiuran (*Argulus*) infestations (*arrows*). A key identifying feature is the flattened, saucer shape. C. Branchiuran (*Argulus*) infestation wet mount. Key diagnostic features include flattened shape, shell-like carapace covering the body, two suckers (*S*) that look like large eyes, eyespots (*E*), and jointed appendages. D. Diagram of a typical branchiuran (*ventral view*). Key diagnostic features include size (5–20 mm), oval body that looks like a scale, and suckers that look like large eyes. (*A* photograph courtesy of D. Mitchum; *B* photograph courtesy of P. Ghittino.)

Isopoda

Speckled sea louse, an intertidal marine isopod from the Belgian Coast 2005. Note the chromophores which give the sea louse its typical speckled appearance. Camera mounted on a Zeiss Stemi C-2000 binocular microscope. Length: ~4 mm.

Glochidia

D. Glochidia infestation (arrows) of the gills of a fish.

Polypodium hydriforme

Lampery (مار ماهی دهان گرد)

Fungal Diseases

Saprolegnia

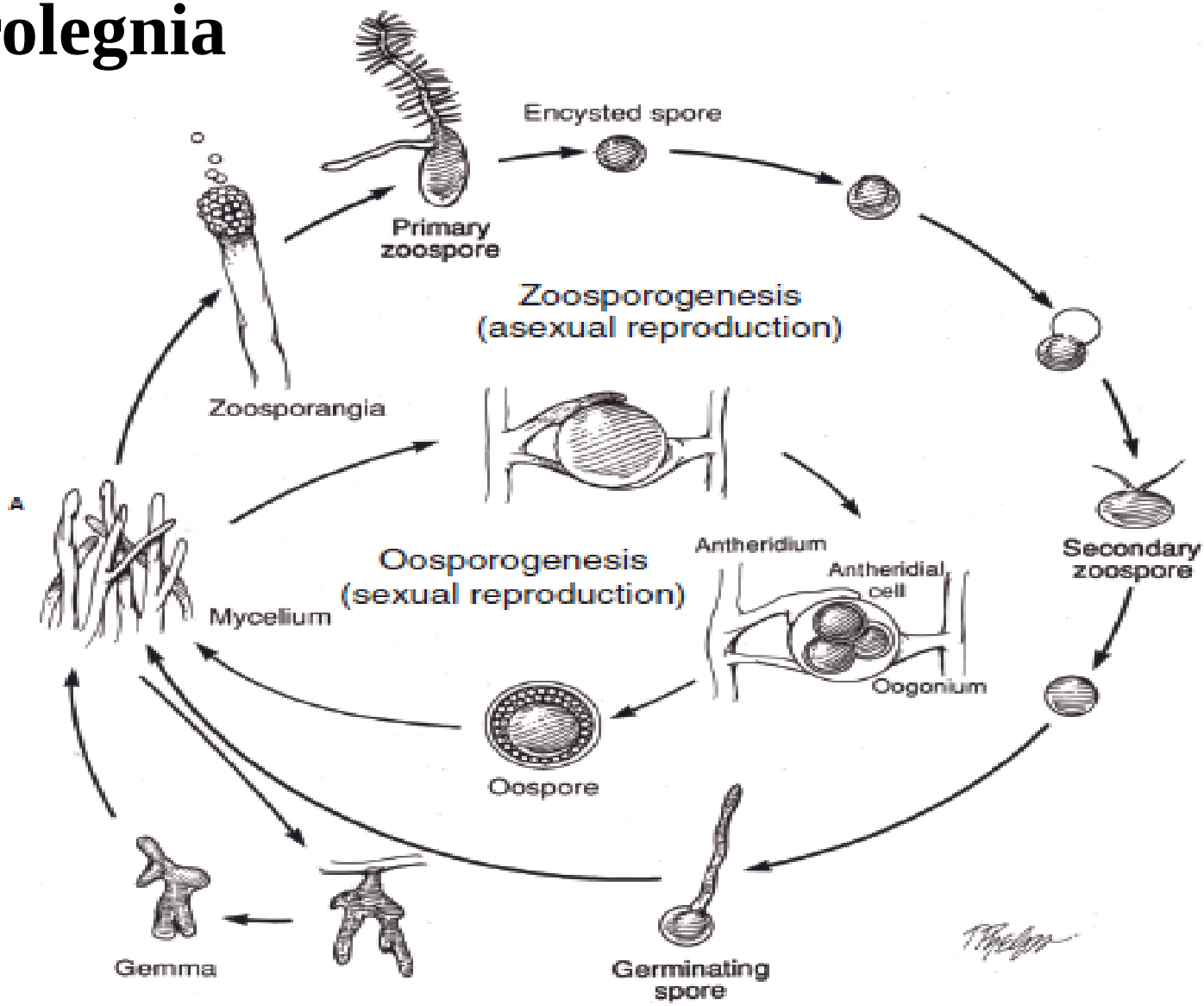


Fig. II-34. A. Life cycle of water molds (Noga 1993b).

Continued.

Saprolegnia

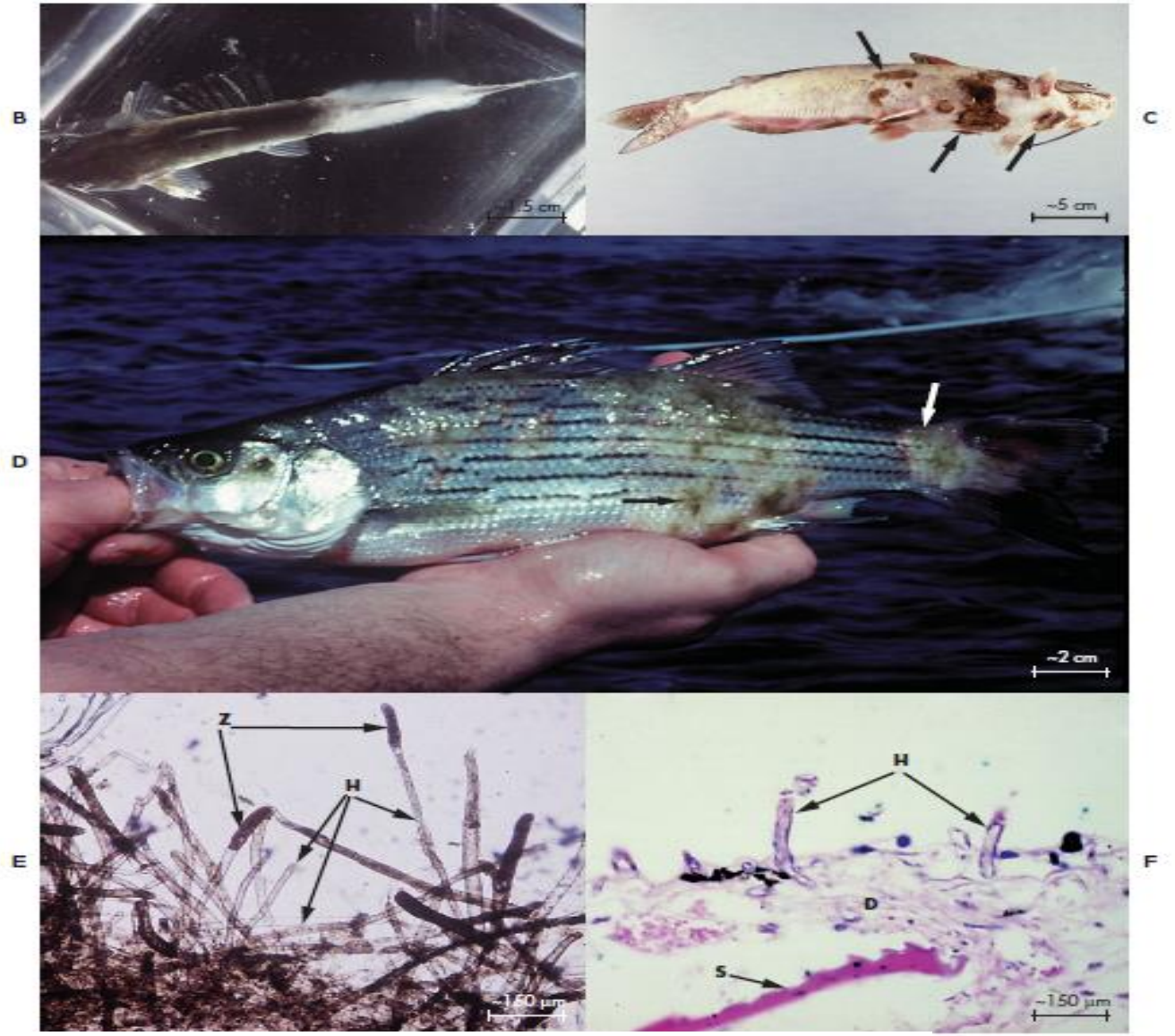


Fig. II-34.—cont'd. B. Water mold infection of a channel catfish. Note the large, white, cottony mass of hyphae (evident when the fish is in the water) and the loss of normal black pigment over the infected skin. C. Water mold infection of a channel catfish with winter kill. The water mold mycelium (*arrows*) is brown because of trapping of debris. D. Water mold infection (*arrows*) of a hybrid striped bass. Note the glistening, matted appearance compared to Fig. II-33, *B*. The mycelia are darker because of the trapped debris. E. Wet mount from a water mold infection. Broad, nonseptate hyphae (*H*). Zoosporangia (*Z*) are not always present in wet mounts of lesions. F. Histological section of a water mold infection of skin. Note the absence of epithelium, the superficial nature of the lesion, and the lack of inflammation. *H* = hypha; *S* = scale; *D* = dermis. Hematoxylin and eosin.

Continued.

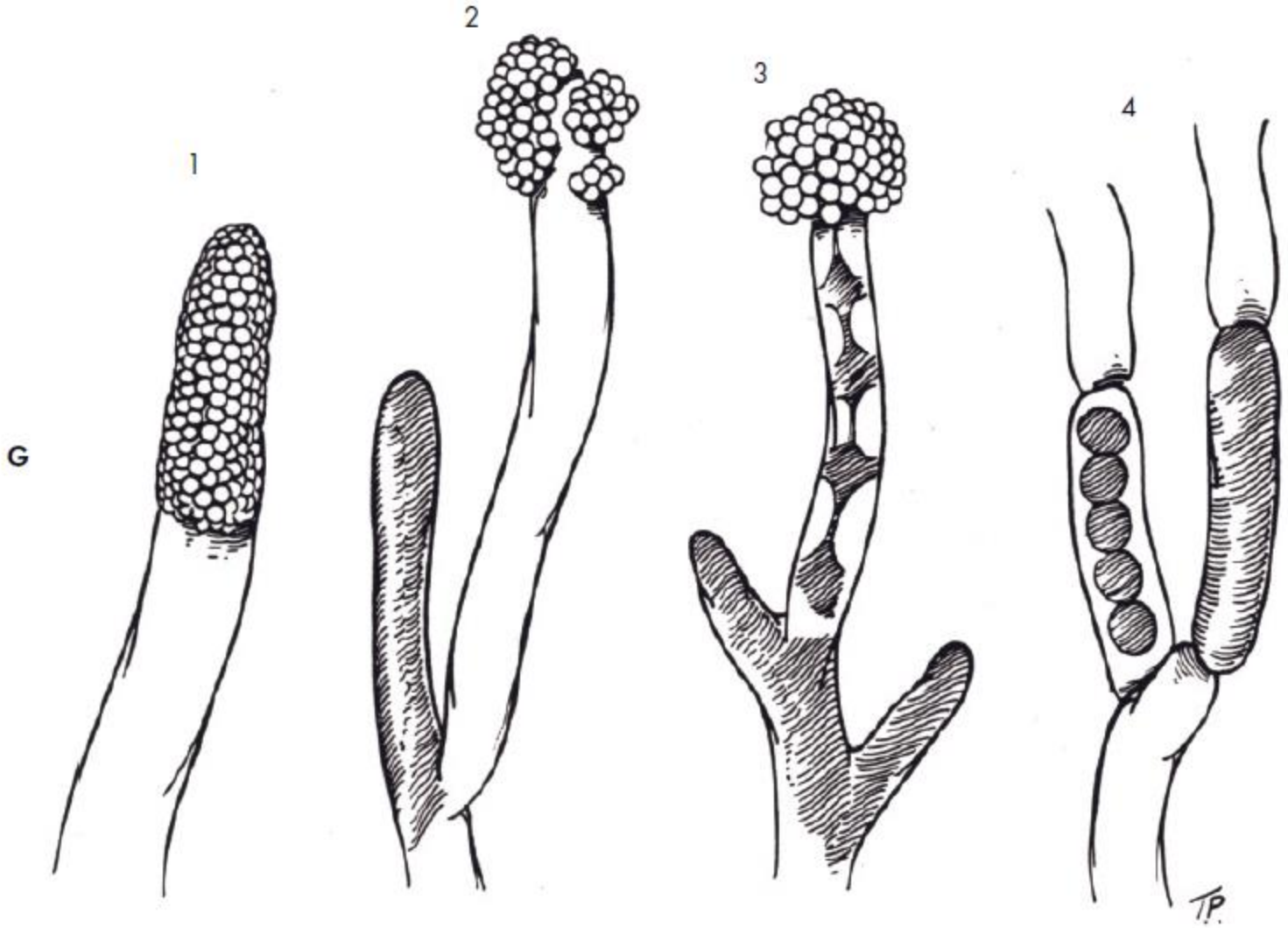


Fig. II-34.—cont'd. G. Zoosporangia of some fish-pathogenic Oomycetes: (*1*) *Saprolagnia;* (*2*) *Achlya;* (*3*) *Aphanomyces;* (*4*) *Leptolegnia* (Noga 1993a). (*B* photograph by R. Bullis and E. Noga; *E* photograph courtesy of A. Colorni.)

Branchiomycosis

- *Branchiomyces sanguinis* , *B. demigrans*

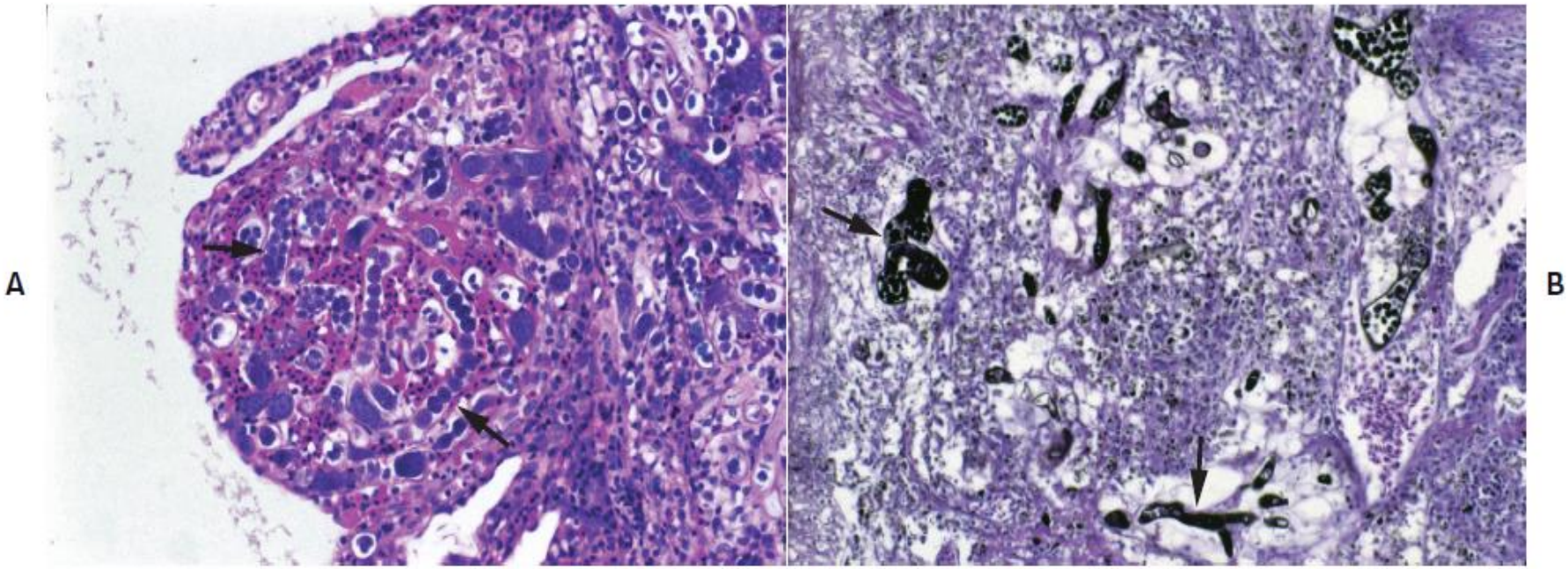


Fig. II-36. A. Histological section through *Branchiomyces*-infected gill. The key diagnostic feature is sporulating hyphae (*arrows*). Hematoxylin and eosin. B. Histological section through *Branchiomyces*-infected gill. The hyphae are black with silver-staining (*arrows*). Gomori methenamine silver.

Branchiomycosis

Ichthyophonosis

Icthyophonus hoferi

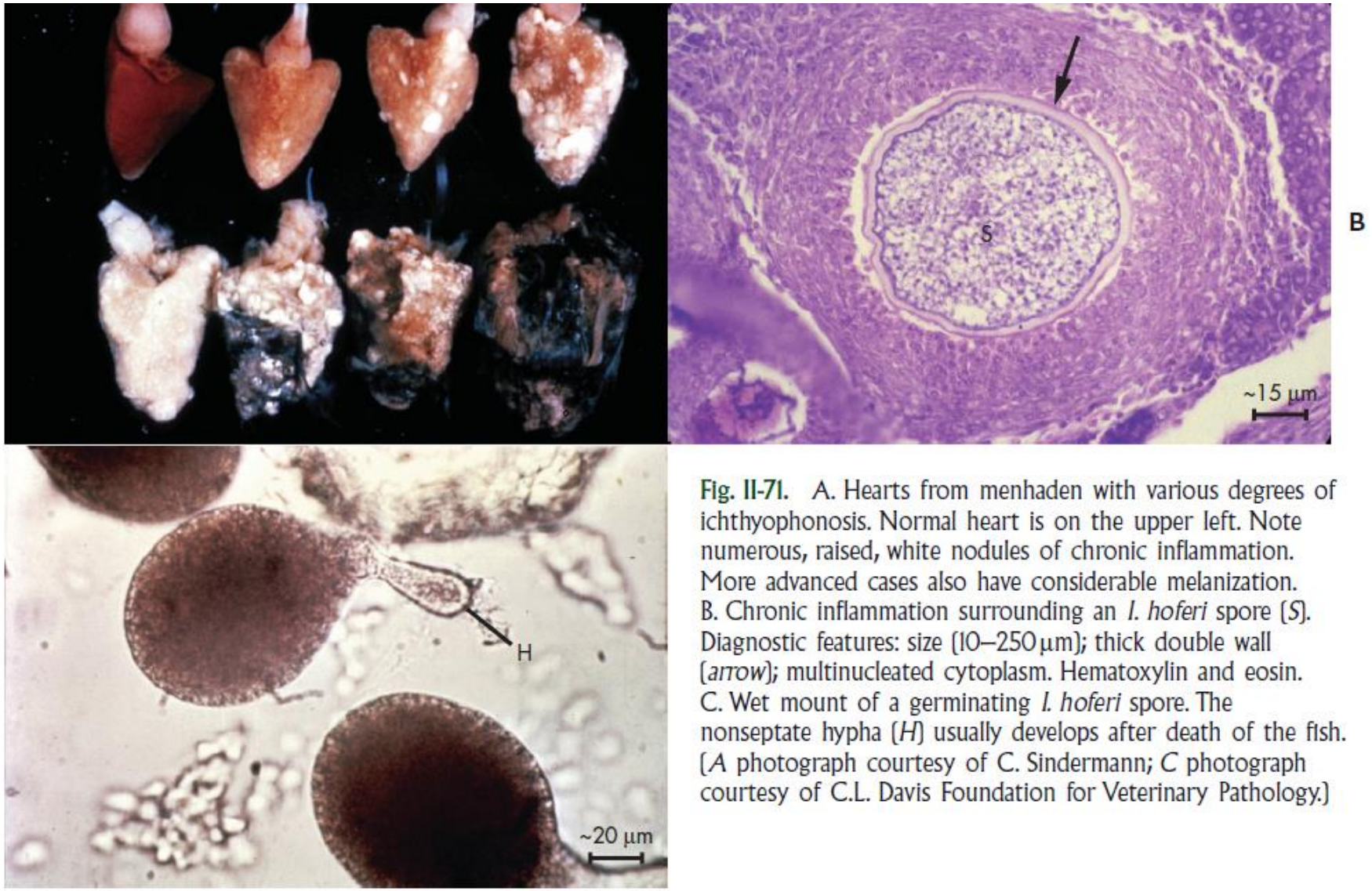


Fig. II-71. A. Hearts from menhaden with various degrees of ichthyophonosis. Normal heart is on the upper left. Note numerous, raised, white nodules of chronic inflammation. More advanced cases also have considerable melanization. B. Chronic inflammation surrounding an *I. hoferi* spore (*S*). Diagnostic features: size (10–250 µm); thick double wall (*arrow*); multinucleated cytoplasm. Hematoxylin and eosin. C. Wet mount of a germinating *I. hoferi* spore. The nonseptate hypha (*H*) usually develops after death of the fish. (*A* photograph courtesy of C. Sindermann; *C* photograph courtesy of C.L. Davis Foundation for Veterinary Pathology.)

Dermocystidium

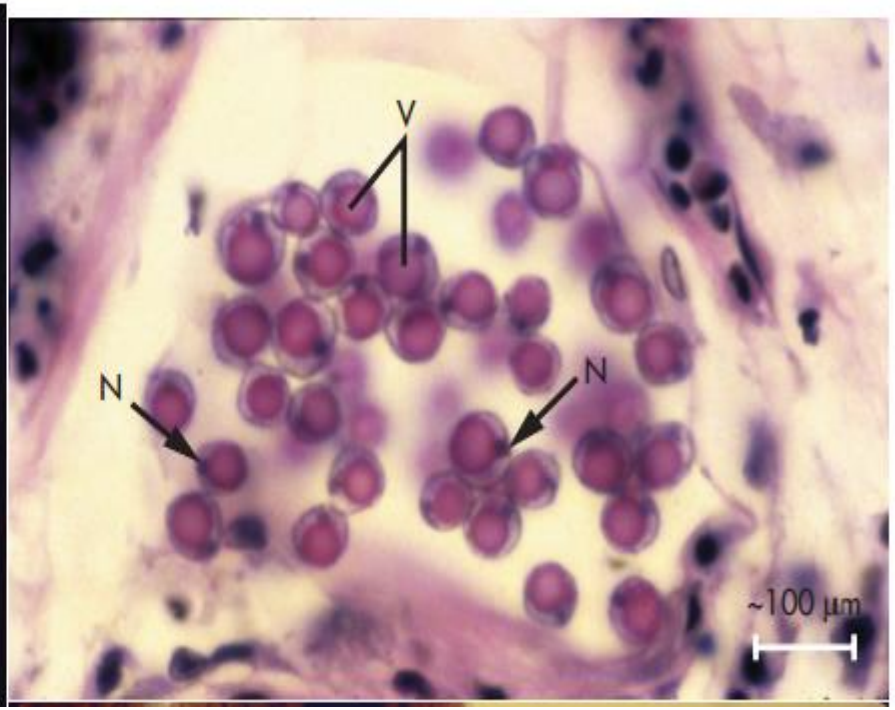


Fig. II-42. A. *Dermocystidium* gross lesion (*arrow*) in the fin of a sunfish. B. *Dermocystidium* spores. The mature spore has a large, PAS (periodic acid–Schiff stain) positive vacuole (*V*) surrounded by a thin rim of host cytoplasm, except where it thickens to make room for the nucleus (*N*). The inclusion is PAS (+) and hematoxylin and eosin (–) (Hatai 1989).

Epizootic Ulcerative Syndrome

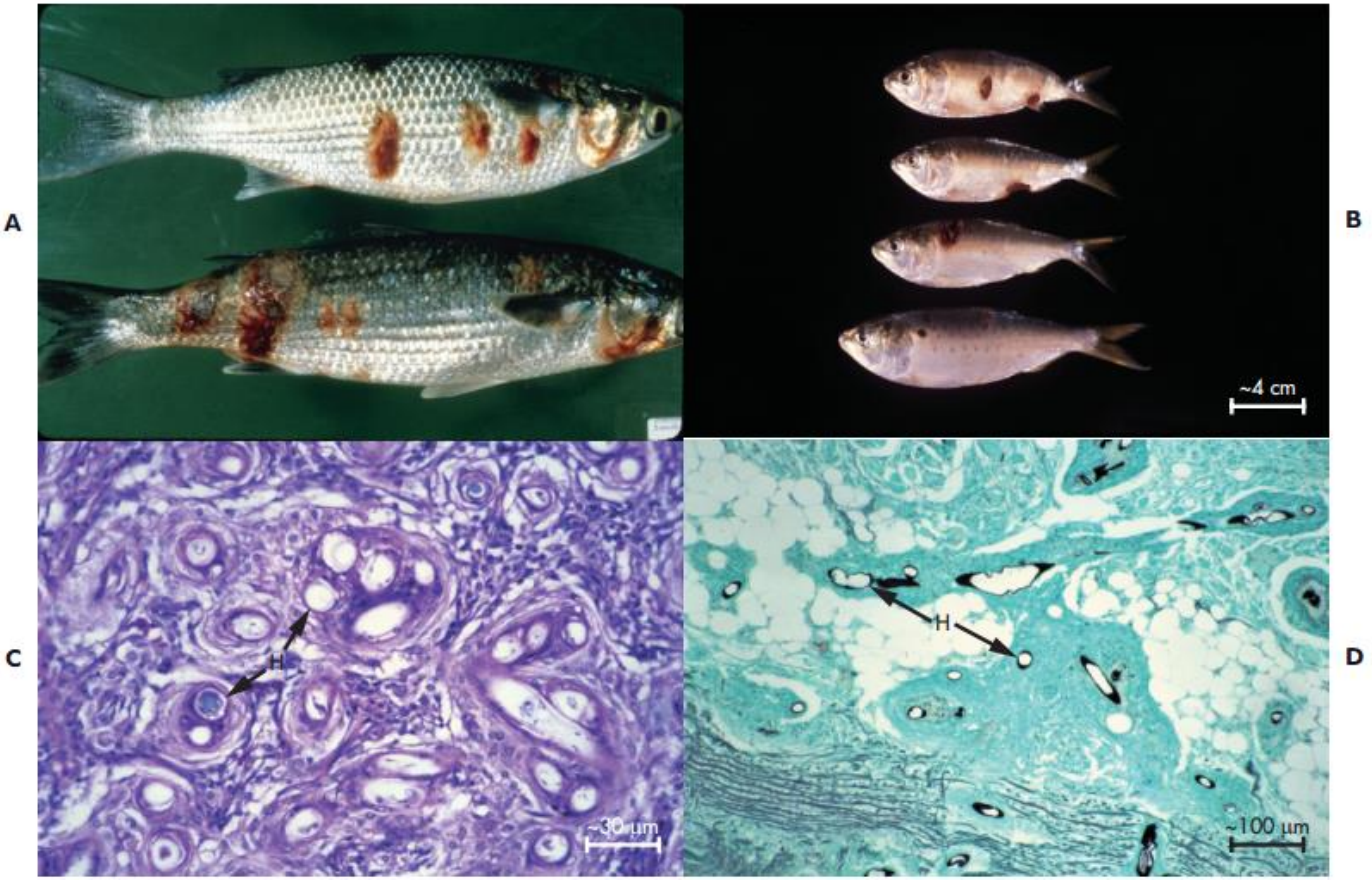


Fig. II-35. A. Relatively early, atypical water mold infection on grey mullet from the Clarence River, Australia. B. Advanced atypical water mold infection on Atlantic menhaden from Pamlico River, United States. C. Histological section of an atypical water mold infection showing chronic inflammatory response to broad, aseptate hyphae (*H*). Hematoxylin and eosin. D. Silver stain of atypical water mold lesion. *H* = hyphae. Gomori methenamine silver. (*A* photograph courtesy of R. Callinan.)