

10900 A. Procedure in Identification

Critical identification of a specimen often is time-consuming, even for an experienced biologist. Before using any key or other aid to identification, carefully study the specimen for one to several minutes. If necessary, find other examples and compare them with the unknown.

It is important to know where or under what conditions the organism lived before attempting to identify it. For example, did it come from fresh water—a lake or a stream? Is it marine—from the open ocean, shoreline, or estuary? Was it a free swimmer or floater in the water? Was it a bottom organism, attached, crawling, or burrowing? Finally, turn to the following key to major groups.

Only the more common types of aquatic organisms are illus-

trated here, with special attention to those most frequently used in water quality evaluation. When specimens do not fit obviously into one of the types listed, consult a professional biologist, a microbiologist for the bacteria and fungi, or some of the references provided. Descriptions of color and movement refer to freshly collected or living specimens, or, in the case of microscopic forms, to those preserved as described in Section 10200.

Sizes of the organisms illustrated in Plates 1 through 27 are shown in parentheses in the legend. These are intended to represent *common* sizes, not absolute maxima or minima. Exceptional individuals and even whole localized populations may be encountered that are considerably larger or smaller than the sizes cited.

10900 B. Key to Major Groups of Aquatic Organisms (Plates 1–35)

Beginning with couplet 1a and 1b of the Keys, choose one of the contrasting statements. Proceed to the couplet number indicated at the end of the chosen statement and repeat the process. Continue until the name of an organism or a plate number is cited instead of another couplet number. Additional information is provided in many of the plate legends.

	<i>Refer to couplet No.</i>
1a. Macroscopic: The organism, mass, or colony is visible to the naked eye	13
1b. Microscopic: Not readily visible to the naked eye	2
 1. Key to Microscopic Organisms	
2a. Specimen a single cell or a mass or colony of relatively independent cells (shapeless, rounded, or threadlike)	3
2b. Specimen a many-celled, highly organized plant or animal	7
3a. Cells contain one or more pigments, including chlorophyll <i>a</i> (overall color may range through various shades of green, blue, red, brown, or yellow). ALGAE (for details, see Section 10900D following, "Key for Identification of Freshwater Algae")	4
3b. Cells typically colorless, lacking chlorophyll <i>a</i>	12
4a. Nuclei present; pigment confined to chloroplasts	5
4b. Nuclei, plastids, or vacuoles absent (pseudovacuoles may be present in certain filamentous forms). Pigment generally diffused throughout cytoplasm. CYANOBACTERIA, Plate 1A.	
5a. Cell wall permanently rigid, composed of SiO ₂ , geometrical in appearance, and with regular patterns of fine markings; composed of two essentially similar halves, one placed over the other as a cover. Golden brown to greenish in color. DIATOMS, Plate 1B.	
5b. Cell wall, if present, capable of sagging or bending, rigidity depending on internal pressure of cell contents. Cell walls usually of one piece	6
6a. Cells or colonies nonmotile. Usually some shade of green. NONMOTILE GREEN ALGAE, Plates 1A, 1B, 28–35 (in part).	
6b. Cells or colonies move by means of relatively long whiplike flagella. PIGMENTED FLAGELLATES, Plates 4A, 4B, 28–35 (in part).	
7a. Body with cilia (hairlike structures used for locomotion)	8
7b. Body without cilia	9
8a. Body generally covered with cilia, usually somewhat elongate or wormlike, bilaterally symmetrical. Minute FLATWORMS (Platyhelminthes), relatives of <i>Planaria</i> , Plate 9.	
8b. Cilia confined to one or two crowns at anterior end, which often present the illusion of rotating wheels. Internal jaws present. ROTIFERS (Rotifera), Plate 8.	
9a. Long, slender, unsegmented worms that move by sinuous crawling or thrashing motion. ROUNDWORMS (Nematoda), Plate 9.	
9b. Possess external skeleton and jointed appendages	10
10a. Crawl about or swim by means of jointed appendages thrust out from between two clamlike shells. All appendages can be withdrawn entirely within shells when disturbed. OSTRACODS (Ostracoda), Plate 11.	
10b. Swim rapidly by means of a pair of enlarged jointed appendages (antennae) that cannot be withdrawn inside carapace or shell	11

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couplet No.

- 11a. Locomotor appendages (antennae) branched. Microcrustacea, CLADOCERA (Cladocera), Plate 11.
- 11b. Locomotor appendages (antennae) unbranched; body tapers toward rear. Microcrustacea, COPEPODS (Copepoda), Plate 11.
 - 12a. Ingest and digest food internally (ingested food of various colors may be visible through body wall). Single-celled or colonial, attached or free-living. PROTOZOANS (Protozoa), Plates 4B, 5A, 5B, and 6.
 - 12b. Digest food externally and absorb products through cell wall. Often secrete masses of slime. BACTERIA and FUNGI, Plates 26 and 27.

2. Key to Macroscopic Organisms

- 13a. Specimen a mass of filaments or a glob of gelatinous or semisolid material containing many tiny units, requiring microscopic examination to determine details of structure 2
- 13b. Specimen a well-organized unit or colony 14
 - 14a. Organism plantlike; flowerlike structures, if present, do not respond when touched, generally are colored some shade of green, brown, or red 16
 - 14b. Organism animal-like; usually responds rapidly when touched, whether attached or free-living 15
- 15a. Internal backbone present (vertebrates) 17
- 15b. No internal backbone present (macroinvertebrates)* 18
 - 16a. Plant structure relatively simple. Attachment structures may be present, but no true roots or fibrous tissue. Larger ALGAE, Plates 2A, 2B, 28 (*Nitella*), 33 (*Chara* and *Batrachospermum*), 35 (numerous).
 - 16b. Plant structure usually includes true roots, stems, and leaves. Fibers or vascular tissue usually present; flowers or seeds may be observed. (One atypical group, "watermeal," consists only of tiny roundish masses, 0.5 to 1 mm in diameter; often misidentified as algae.) HIGHER PLANTS, Plates 3A, 3B, and 3C.
- 17a. Side appendages, if present, are flat fins. FISHES, Plate 24.
- 17b. Side appendages, if present, are footlike, with separate digits. AMPHIBIANS, Plate 25.

3. Key to Macroinvertebrates

- 18a. Body bilaterally symmetrical (with right and left sides, but may be superficially coiled into a spiral); animal usually not attached but may live inside an attached cocoon or case, or crawl about; usually solitary 23
- 18b. Symmetry not bilateral 19
- 19a. Body typically radially symmetrical 21
- 19b. Body or colony nonsymmetrical 20
 - 20a. Body mass generally porous; not a colony, sometimes finger- or antler-like. Freshwater representatives generally are fragile, colored green or brown; marine forms tougher, various colors. SPONGES (Porifera), Plate 7.
 - 20b. Body mass otherwise 22
- 21a. Animals with soft smooth bodies and tentacles around a mouth; no anus. Solitary or colonial. Larger colonies usually have rigid limy skeleton of massive, branched, or fan-shaped form. HYDRAS, SEA ANEMONES, JELLYFISHES, CORALS, etc. (Cnidaria), Plate 7.
- 21b. Body covering usually spiny, soft or rigid, flattened or elongate, typically having five radii, with or without spines or arms; anus present. Solitary. Marine only. STARFISHES and relatives (Echinodermata), Plate 23.
 - 22a. Colony a jellylike mass, a network of branching tubes, a plant-like tuft, or a lacy, limy crust or mass. MOSS ANIMALS (Ectoprocta), Plate 22.
 - 22b. Exclusively marine. Surface of body or colony relatively smooth but tough. Solitary forms, sac-like, with two external openings. Exhibit all degrees of colonialism. Compound forms range from thin slimy masses, with organisms arranged in tiny radial patterns, to huge, shapeless masses resembling tough frozen gelatin. SEA SQUIRTS, SEA PORK (Asciacea, Urochorda, Chordata), not illustrated.
- 23a. Animal living within a hard, limy shell, soft body (Mollusca or Brachiopoda) 29
- 23b. Animal without a limy shell 24
 - 24a. Jointed legs present (may not be functional). Body may be hard or soft 30
 - 24b. Jointed legs absent, body covering mostly soft, animal pliable (a hardened head capsule may be present) 25
- 25a. Body girded by annulations or creases at regular intervals, dividing it into many small segments much wider than long 26
- 25b. Segments present or absent; if present, not much wider than they are long 27
 - 26a. Body with suction disk at one or both ends, in length usually less than 10 times its width. LEECHES (Annelida, Hirudinea), Plate 9.
 - 26b. Body without suction disks, in length usually more than 10 times its width; hairs or bristles often evident. SEGMENTED WORMS (Annelida), Plates 9 and 10.
- 27a. Body unsegmented 28
- 27b. Body segmented, slender. TWO-WINGED FLIES (Diptera), Plate 16.
 - 28a. Body long and slender, appearing smooth, evenly tapered to a fine point at one end. ROUNDWORMS (Nematoda), Plate 9.

* Invertebrates retained on a U.S. Standard No. 35 sieve (0.5 mm).

Refer to
couplet No.

- 28b. Body flat, elongate, or oblong; pigmented spots on head; head often spade-shaped. FLATWORMS (Platyhelminthes, Turbellaria), Plate 9.
 - 28c. Body long and slender with a circle of tentacles at one end; lives in a sandy tube, marine (Phoronidea), Plate 22.
 - 29a. Shell consisting of two hinged halves. BIVALVES (Pelecypoda) or LAMP SHELLS (Brachiopoda), Plate 21.
 - 29b. Shell entire, usually spiral but may be "coolie hat" -shaped. SNAILS (Gastropoda), Plate 20.
 - 30a. Body with functional legs..... 31
 - 30b. Body without functional legs, mummy- or capsule-like, living in a cocoon. PUPAE (Insecta), Plates 15, 16, and 17.
 - 31a. Body with three pairs of legs. Larvae, nymphs, and some adults (Insecta)..... 42
 - 31b. Body with more than three pairs of legs..... 32
 - 32a. Body compact, spider-like, with four conspicuous pairs of legs (two other pairs of appendages present). WATER MITES (Acari) or SEA SPIDERS (Pycnogonidea), Plates 12 and 22.
 - 32b. Body with at least five conspicuous pairs of legs. CRUSTACEANS (Crustacea)..... 33
 - 32c. Body covering hard; divided into broad head, truncate body, and sharp tail section (marine). HORSESHOE CRAB (Arachnoidea), Plate 22.
4. Key to Crustacea
- 33a. Paired compound eyes on stalks..... 34
 - 33b. Paired compound eyes, if present, sessile..... 36
 - 34a. Carapace, if present, does not fuse with more than four thoracic segments..... 35
 - 34b. Carapace fused with all thoracic segments; pincers present. Decapoda, Plate 12.
 - 35a. Carapace covers most of the thoracic segments. Mysidacea, Plate 11.
 - 35b. Carapace extends over the anterior segments of abdominal region. Leptostraca, Plate 12.
 - 36a. Body flattened horizontally..... 37
 - 36b. Body flattened laterally. SCUDS (Amphipoda), Plate 12.
 - 37a. First pair thoracic legs with pincers. Tanaidacea, Plate 12.
 - 37b. First pair of thoracic legs pointed and similar to all thoracic legs. Isopoda, Plate 12.
5. Key to Insect Pupae
- 38a. Back of pupa with small, paired, hook-bearing plates. CADDISFLIES (Trichoptera), Plate 15.
 - 38b. Back without paired hook-bearing plates but may have knobs or bristles..... 39
 - 39a. Developing wings (pads) held free from body. BEETLES (Coleoptera), Plate 17.
 - 39b. Wing pads closely appressed to body, mummy-like, or appendages not evident..... 40
 - 40a. With one closely appressed pair of wing pads, but not fused to body; or capsule-like, appendages not evident. TWO-WINGED FLIES (Diptera), Plate 16.
 - 40b. Two pairs of wing pads..... 41
 - 41a. First two or three abdominal segments with spiracles (holes for breathing) on each side; body without numerous projections. AQUATIC MOTHS (Lepidoptera), not illustrated.
 - 41b. Body differing from above, may have numerous knobs or other projections on back. HELLGRAMMITES (Neuroptera and Megaloptera), Plate 15.
6. Key to Insect Larvae, Nymphs, and Some Adults
- 42a. Animal flea-like, with a bifid projecting appendage on the underside. SPRINGTAILS (Collembola), Plate 22.
 - 42b. Animal otherwise..... 43
 - 43a. Body ending in long segmented filaments..... 44
 - 43b. Long filaments absent or, if present, not segmented..... 45
 - 44a. Two tail filaments, all legs ending in two claws. STONEFLIES (Plecoptera), Plate 13.
 - 44b. Middle and hind legs ending with one claw, three tail filaments (usually). MAYFLIES (Ephemeroptera), Plate 13.
 - 45a. Back of body covered with two hard wing covers, a pair of membranous wings underneath the covers. ADULT BEETLES (Coleoptera), Plate 17.
 - 45b. Back without hard wing covers..... 46
 - 46a. Body with exposed membranous wings or wing pads on back..... 47
 - 46b. Body without membranous wings or wing pads (larvae)..... 49
 - 47a. Membranous wings present; held flat and in a V-shape on back. Mouth parts formed into a long, sharply pointed beak folded underneath body. TRUE BUGS (Hemiptera), Plate 18.
 - 47b. Membranous wings absent, wing pads present. Mouth parts formed into an extendable, scoop-like mask that covers face. (Odonata)..... 48
 - 48a. Body ending in three oblong, fan-like plates. DAMSELFLIES (Zygoptera), Plate 14.
 - 48b. Fan-like plates absent. DRAGONFLIES (Anisoptera), Plate 14.
 - 49a. Mouth parts formed into slender curved rods nearly half as long as body (less than 10 mm). SPONGILLA FLIES (Neuroptera), not illustrated.

ACKNOWLEDGMENTS

Plates 1 through 27, which follow on succeeding pages, present over 300 marine and freshwater organisms commonly found in natural, polluted, and treated waters. These plates were drawn for this work by Lhisa J. Reish of Olympia, Washington. Figures were redrawn by Lhisa J. Reish from original illustrations by Dr. Harold Walker (Figure 15C, 16 A, K, L, and O) and Dr. W. Bridge Cooke (Plates 26 and 27). In a number of instances, it would have been impossible to illustrate a certain organism for the purposes of this manual were it not for the courtesy of other publishers, who permitted illustrations from their publications to be redrawn to be incorporated herein. The following organisms were so reproduced:

- Plate
- 1B S—*Achnanthes*, courtesy of Veb Gustav Fischer Verlag, Jena. Source: Die Susswasser—Flora Mitteleuropas, Heft 10, by F. Hustedt, 1930.
 U—*Coscinodiscus*, courtesy of E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. Source: Das Phytoplankton des Susswassers, Die Binnengewasser, Band XVI, Teil II, Halfte II, by G. Huber-Pestalozzi and F. Hustedt, 1942. Plates CVIII–CXVI and CXXIII.
 W—*Skeletonema*, courtesy of Akademische Verlagsgesellschaft, Leipzig. Source: Die Kieselalgen, by F. Hustedt. In: L. Rabenhorst, Kryptogamen-Flora von Deutschland, Osterreich und der Schweiz, Band VII, 1930.
- 8 I—*Notholca* Robert W. Pennak, Fresh-Water Invertebrates of the United States, Copyright© 1953, The Ronald Press Company, New York. Figure 116N, page 190, adapted for Figure 8, courtesy of The Ronald Press.
- 11 H—*Diaptomus* (copepod)
- 12 H—*Cambarus* (crayfish, crawdad) courtesy of Holden-Day, Inc., San Francisco, California. Source: Needham & Needham's Guide to the Study of Freshwater Biology, 1951. Figures 1 and 10, Plate 14, page 37; Figures 16, 18, and 20, Plate 24, page 61; and Figure 9, Plate 14, page 37.
- 19 E—*Tarebia*,
 H—*Lymnaea* (pond snail),
 I—Orb snail, and
 J—*Ferrissia* (limpet), courtesy of R.M. Sinclair, Advisor for Biological Sampling and Analysis (American Public Health Association), 13th ed.
 K—*Lanx* (limpet) courtesy of John Wiley & Sons, Inc., New York. Source: Ward & Whipple, Fresh Water Biology (2nd ed.), W.T. Edmondson, Editor, 1959. Figures 43.62B(E), 43.13(H), 43.20(I) and 43.14(K).
- 22 C—*Limulus* (horseshoe crab) courtesy of Western Publishing Company, Inc., Golden Press Division, Racine, Wisconsin. Source: Seashores, a Golden Nature Guide, 1955. Page 79.
- 23 A—*Asterias*, and
 C—*Thyrone*, courtesy of Connecticut State Geological and Natural History Survey: Echinoderms of Connecticut, by Wesley Roswell Coe, 1912.
- 25 C—*Ambystoma* (terrestrial adult), courtesy of Dover Publications, Inc., New York. Source: Biology of the Amphibia, by G.K. Noble, 1931. Figure 147C, page 471.
 D—*Ambystoma* (aquatic larva), courtesy of the New York State Museum and Science Service, Albany, New York. Source: The Salamanders of New York, by Sherman C. Bishop, 1941. Figure 33b, page 166. [Bulletin 324, New York State Museum, Albany.]
 E—*Necturus*, courtesy of Dover Publications, Inc., New York. Source: Biology of the Amphibia, by G.K. Noble, 1931. Figure 35B, page 99.
 G—*Siren intermedia* (siren), reprinted from Sherman Bishop: Handbook of Salamanders. Copyright 1943 by Comstock Publishing Company, Inc. Used by permission of Cornell University Press.
- 26 A—Micrococcus,
 B—Streptococcus,
 C—Sarcina,
 D—Bacillus,
 E—Vibrio and
 F—Spirillum, courtesy of John Wiley & Sons, Inc., New York. Source: Ward & Whipple, Fresh Water Biology (2nd ed.), W.T. Edmondson, Editor, 1959. Figure 3.1.
 K—Actinomycete growth form, Selman A. Waksman, The Actinomycetes. Copyright(c) 1957, The Ronald Press Company, New York. Figure 2–6, page 18, adapted for Figure 26K, courtesy The Ronald Press.
 O—*Tetracladium*, and
 P, Q—*Achlya*, courtesy of John Wiley & Sons, Inc., New York. Source: Ward & Whipple, Fresh Water Biology (2nd ed.), W.T. Edmondson, Editor, 1959. Figure 4.119 and 4.79.
- 28–35 Courtesy of U.S. Environmental Protection Agency. Source: Algae and Water Pollution by C.M. Palmer (R.L. Lewis, ed.), 1977. U.S. Environmental Protection Agency, Off. Research and Development, Cincinnati, Ohio.



Plate 1A. Cyanobacteria and green algae. Dimensions refer to individual cells or filaments. All organisms inhabit fresh water.

Cyanobacteria (Phylum Cyanophyta):

- A—*Aphanizomenon*, aggregate of filaments (3–6 μm)
- B—*Aphanizomenon*, detail
- C—*Gloeotrichia*, portion of colony (cells 7–9 μm diameter)
- D—*Gloeotrichia*, detail

Green algae (Phylum Chlorophyta):

- E—*Dictyosphaerium* (8–14 μm)

- F—*Westella* (5–7 μm)
- G—*Selenastrum* (6–7 μm)
- H—*Tetrastrum* (5–9 μm)
- I—*Crucigenia* (5–8 μm)
- J—*Ankistrodesmus* (2–3 μm)
- K—*Schizomeris* (12–18 μm)

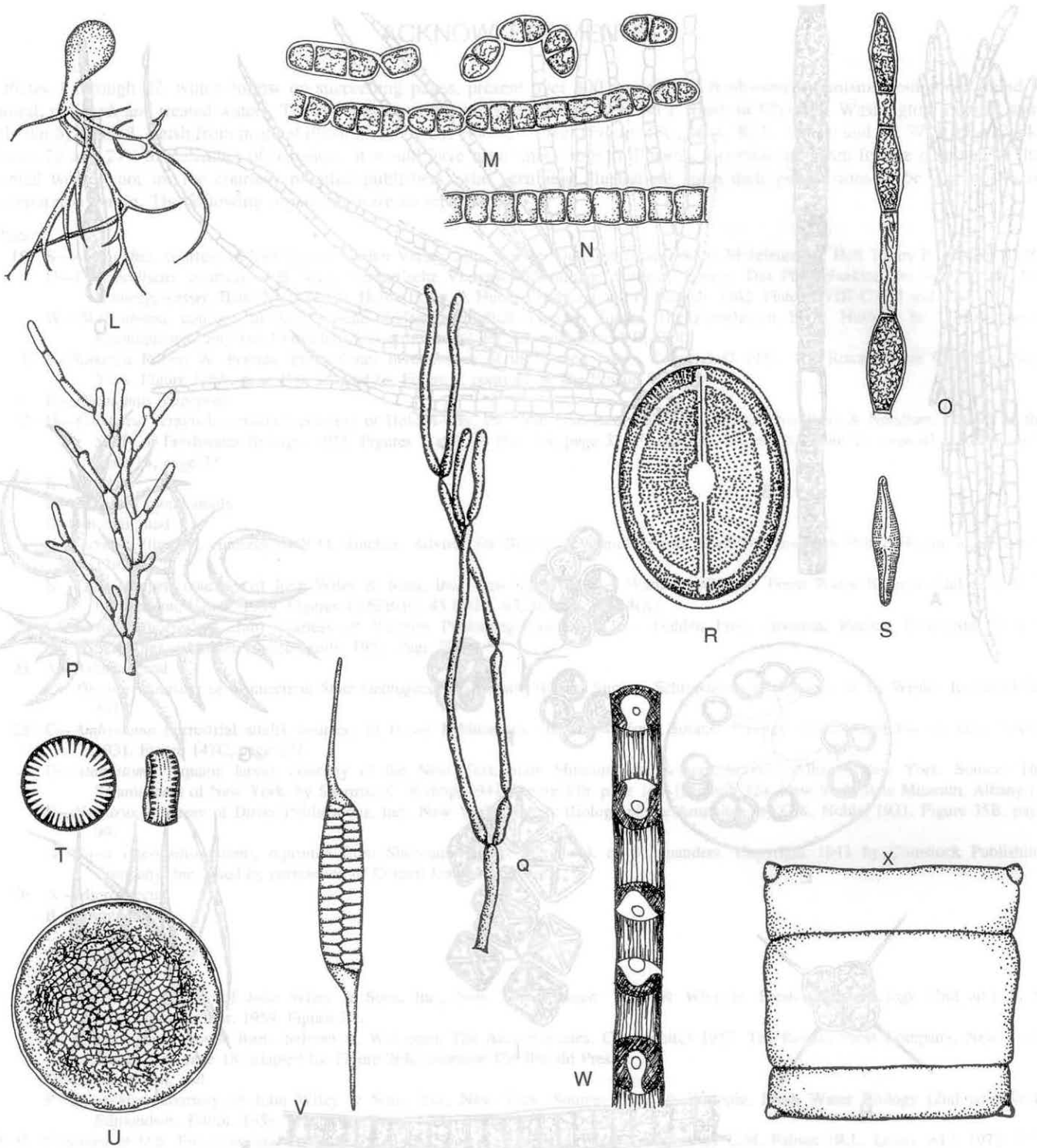


Plate 1B. Yellow-green, green, and golden-brown algae. Dimensions refer to individual cells or filaments. All organisms inhabit fresh water.

Yellow-green algae (Phylum Xanthophyta):

L—*Botrydium*

Green algae (Phylum Chlorophyta):

M—*Stichococcus*

N—*Hyalotheca*

O—*Pithopora*

P—*Microthamnion*

Q—*Dichotomosiphon*

(1–2 μm)

(3 μm)

(12–30 μm)

(50–100 μm)

(2–4 μm)

(50–100 μm)

Golden-brown algae (Phylum Chrysophyta) (diatoms):

R—*Cocconeis*

S—*Achnanthes*

T—*Cyclotella*

U—*Coscinodiscus*

V—*Rhizosolenia*

W—*Skeletonema*

X—*Bidulphia*

(10 μm)

(10 μm)

(10 μm)

(120 μm)

(5–15 μm)

(5–15 μm)

(100 μm)

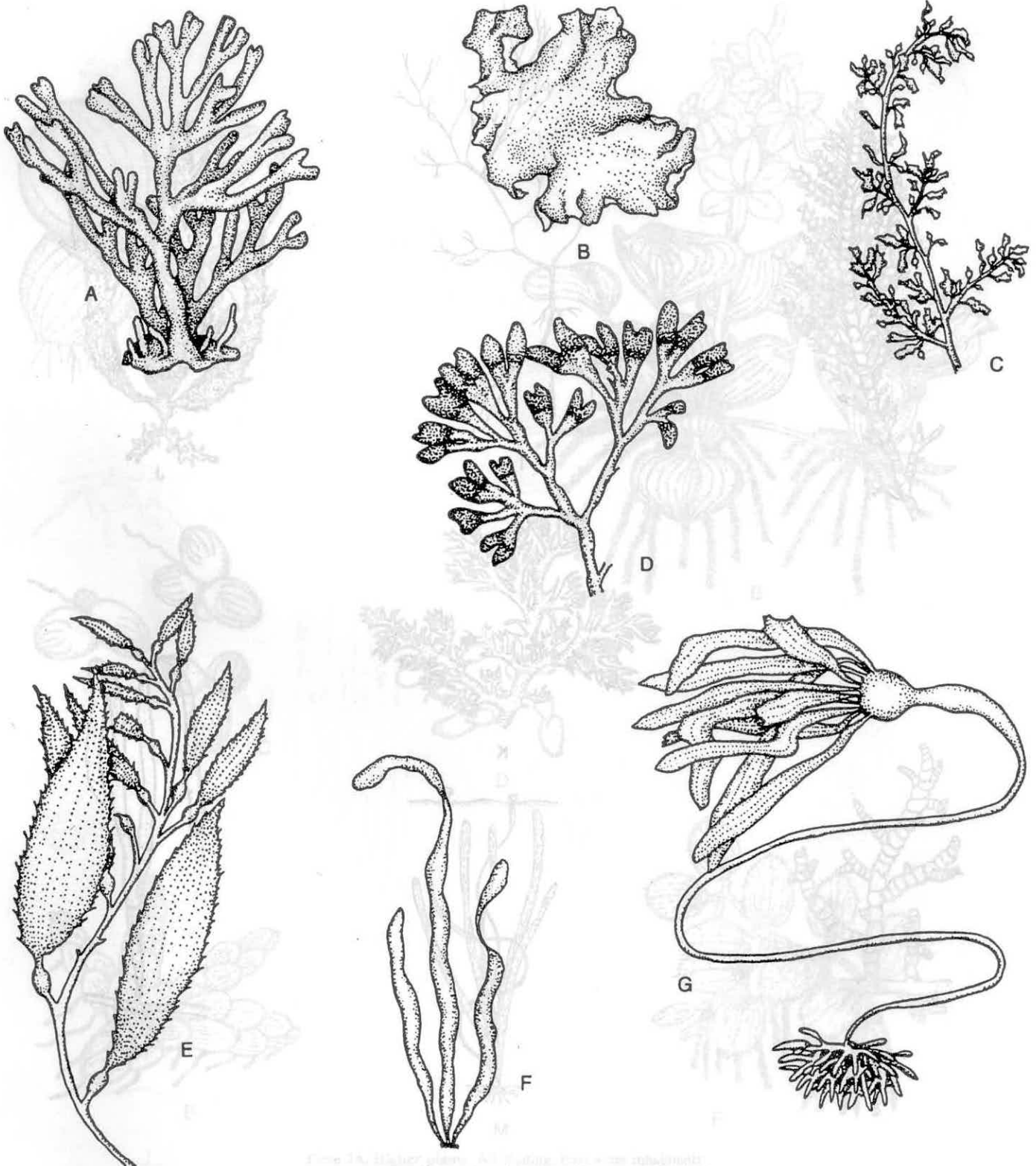


Plate 2A. Types of large marine algae.

Green algae (Phylum Chlorophyta):

- A—Sponge weed, *Codium* (30–40 cm)
- B—Sea lettuce, *Ulva* (20 cm)
- C—*Sargassum* (20–100 cm)

Brown algae (Phylum Phaeophyta):

- D—Rockweed, *Fucus* (75 cm)
- E—Giant kelp, *Macrocystis* (30 m)
- F—*Enteromorpha* (40 cm)
- G—Bull whip, *Nereocystis* (20 m)

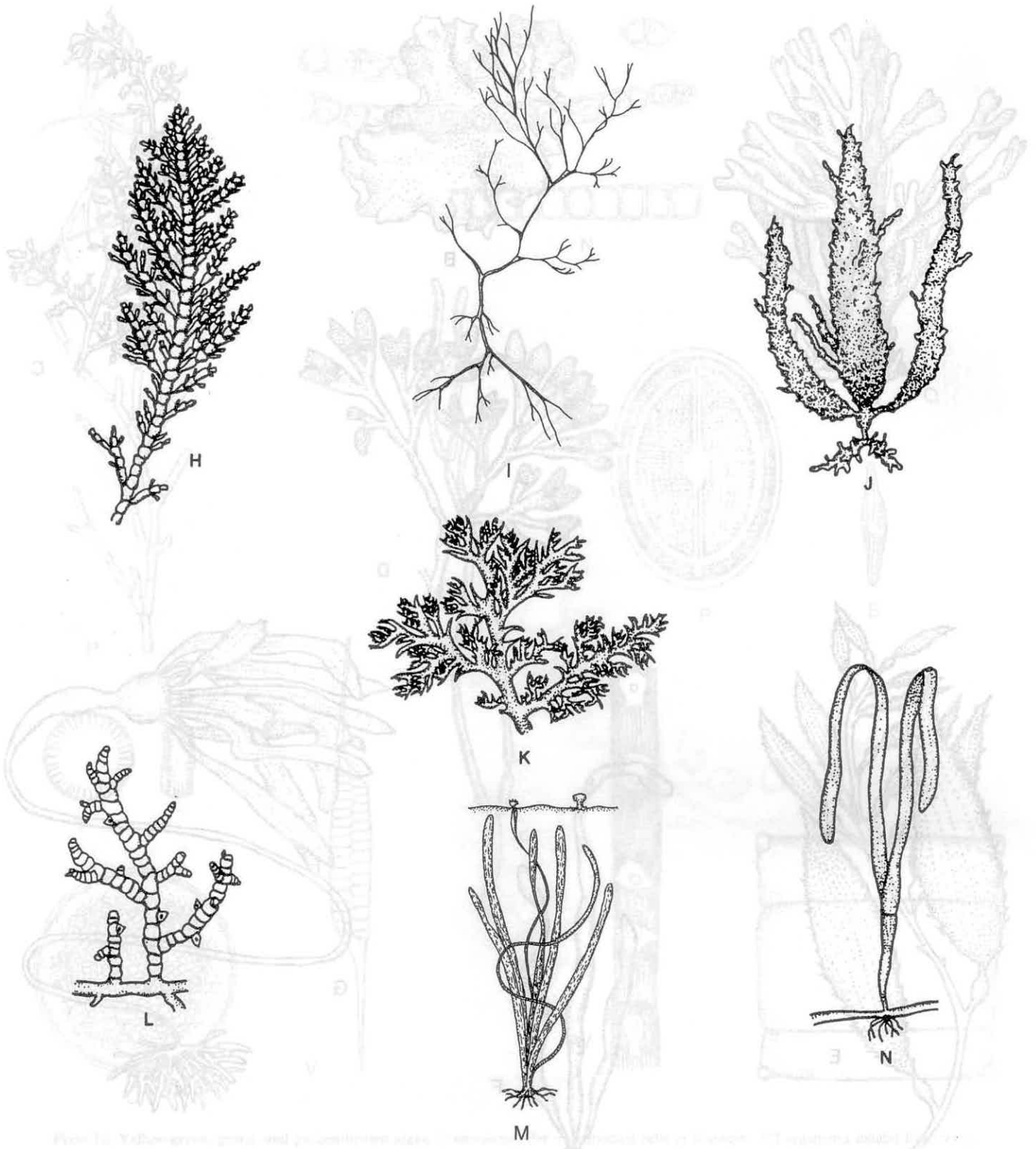


Plate 2B. Types of large marine algae and marine grasses:

Red algae (Phylum Rhodophyta):

- H—*Corallina* (4 cm)
- I—*Gracilaria* (50 cm)
- J—*Gigartina* (30–40 cm)
- K—*Plocamium* (30 cm)

- L—*Champia* (1–6 cm)
- Marine grasses (Phylum Spermatophyta):
- M—Eelgrass, *Vallisneria* (50 cm)
- N—Eelgrass, *Zostera* (45 cm)

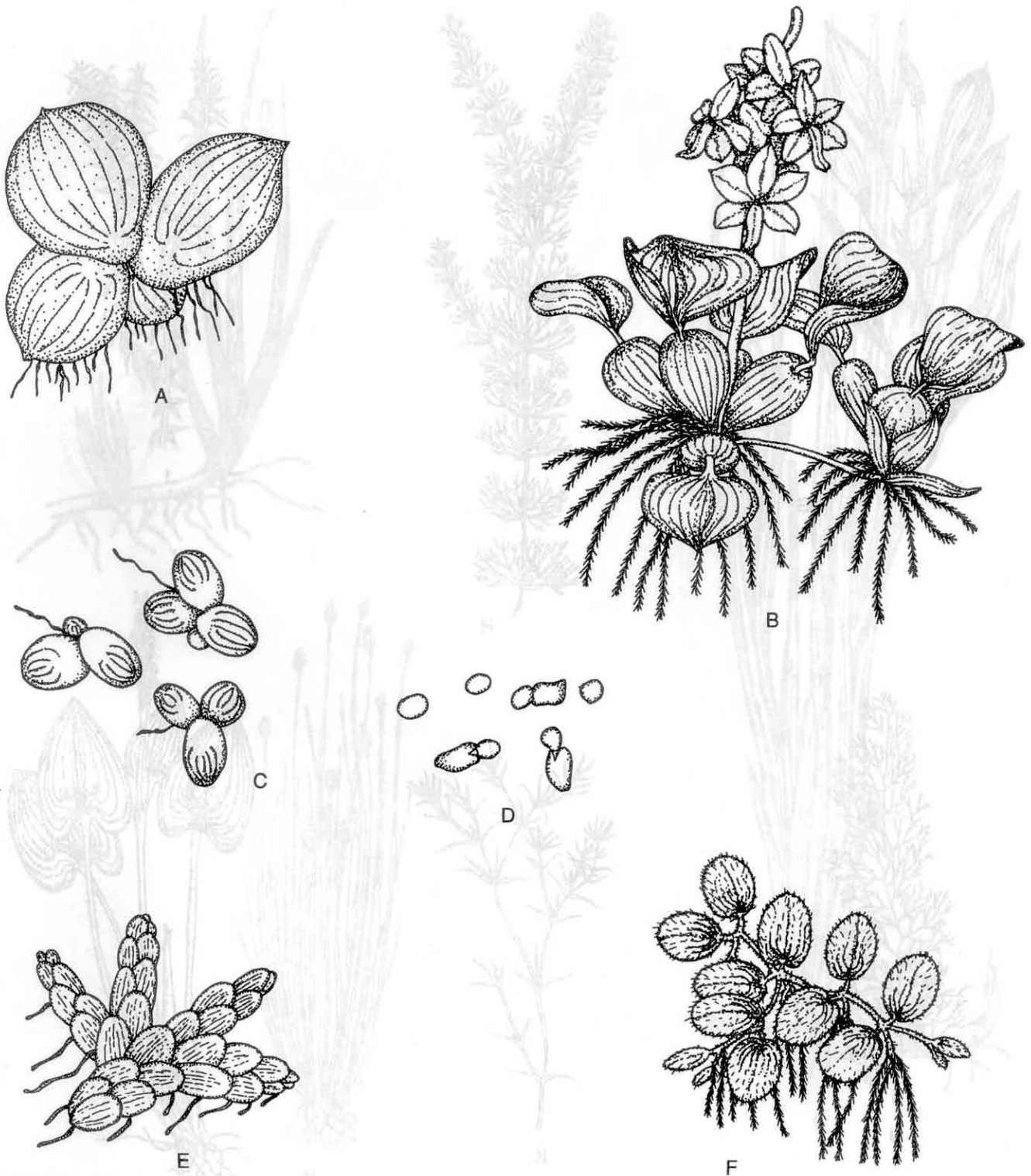


Plate 3A. Higher plants. All floating, freshwater inhabitants.

Phylum Spermatophyta:

- A—Great duckweed, *Spirodela* (8 mm)
- B—Water hyacinth, *Eichhornia* (22 cm)
- C—Lesser duckweed, *Lemna* (5 cm)

Phylum Pteridophyta:

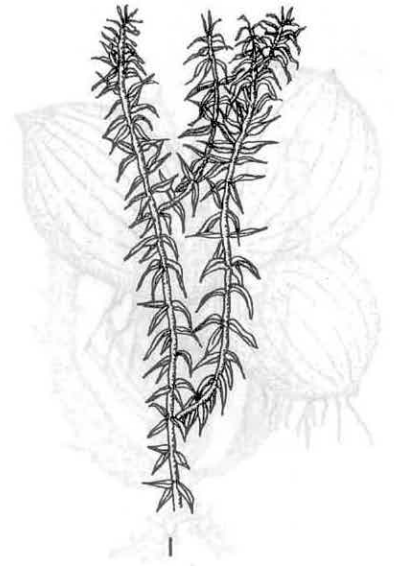
- D—Watermeal, *Wolffia* (1–1.5 mm)
- E—Water velvet, *Azolla* (1 cm)
- F—Water fern, *Salvinia* (4 cm)



G



H



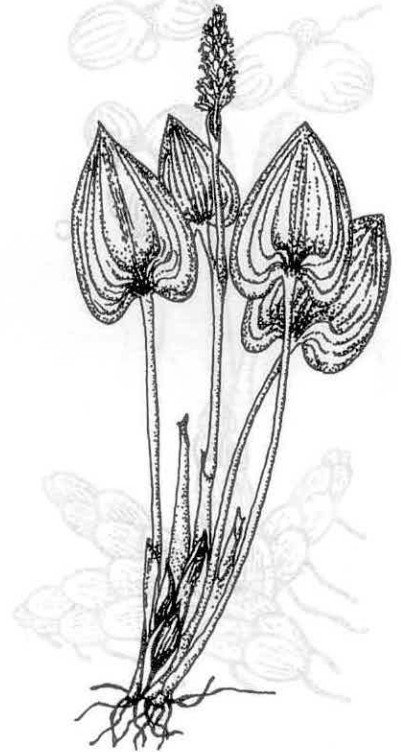
I



J



K



L

Plate 3B. Higher plants. All freshwater inhabitants (Phylum Spermatophyta).

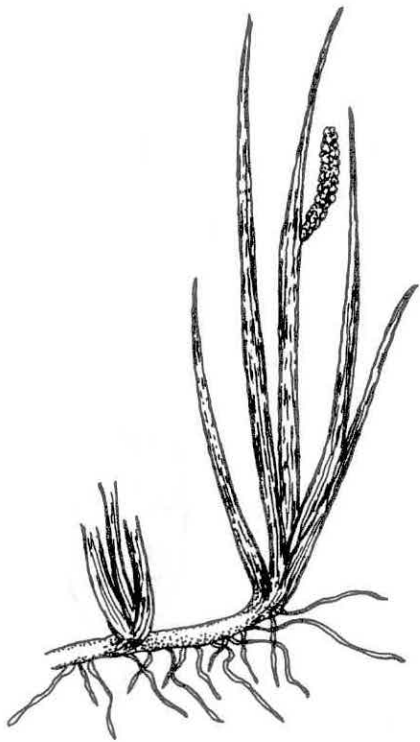
Submerged:

- G—Pondweed, *Potamogeton*
- H—Coontail, *Ceratophyllum*
- I—Waterweed, *Elodea*

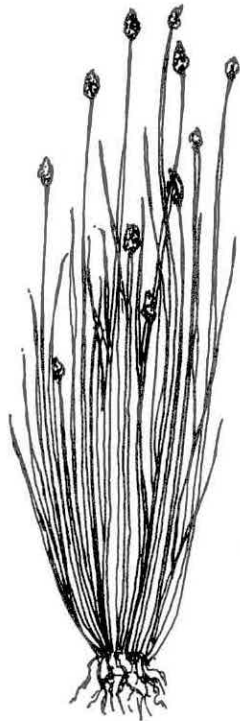
(30–60 cm)
(30 cm)
(15 cm)

Emersed:

- J—Water milfoil, *Myriophyllum* (30 cm)
- K—Naiad, *Najas* (60 cm)
- L—Pickerelweed, *Pontederia* (60 cm)



M



N



O

Plate 3C. Higher plants. All freshwater inhabitants (Phylum Spermatophyta), emersed.

M—Sweet flag, *Acorus*
 N—Spike rush, *Eleocharis*

(30 cm)
 (30 cm)

O—Cattail, *Typha*

(1-2 m)

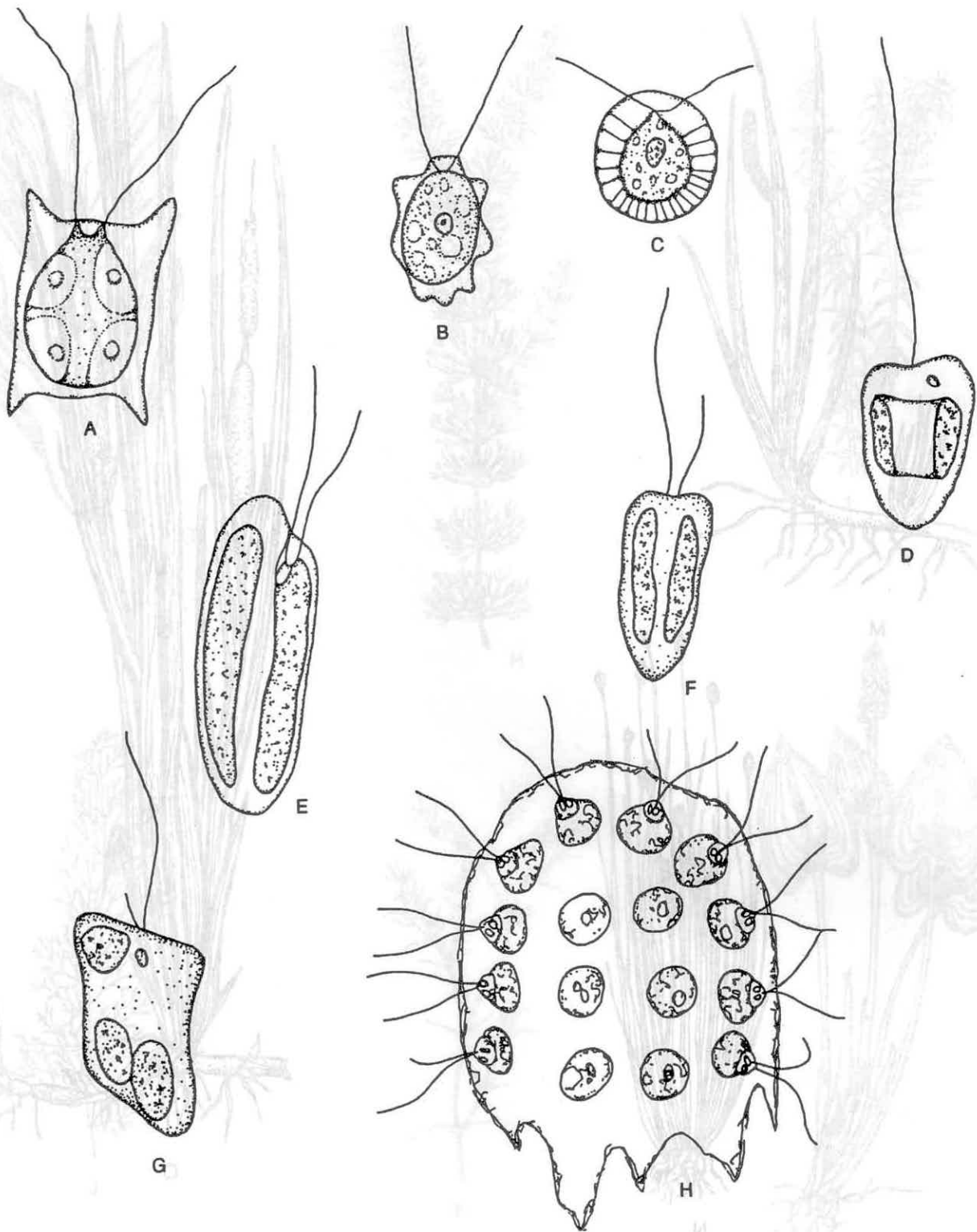


Plate 4A. Flagellates. Pigmented flagellates, various phyla. Freshwater inhabitants.

A—*Pteromonas*
 B—*Lobomonas*
 C—*Haematococcus*
 D—*Chromulina*

(5–18 μm)
 (5–14 μm)
 (40–45 μm)
 (4–10 μm)

E—*Cryptomonas*
 F—*Ochromonas*
 G—*Chloramoeba*
 H—*Platydorina*

(6–12 μm)
 (7–14 μm)
 (10–15 μm)
 (66–70 μm ,
 colony)

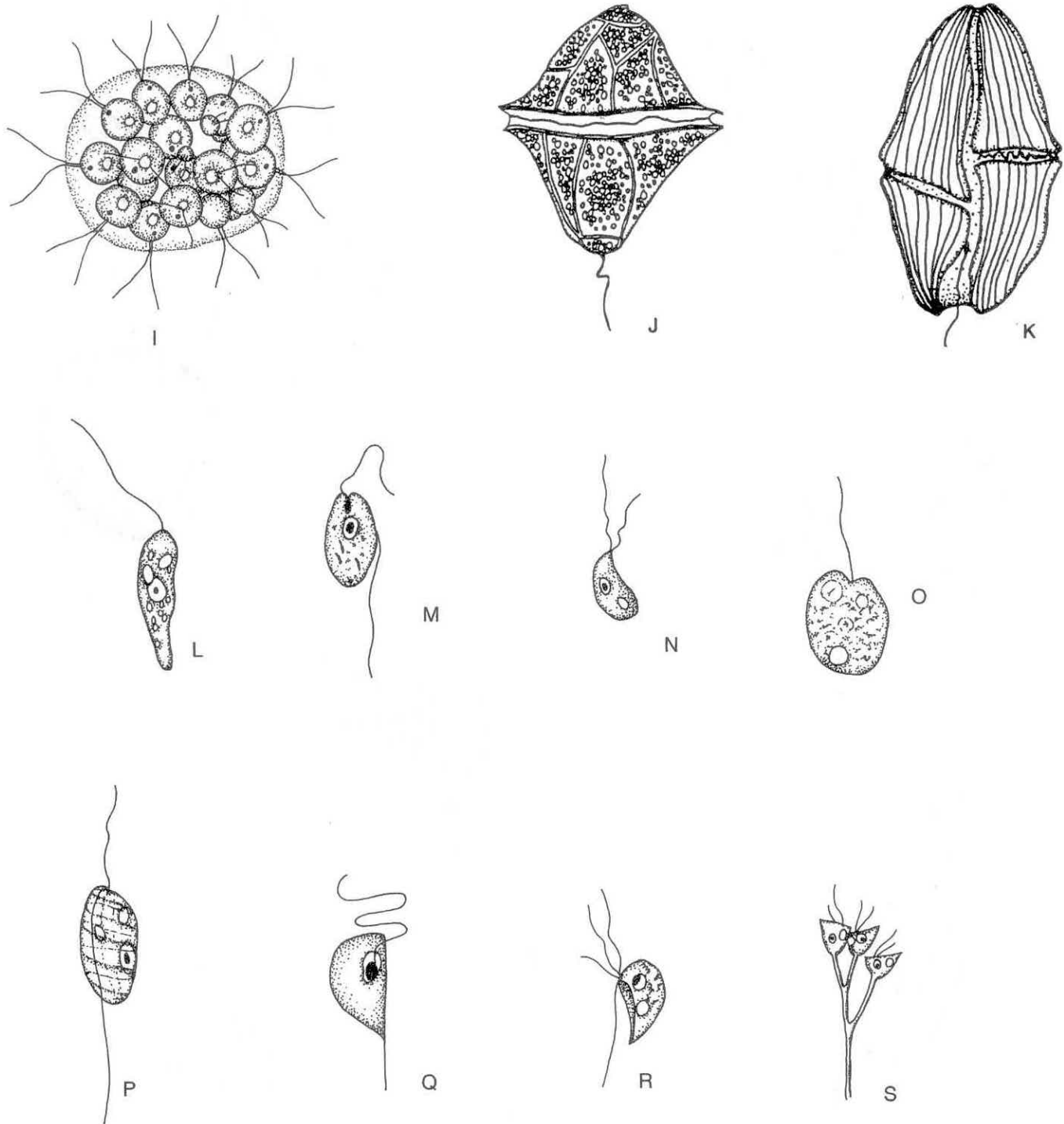


Plate 4B. Flagellates. Freshwater inhabitants except as noted.

Pigmented (various phyla):

- I—*Pleodorina* (8–10 μm)
- J—*Gonyaulax* (marine) (10 μm)
- K—*Gymnodinium* (marine) (10 μm)

Nonpigmented (Phylum Protozoa):

- L—*Astasia* (40–50 μm)
- M—*Bodo* (11–22 μm)

- N—*Dinomonas* (15–16 μm)
- O—*Oikomonas* (5–20 μm)
- P—*Anisonema* (14–60 μm)
- Q—*Cercomonas* (10–36 μm)
- R—*Tetramitus* (11–30 μm)
- S—*Dendromonas* (8 μm)

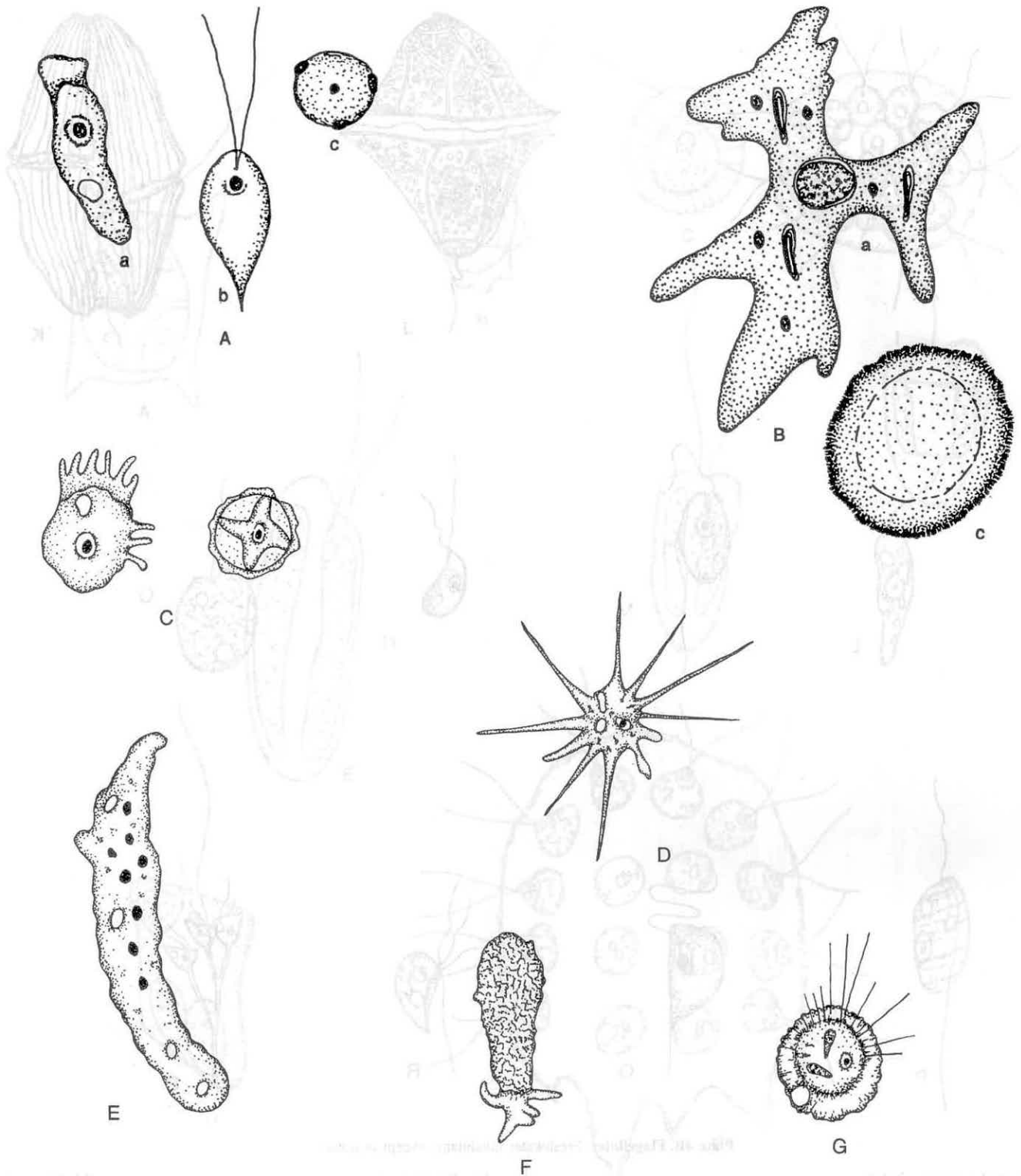


Plate 5A. Amoebas (Phylum Protozoa).

A—*Naegleria*, (a) amoeboid stage, (b) flagellated stage, (c) cyst stage

(10–36 μm)

B—*Amoeba*, (a) amoeboid state, (c) cyst stage

(30–600 μm)

C—*Acanthamoeba (Hartmannella)*, (left) amoeboid stage, (right) cyst stage

(15–25 μm)

D—*Amoeba radiosa*

(30–120 μm)

E—*Pelomyxa*

(0.25–3 mm)

F—*Diffugia*

(40 μm)

G—*Actinophrys*

(25–50 μm)

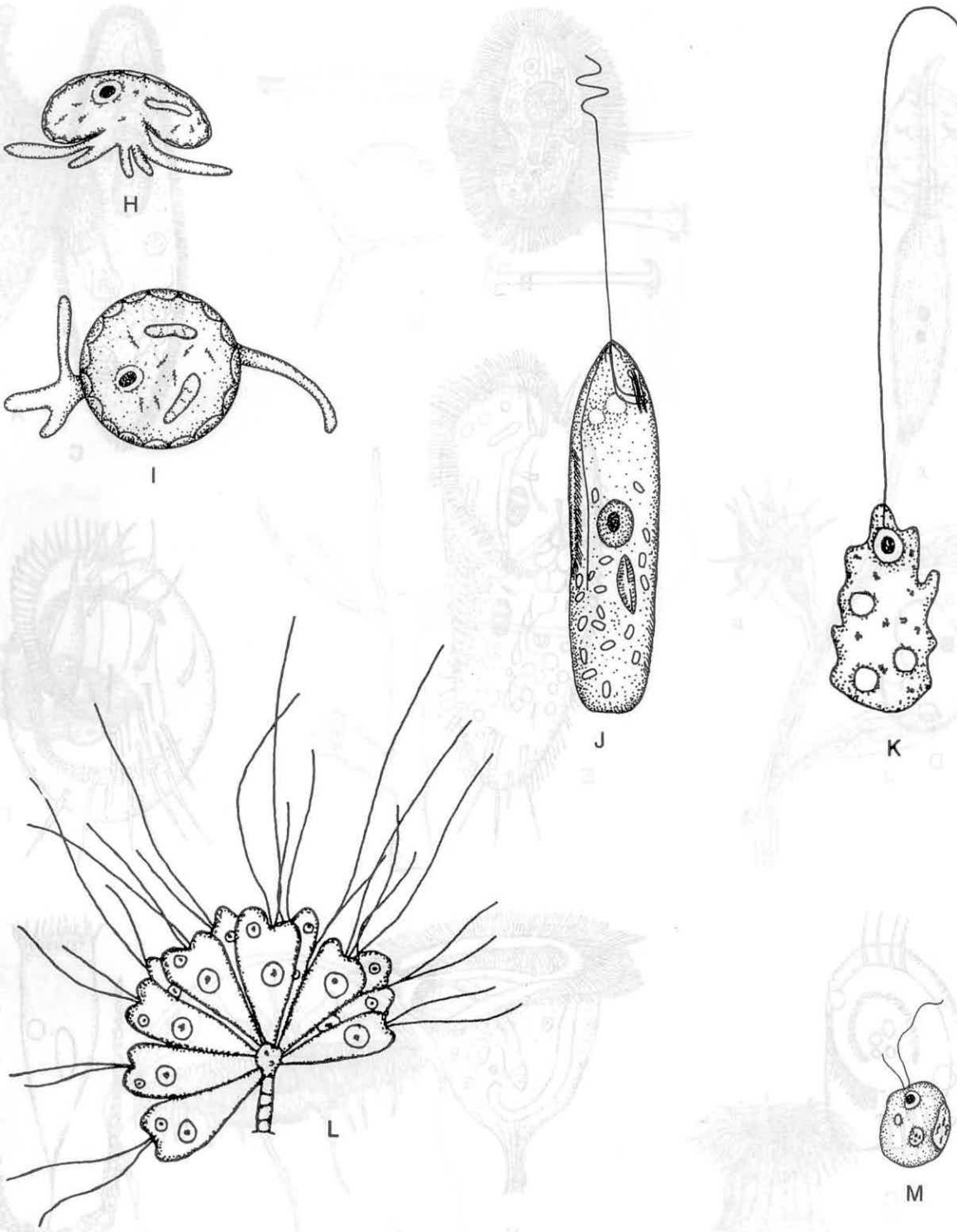


Plate 5B. Amoebas and nonpigmented flagellates (Phylum Protozoa).

Amoebas:

- H—*Arcella* (side view)
- I—*Arcella* (top view)

(30–260 μm)
 (30–260 μm)

Nonpigmented flagellates:

- J—*Peranema*
- K—*Mastigamoeba*
- L—*Anthophysa*
- M—*Monas*

(40–70 μm)
 (28–200 μm)
 (5–6 μm)
 (5–16 μm)

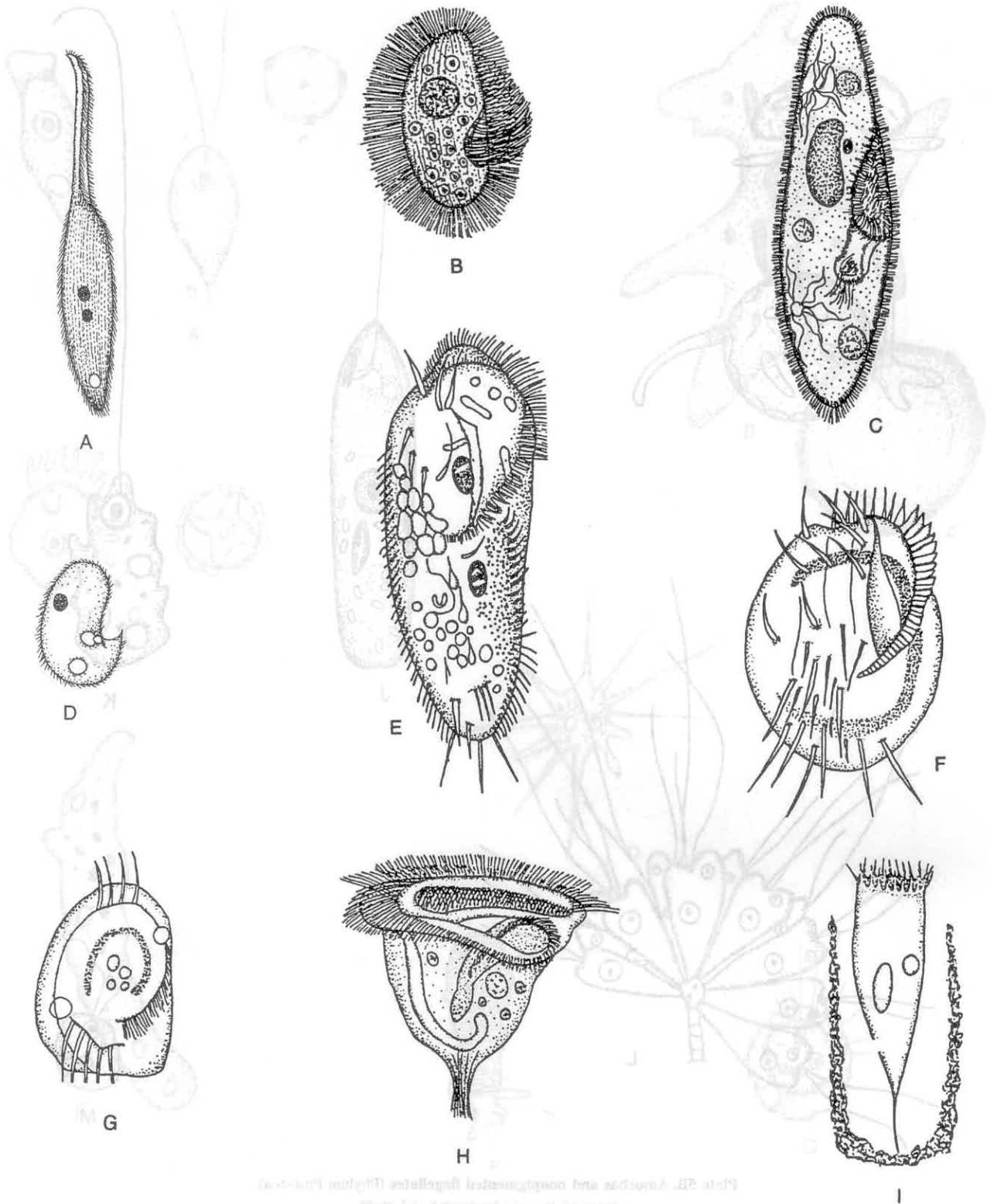


Plate 6. Ciliates (Phylum Protozoa).

A—*Lionotus*
 B—*Pleuronema*
 C—*Paramecium*
 D—*Colpoda*
 E—*Stylonychia*

(100 μm)
 (38–120 μm)
 (50–330 μm)
 (12–110 μm)
 (100–300 μm)

F—*Euplotes*
 G—*Aspidisca*
 H—*Vorticella*
 I—*Tintinnidium*

(70–195 μm)
 (30–50 μm)
 (40–175 μm)
 (40–200 μm)

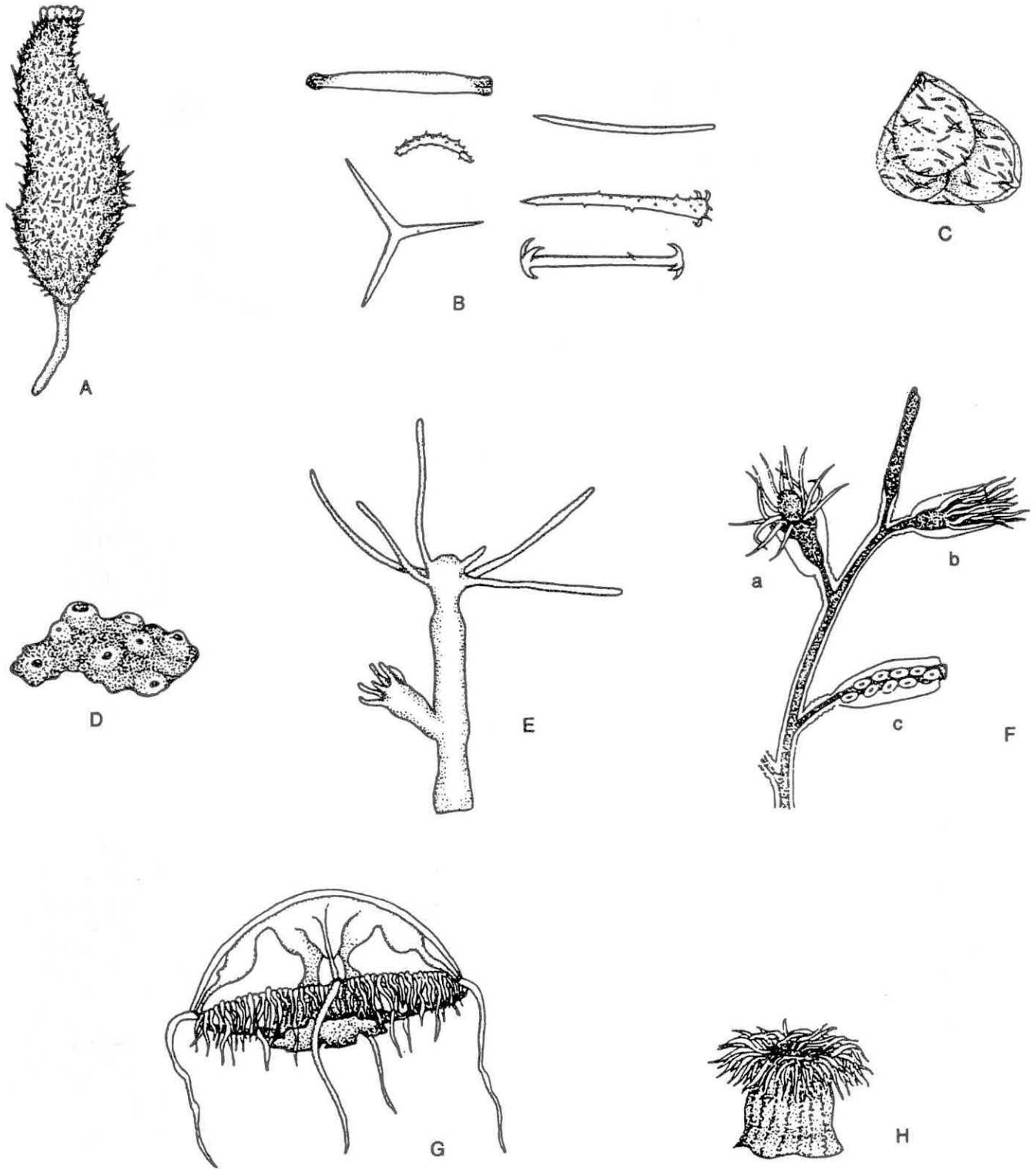


Plate 7. Sponges and coelenterates.

Sponges (Phylum Porifera):

- A—Vase sponge, marine (1 cm)
- B—Sponge spicule types (0.2–0.5 cm)
- C—*Trochospongilla*, 3 gemmules, freshwater (1 mm)
- D—Purple sponge, *Haliclona*, marine (1–10 cm)

Coelenterates (Phylum Cnidaria):

- E—*Hydra* extended with bud, freshwater (2 cm)
- F—*Obelia* extended (a) and contracted (b) hydranth and gonotheca (c), marine (2–10 cm)
- G—Jellyfish (medusoid stage), *Craspedascusta*, freshwater (10–15 mm)
- H—Sea anemone, *Anthopleura*, marine (5–15 cm)

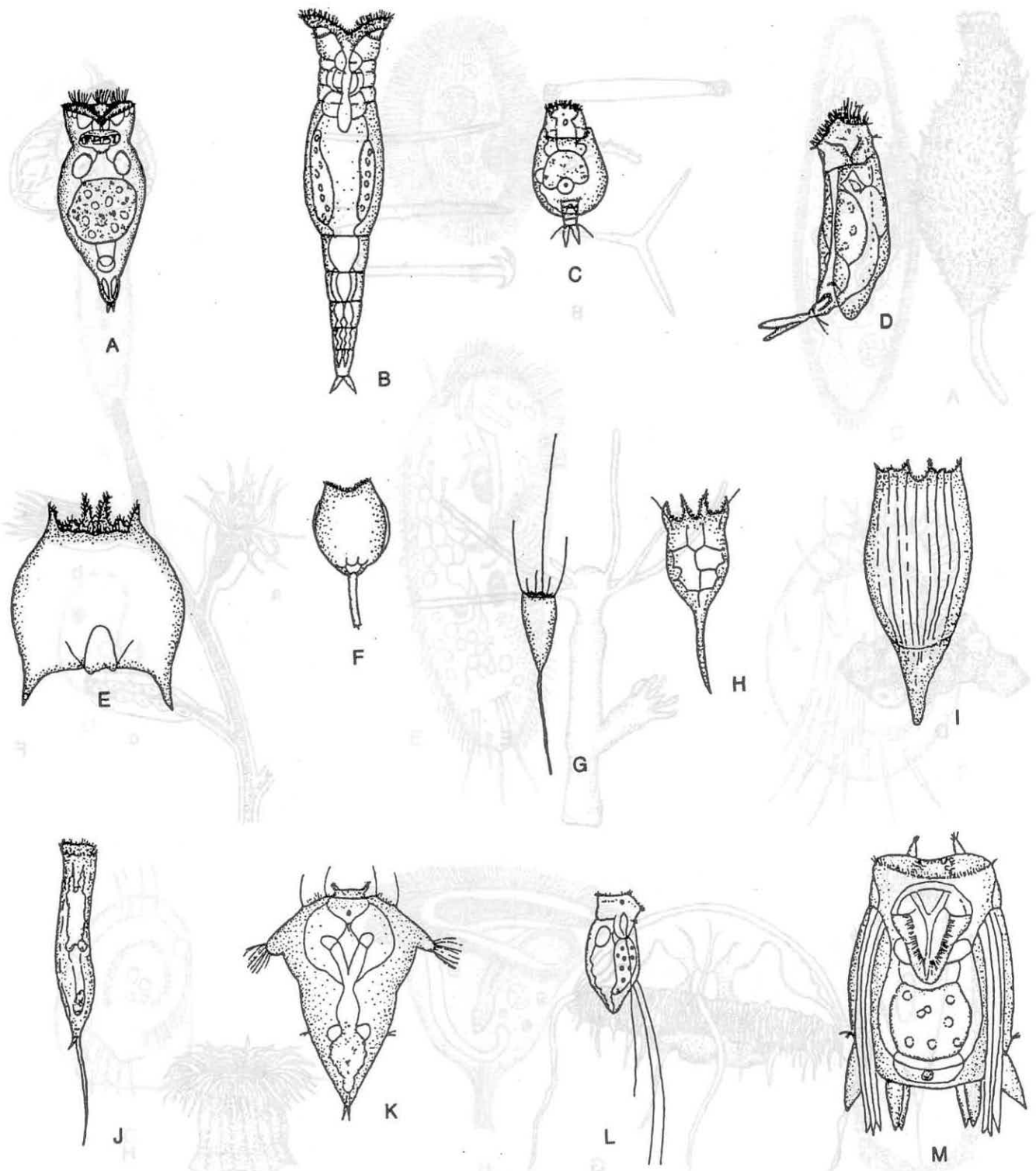


Plate 8. Rotifers (Phylum Rotifera). All freshwater inhabitants. Dimensions include spines.

- | | | | |
|-----------------------|-----------|-----------------------|------------|
| A— <i>Epiphanes</i> | (0.6 mm) | H— <i>Keratella</i> | (0.2 mm) |
| B— <i>Philodina</i> | (0.4 mm) | I— <i>Notholca</i> | (0.2 mm) |
| C— <i>Euchlanis</i> | (0.25 mm) | J— <i>Trichocerca</i> | (0.6 mm) |
| D— <i>Proales</i> | (0.45 mm) | K— <i>Synchaeta</i> | (0.26 mm) |
| E— <i>Brachionus</i> | (0.2 mm) | L— <i>Filinia</i> | (0.15 mm) |
| F— <i>Monostyla</i> | (0.15 mm) | M— <i>Polyarthra</i> | (0.175 mm) |
| G— <i>Kellicottia</i> | (1 mm) | | |

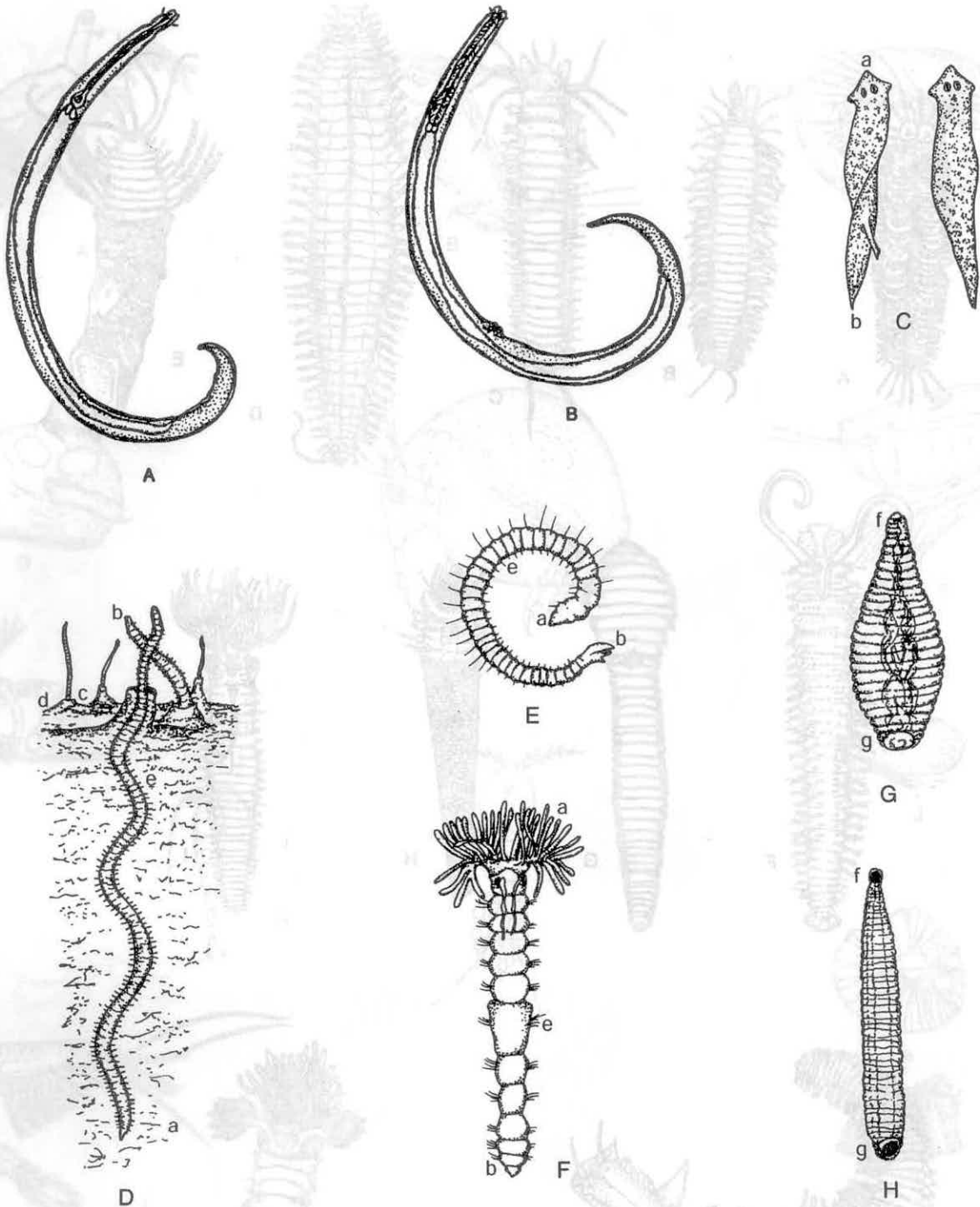


Plate 9. Roundworms, flatworms, and segmented worms. (a) anterior end, (b) posterior end, (c) tubes, (d) mud surface, (e) setae, (f) anterior sucker, (g) posterior sucker. All freshwater inhabitants.

Roundworms (Phylum Nematoda):

- A—*Plectus* (1.0 mm)
- B—*Triplya* (1.0 mm)

Flatworms (Phylum Platyhelminthes):

- C—*Planaria* (5–13 mm)

Segmented worms (Phylum Annelida, Class Oligochaeta):

- D—*Tubifex*, sludgeworm (2.5–5 mm)
- E—*Dero* (3–7 mm)

Segmental worms (Phylum Annelida, Class Polychaeta):

- F—*Manayaunkia*, lives in tube (5 mm)

Segmental worms (Phylum Annelida, Class Hirudinea):

- G—Leech (3–6 mm)
- H—Leech (3–6 mm)

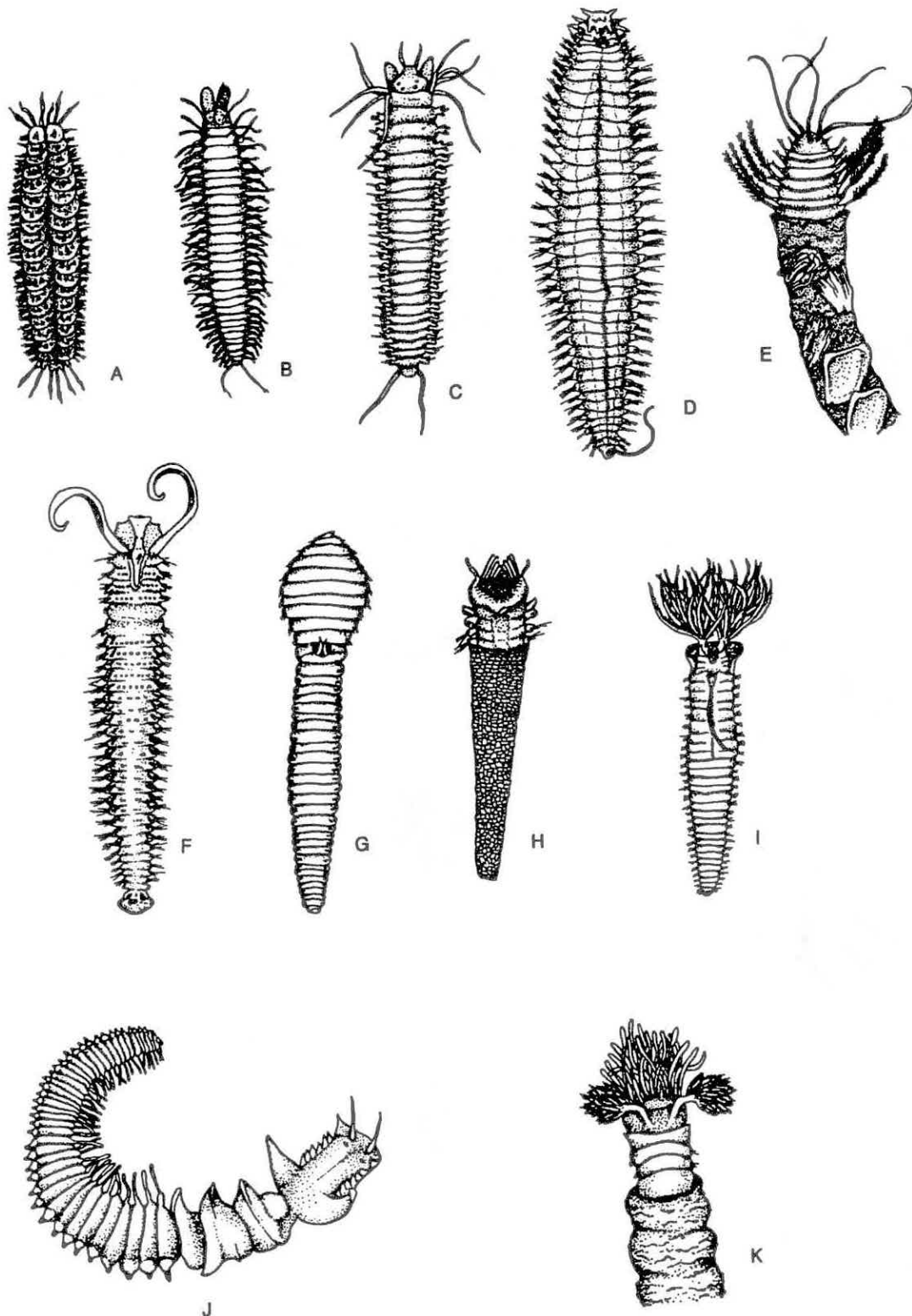


Plate 10. Segmented marine worms (Phylum Annelida, Class Polychaeta).

- | | | | |
|--|-----------|--|------------|
| A—Scale worm, <i>Halosydna</i> | (5 cm) | G—Capitellid, <i>Capitella</i> | (2–4 cm) |
| B—Syllids, <i>Typosyllis</i> | (2–5 cm) | H—Ice cream cone worm, <i>Pectinaria</i> | (1–3 cm) |
| C—Nereid, <i>Nereis</i> | (4–15 cm) | I—Feather duster worm, <i>Sabella</i> | (10–15 cm) |
| D—Nephtyid, <i>Nephtys</i> | (5–25 cm) | J—Chaetopterid, <i>Chaetopterus</i> , lives in U-shaped tube | (10–20 cm) |
| E—Onuphid, <i>Diopatra</i> , in tube covered with shells | (5–25 cm) | K—Terebellid, <i>Pista</i> | (10–15 cm) |
| F—Spionid, <i>Polydora</i> | (2–4 cm) | | |

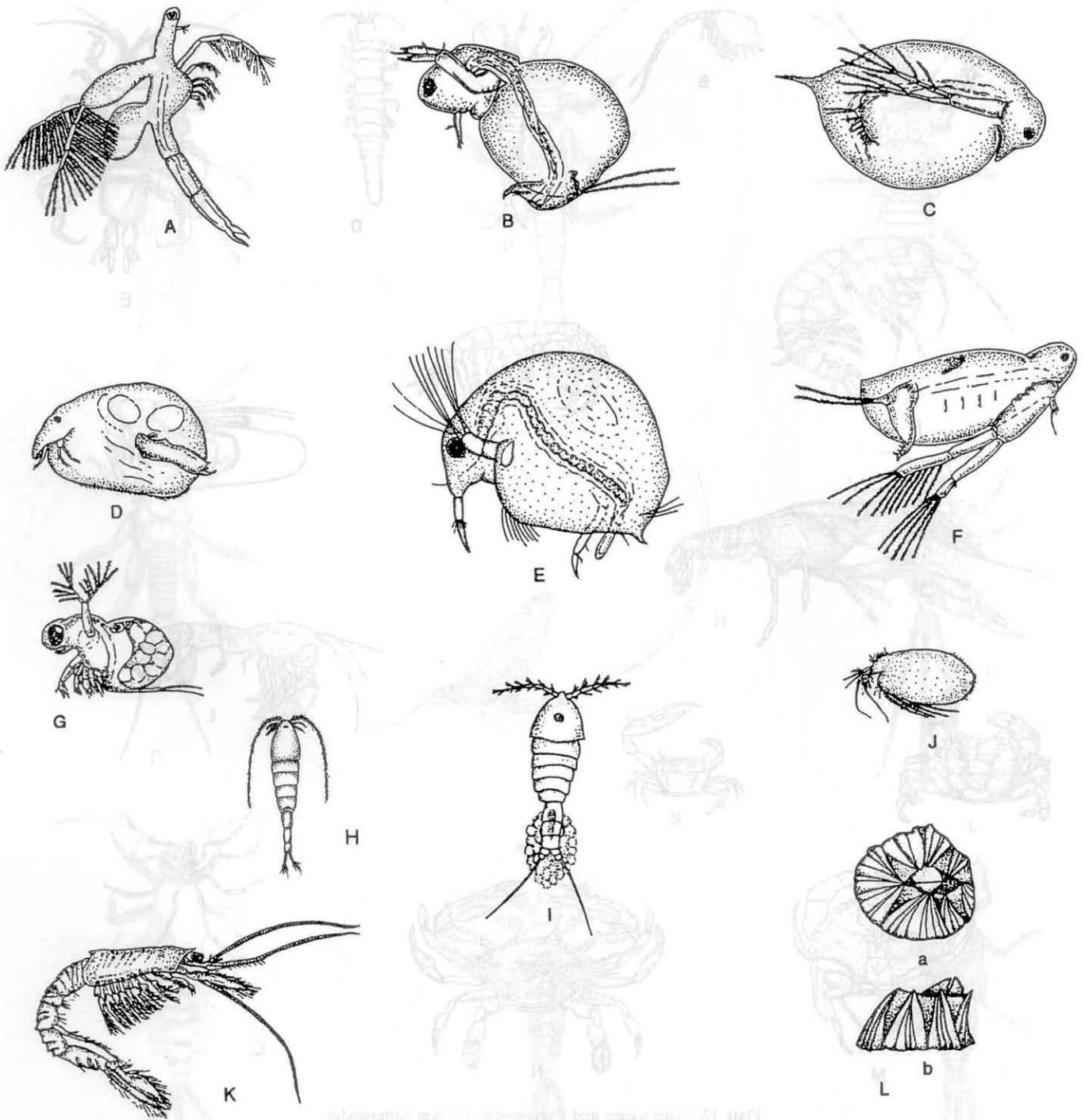


Plate 11. Crustaceans (Phylum Arthropoda). All freshwater inhabitants, except as noted.

Order Cladocera:

- A—*Leptodora* (9 mm)
- B—*Moina* (1.5 mm)
- C—*Daphnia* (2 mm)
- D—*Alona* (0.4 mm)
- E—*Bosmina* (0.4 mm)
- F—*Diaphanosoma* (1.5 mm)
- G—*Polyphemus* (1.5 mm)

Order Copepoda:

- H—*Diaptomus* (2 mm)
- I—*Tigriopus*, marine (2–4 mm)

Order Ostracoda:

- J—*Ostracod*, marine (2–3 mm)

Order Mysidacea:

- K—*Holmesimysis*, marine (10–20 mm)

Order Cirripedia:

- L—Barnacle, *Balanus*, marine, a. top view, (10 mm)
b. side view

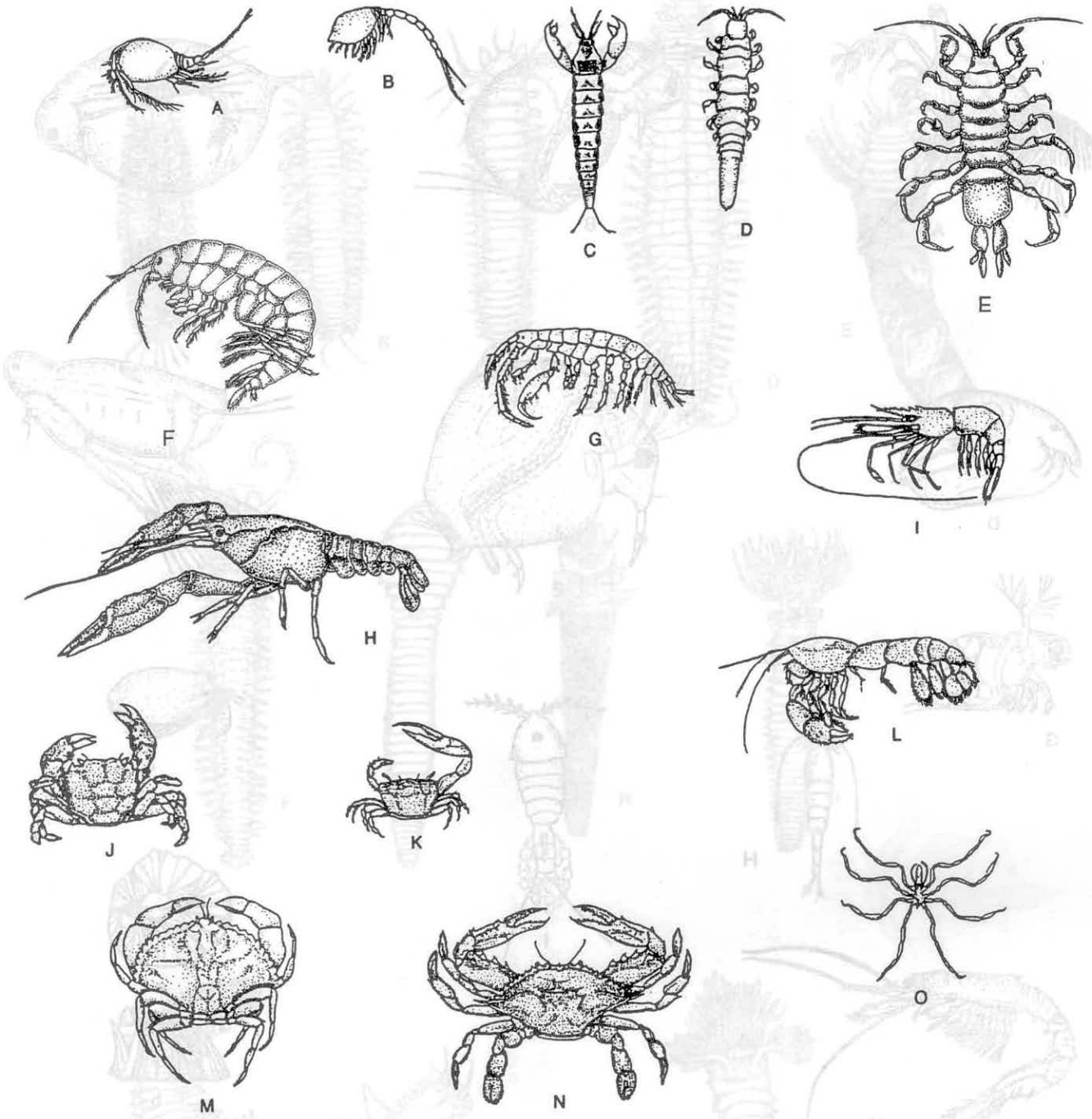


Plate 12. Crustaceans and Pycnogonid (Phylum Arthropoda).

Crustaceans:

Order Leptostraca:

A—*Epinephialia*, marine (10–20 mm)

Order Cumacea:

B—*Oxyurostylis*, marine (8–12 mm)

Order Tanaidacea:

C—*Anatanis*, marine (8–10 mm)

Order Isopoda:

D—*Idotea*, marine (1–3 cm)

E—*Asellus*, freshwater (2 cm)

Order Amphipoda:

F—Scud, *Gammarus*, freshwater (1.5 cm)

G—*Jassa*, marine (1.5 cm)

Order Decapoda:

H—Crayfish or crawdad, *Cambarus*, freshwater (150 mm)

I—Shrimp, *Spirontocaris*, marine (3–6 cm)

J—Mud crab, *Hemigrapsus*, marine (3–6 cm)

K—Fiddler crab, *Uca*, marine (3–6 cm)

L—Ghost shrimp, *Callinassa*, marine (5–10 cm)

M—Cancer crab, *Cancer*, marine (3–18 cm)

N—Blue crab, *Callinectes*, marine (10–20 cm)

Pycnogonid, Class Pycnogonidea:

O—Sea spider, pycnogonid, marine (10–20 mm)

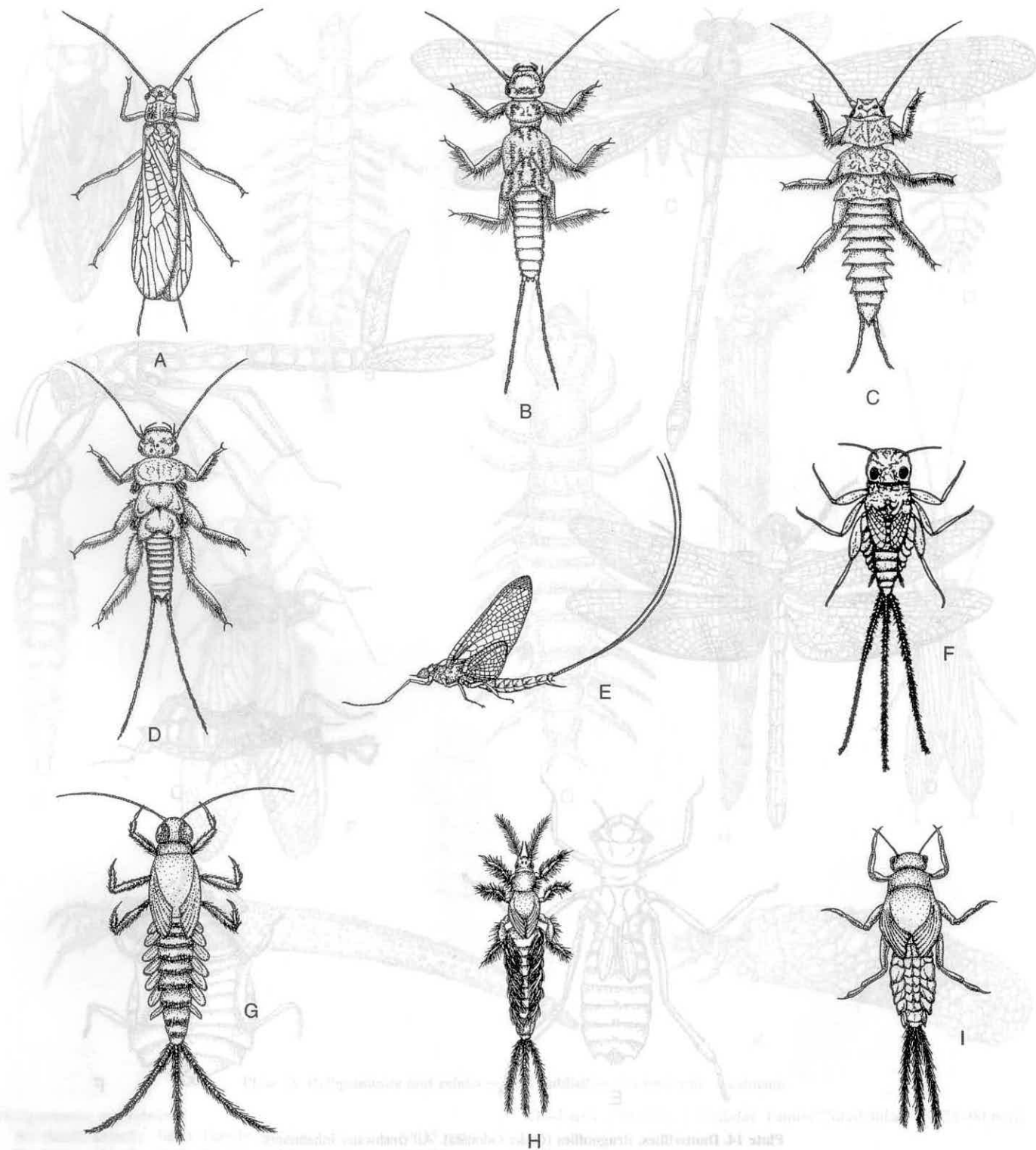


Plate 13. Stoneflies and mayflies. All freshwater inhabitants.

Stoneflies (Order Plecoptera):

- A—Adult, *Isoperla*, Family Perlodidae (14–23 mm)
- B—Nymph, *Isoperla*, Family Perlodidae (10–14 mm)
- C—Nymph, *Pteronarcys*, Family Pteronarcidae (10–40 mm)
- D—Nymph, *Acroneuria*, Family Perlidae (20–30 mm)

Mayflies (Order Ephemeroptera):

- E—Adult, mayfly, Family Heptageniidae (12–18 mm)
- F—Nymph, *Stenonema*, Family Heptageniidae (10–14 mm)
- G—Nymph, *Baetis*, Family Baetidae (7–14 mm)
- H—Nymph, *Hexagenia*, Family Ephemeridae (20–30 mm)
- I—Nymph, *Ephemerella*, Family Ephemerellidae (8–15 mm)

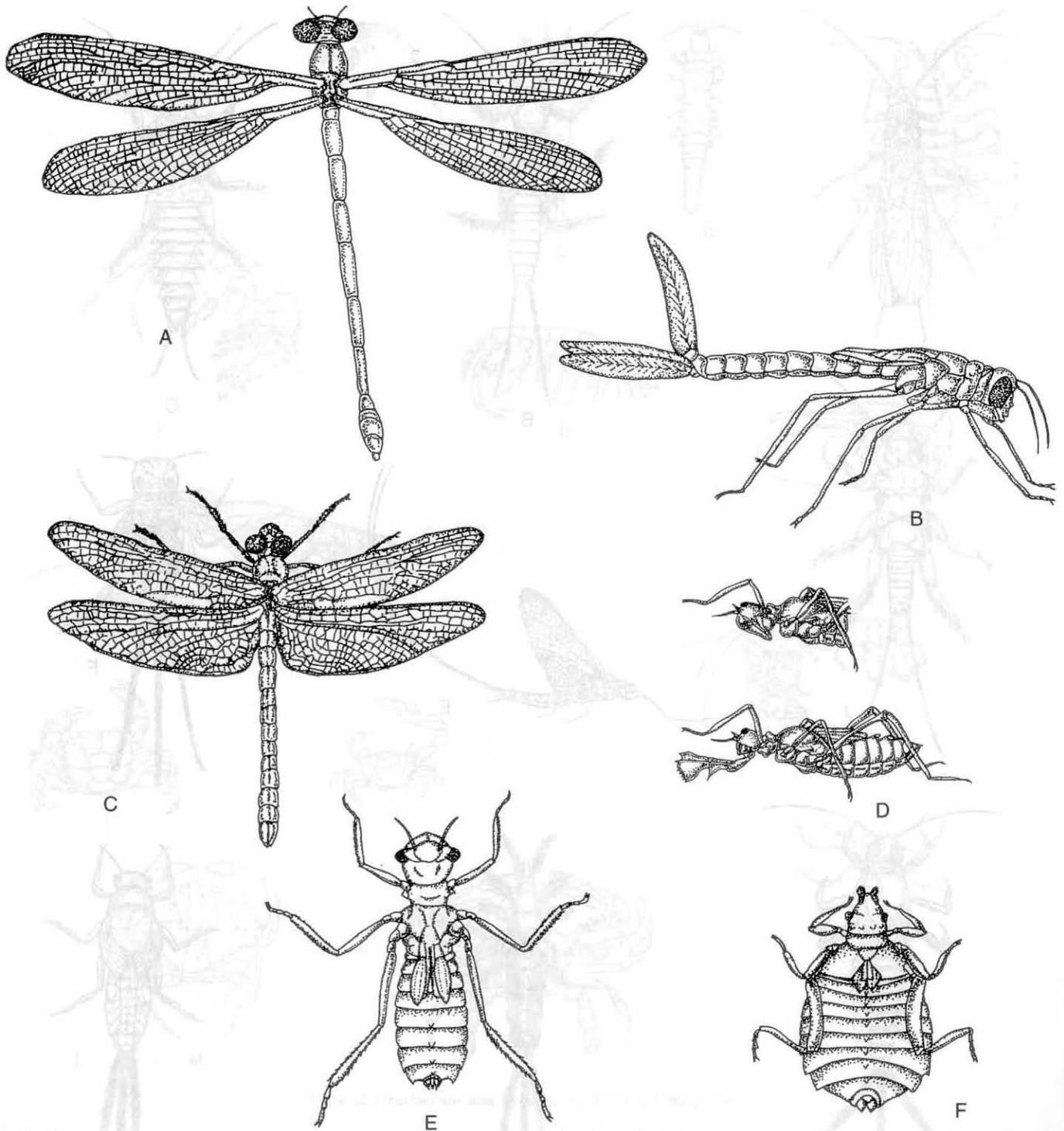


Plate 14. Damselflies, dragonflies (Order Odonata). All freshwater inhabitants.

- | | | | |
|--|------------|---|------------|
| A—Adult, damselfly | (35–55 mm) | D—Nymph, dragonfly, <i>Macromia</i> , Family Macromiidae, showing “mask” both extended and contracted | (15–45 mm) |
| B—Nymph, damselfly, <i>Lestes</i> , Family Lestidae | (20–30 mm) | E—Nymph, dragonfly, <i>Helocordulia</i> , Family Libellulidae | (15–45 mm) |
| C—Adult, dragonfly, <i>Macromia</i> , Family Macromiidae | (50–70 mm) | F—Nymph, dragonfly, <i>Hagenius</i> , Family Gomphidae | (15–20 mm) |

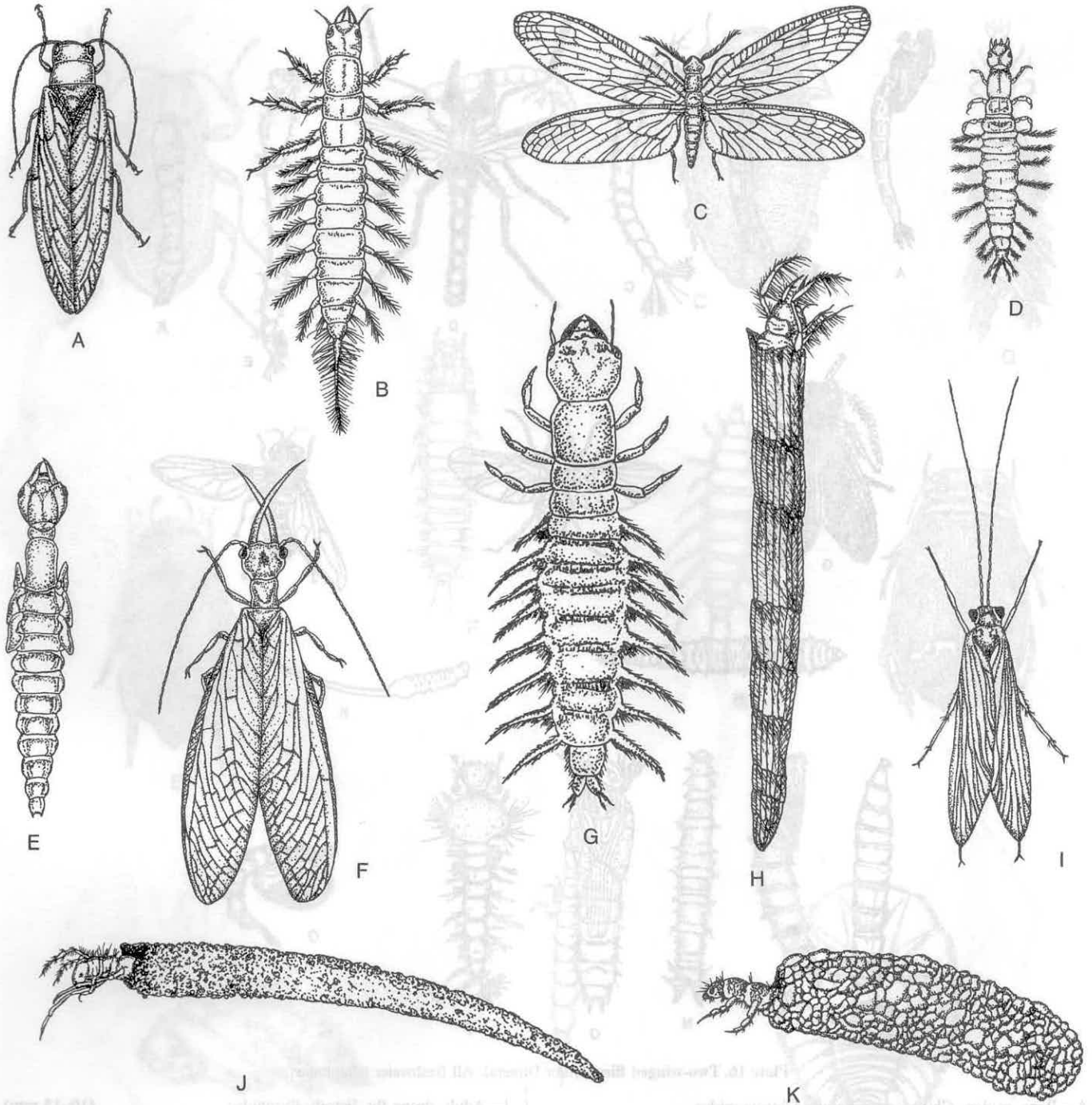


Plate 15. Hellgrammite and relatives, and caddisflies. All freshwater inhabitants.

Hellgrammite and relatives:

- A—Adult, alderfly, *Sialis*, Family Sialidae (9–15 mm)
- B—Larva, alderfly, *Sialis*, Family Sialidae (15–30 mm)
- C—Adult, fishfly, *Chauliodes*, Family Corydalidae (15–30 mm)
- D—Larva, fishfly, *Chauliodes*, Family Corydalidae (20–40 mm)
- E—Pupa, hellgrammite, *Corydalus*, Family Corydalidae
- F—Adult, dobsonfly, *Corydalus*, Family Corydalidae (25–70 mm)

- G—Larva, dobsonfly, *Corydalus*, Family Corydalidae (25–90 mm)

Caddisflies:

- H—Larva and case, *Triaenodes*, Family Leptoceridae (10–14 mm)
- I—Adult, *Hydropsyche*, Family Hydropsychidae (20–30 mm)
- J—Larva and case, *Ochrotricha*, Family Hydroptilidae (4–6 mm)
- K—Larva and case, *Leptocella*, Family Leptoceridae (14–18 mm)

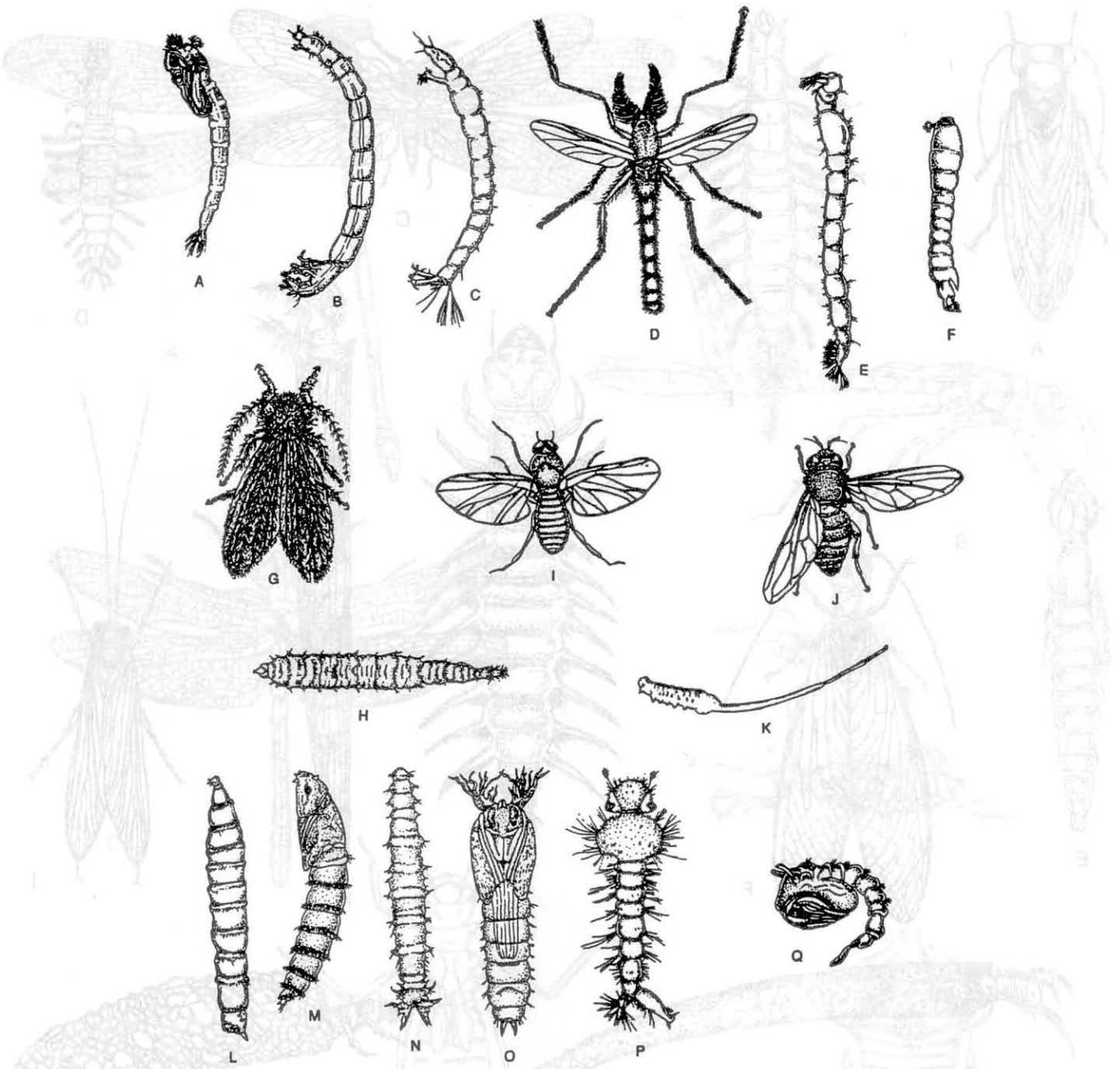


Plate 16. Two-winged flies (Order Diptera). All freshwater inhabitants.

- | | | | |
|---|-----------|--|------------|
| A—Pupa, midge, <i>Chironomus</i> , Family Chironomidae | | J—Adult, drone fly, Family Syrphidae | (10–15 mm) |
| B—Larva, midge, <i>Chironomus</i> , Family Chironomidae | (5–30 mm) | K—Rat-tailed maggot, <i>Eristalis</i> , Family Syrphidae | (15–30 mm) |
| C—Larva, midge, <i>Ablabesmyia</i> , Family Chironomidae | (5–10 mm) | L—Larva, <i>Tabanus</i> , Family Tabanidae | (30–40 mm) |
| D—Adult, midge, Chironomidae | (4–12 mm) | M—Blowfly, <i>Tabanus</i> , Family Tabanidae | |
| E—Larva, phantom midge, <i>Chaoborus</i> , Family Culicidae | (8–12 mm) | N—Larva, crane fly, <i>Tipula</i> , Family Tipulidae | (30–40 mm) |
| F—Larva, housefly, <i>Musca</i> , Family Muscidae | (3–8 mm) | O—Pupa, crane fly, <i>Antocha</i> , Family Tipulidae | |
| G—Adult, sewage fly, <i>Psychoda</i> , Family Psychodidae | (2–5 mm) | P—Larva, mosquito, <i>Aedes</i> , Family Culicidae | (10–15 mm) |
| H—Larva, sewage fly, <i>Psychoda</i> , Family Psychodidae | (4–6 mm) | Q—Pupa, mosquito, <i>Culex</i> , Family Culicidae | |
| I—Adult, blackfly, <i>Simulium</i> , Family Simuliidae | (2–6 mm) | | |

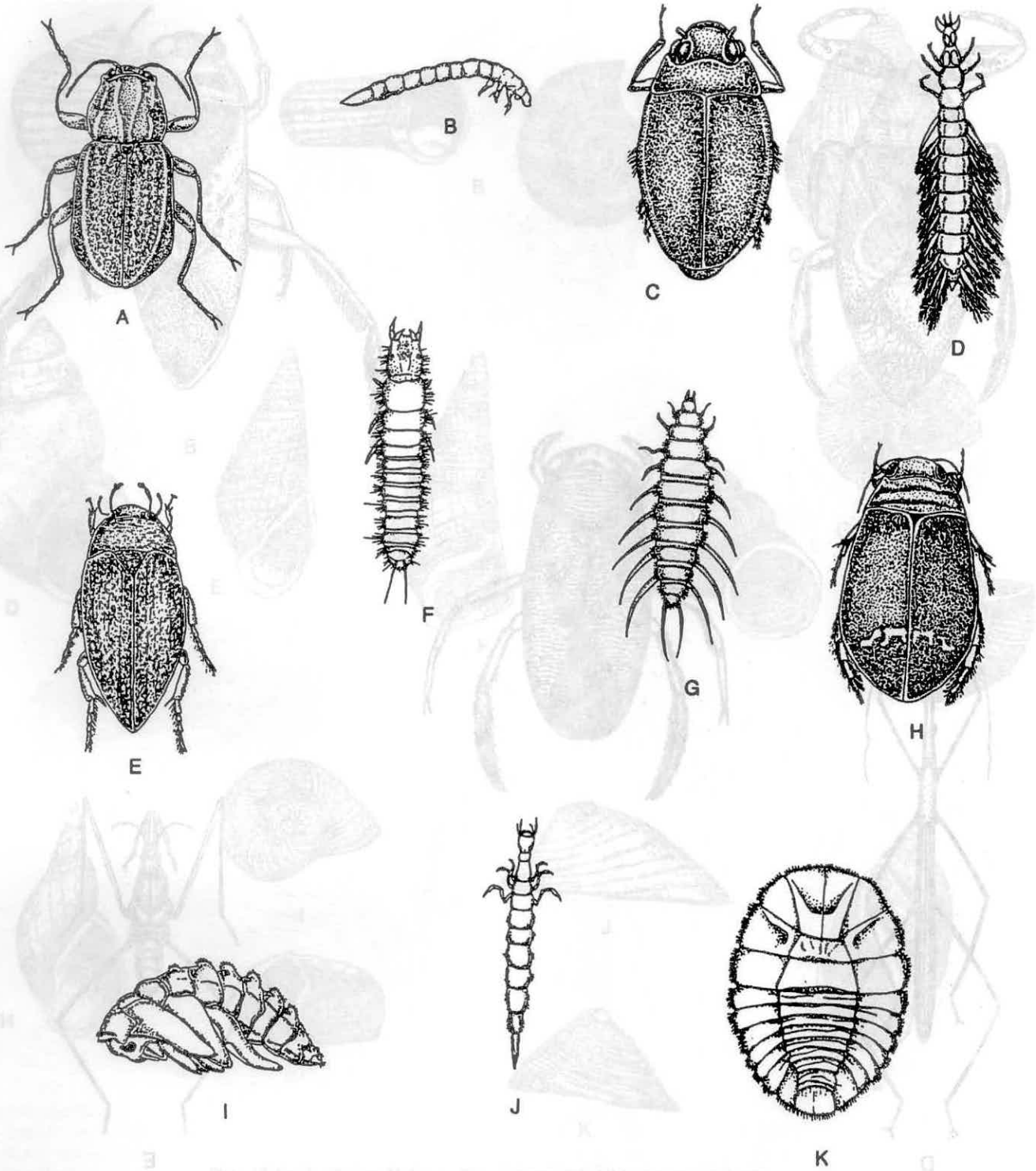
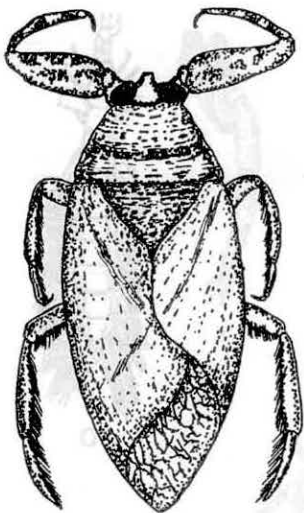
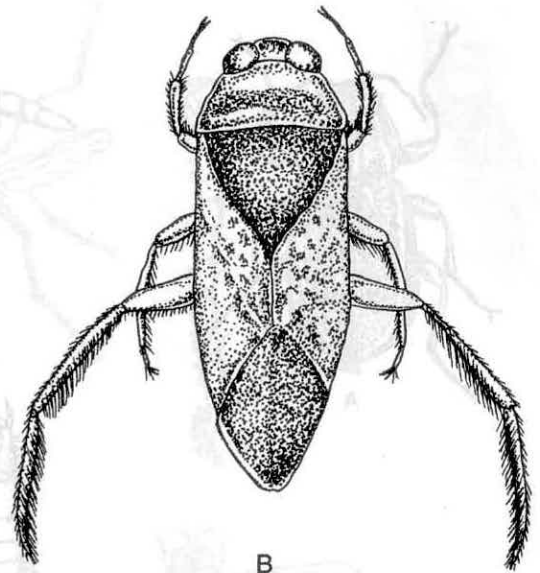


Plate 17. Beetles (Order Coleoptera). All freshwater inhabitants.

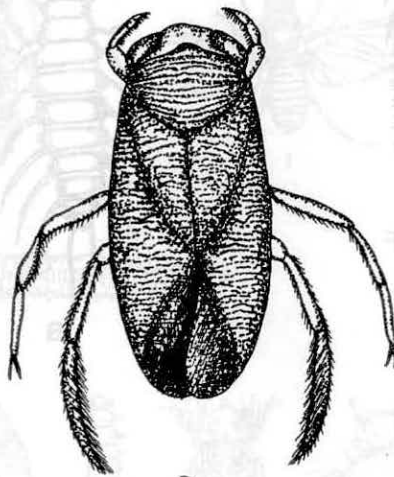
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|--|------------|--|------------|
| A—Adult, riffle beetle, <i>Stenelmis</i> , Family Elmidae | (4–10 mm) | G—Larva, <i>Enochrus</i> , Family Hydrophilidae | (10–25 mm) |
| B—Larva, <i>Narpus</i> , Family Elmidae | (7–15 mm) | H—Adult, predaceous diving beetle, <i>Dytiscus</i> , Family Dytiscidae | (2–40 mm) |
| C—Adult, whirligig beetle, <i>Dineutus</i> , Family Gyrinidae | (10–30 mm) | I—Pupa, <i>Cybister</i> , Family Dytiscidae | |
| D—Larva, <i>Dineutus</i> , Family Gyrinidae | (2–40 mm) | J—Larva, <i>Cybister</i> , Family Dytiscidae | (10–25 mm) |
| E—Adult, water scavenger beetle, <i>Hydrophilus</i> , Family Hydrophilidae | (5–20 mm) | K—Larva, water penny, <i>Psephenus</i> , Family Psephenidae | (3–10 mm) |
| F—Larva, <i>Berosus</i> , Family Hydrophilidae | (2–5 mm) | | |



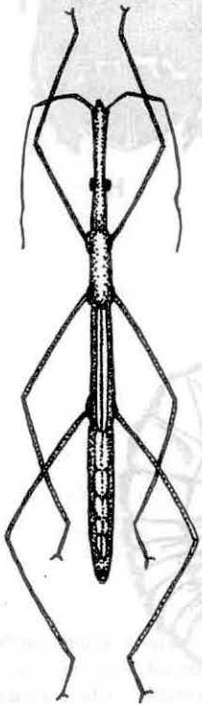
A



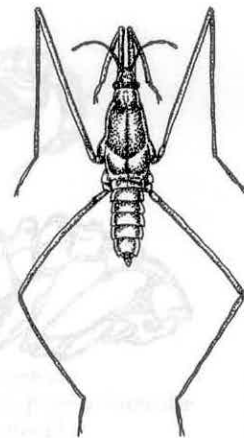
B



C



D



E

Plate 18. True bugs (Order Hemiptera, all adults). All freshwater inhabitants.

A—Electric light bug, *Lethocerus*, Family Belostomidae (20–70 mm)
 B—Backswimmer, *Notonecta*, Family Notonectidae (5–17 mm)
 C—Water boatman, *Sigara*, Family Corixidae (3–12 mm)

D—Marsh treader, *Hydrometra*, Family Hydrometridae (8–11 mm)
 E—Water strider, *Gerris*, Family Gerridae (2–15 mm)

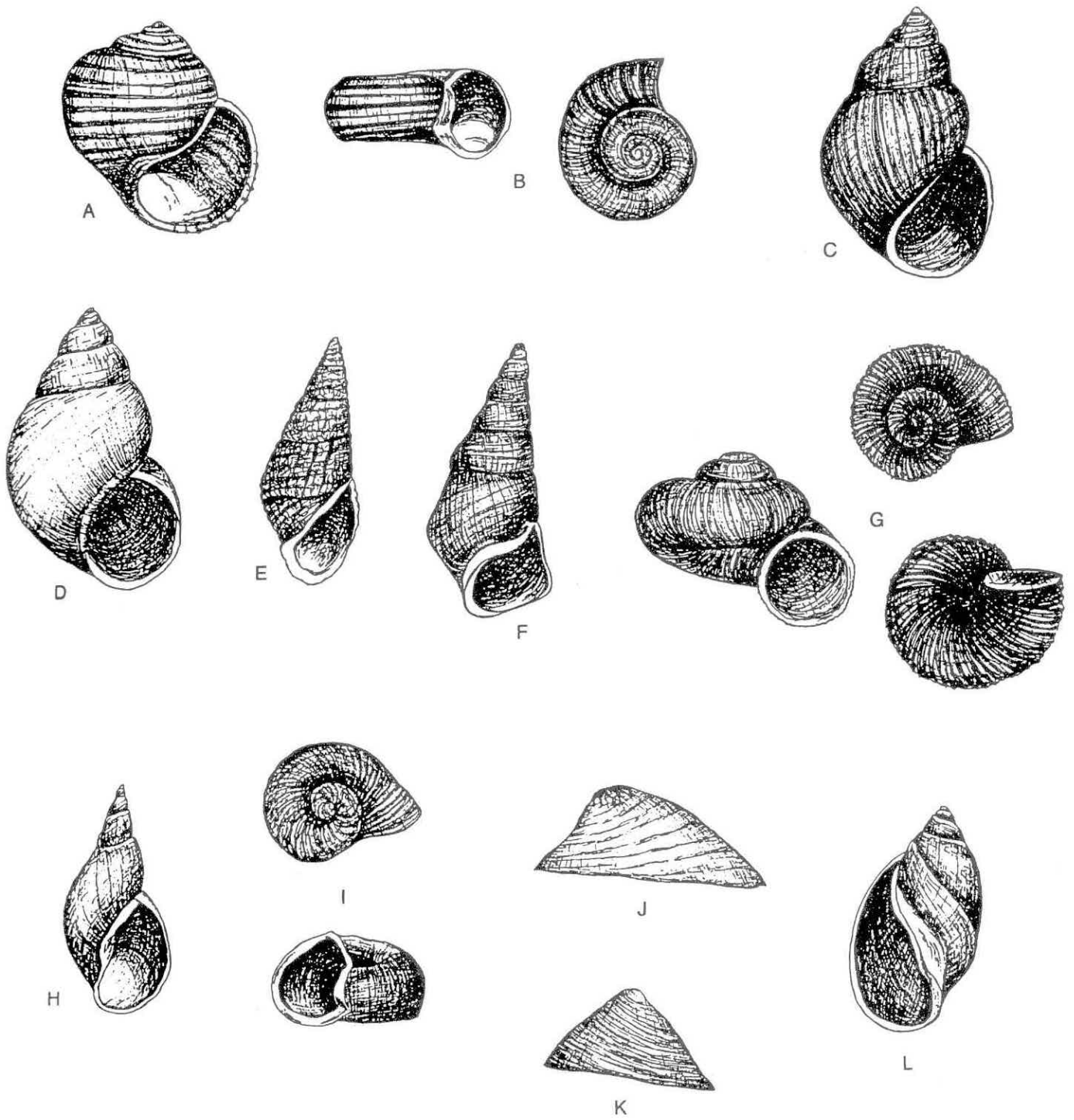


Plate 19. Snails (Phylum Mollusca, Class Gastropoda). All freshwater inhabitants.

- | | | | |
|---|---------|---|----------|
| A—Apple snail, <i>Pomacea</i> , Family Piliidae | (5 cm) | G— <i>Valvata</i> , side, top and bottom views, Family Valvatidae | (1 cm) |
| B— <i>Marisa</i> , side and top views, Family Piliidae | (15 mm) | H—Pond snail, <i>Lymnaea</i> , Family Lymnaeidae | (15 mm) |
| C— <i>Campeloma</i> , Family Viviparidae | (4 cm) | I—Orb snail, top and side views, <i>Helisoma</i> , Family Planorbidae | (1 cm) |
| D—Faucet snail, <i>Bithynia</i> , Family Amnicolidae | (2 cm) | J—Limpet, <i>Ferrissia</i> , Family Ancyliidae | (2 mm) |
| E— <i>Tarebia</i> , Family Thiacididae | (15 mm) | K—Limpet, <i>Lanx</i> , Family Lancidae | (10 mm) |
| F—River snail, <i>Pleurocera</i> , Family Pleuroceridae | (3 cm) | L—Pouch snail, <i>Physa</i> , Family Physidae | (3–5 mm) |

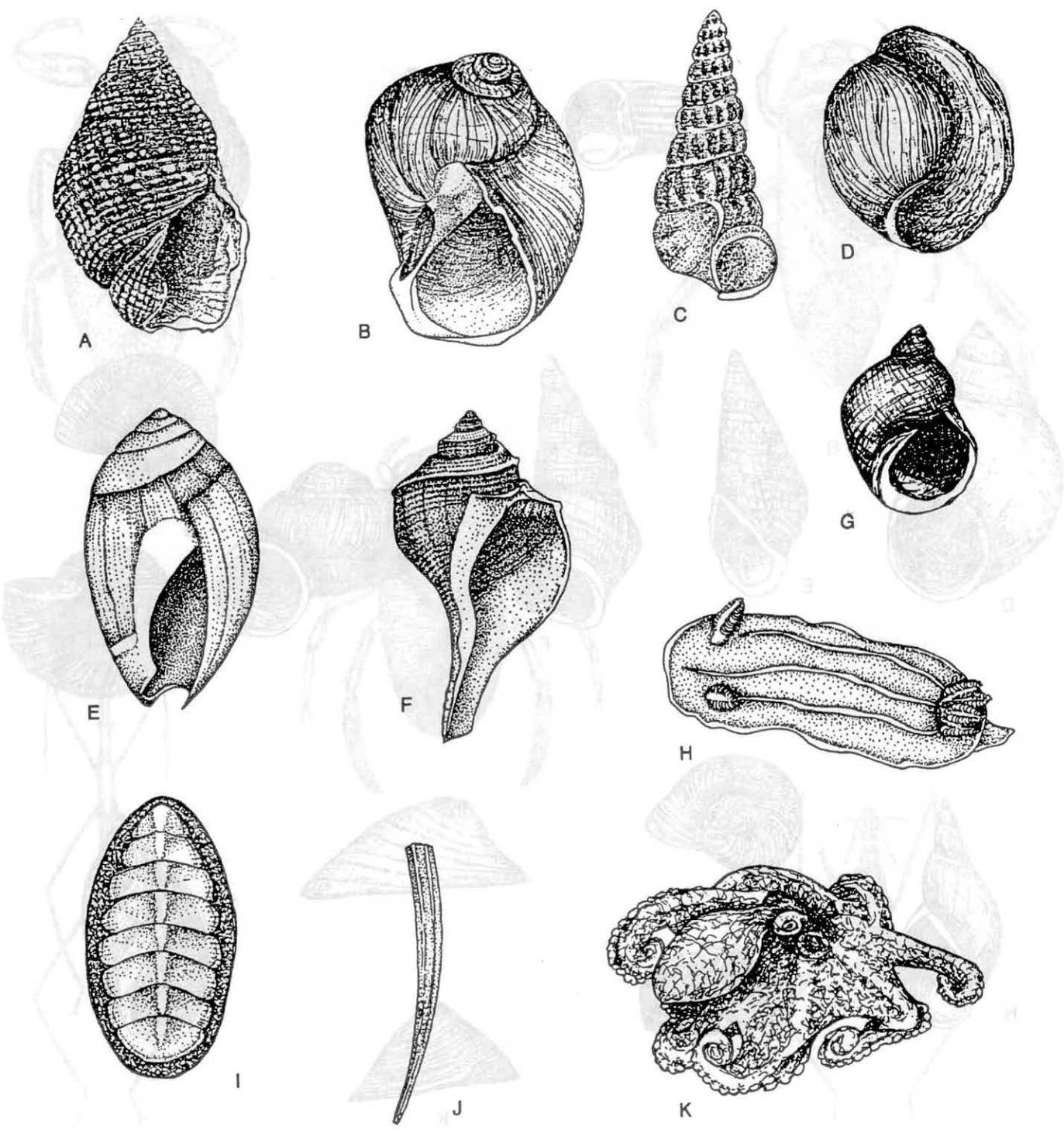


Plate 20. Some marine mollusks.

Snails (Class Gastropoda):

- A—Basket snail, *Nassarius*, Family Nassidae (2–5 cm)
- B—Moon snail, *Polinices*, Family Naticidae (5–8 cm)
- C—Horn snail, *Cerithidea*, Family Cerithiidae (1–3 cm)
- D—Bubble snail, *Bulla*, Family Bullidae (3–5 cm)
- E—Olive snail, *Olivella*, Family Olividae (2–3 cm)
- F—*Busycon*, Family Melongenidae (5–8 cm)
- G—Periwinkle, *Littorina*, Family Littorinidae (1 cm)

H—Sea slug, *Chromodoris*

Chitons (Class Polyplacophora):

- I—Conspicuous chiton, *Stenoplax* (3–6 cm)

Tusk shell (Class Scaphopoda):

- J—*Dentalium* (2–4 cm)

Octopus (Class Cephalopoda):

- K—*Octopus* (3–10 cm up to 1 m or more)

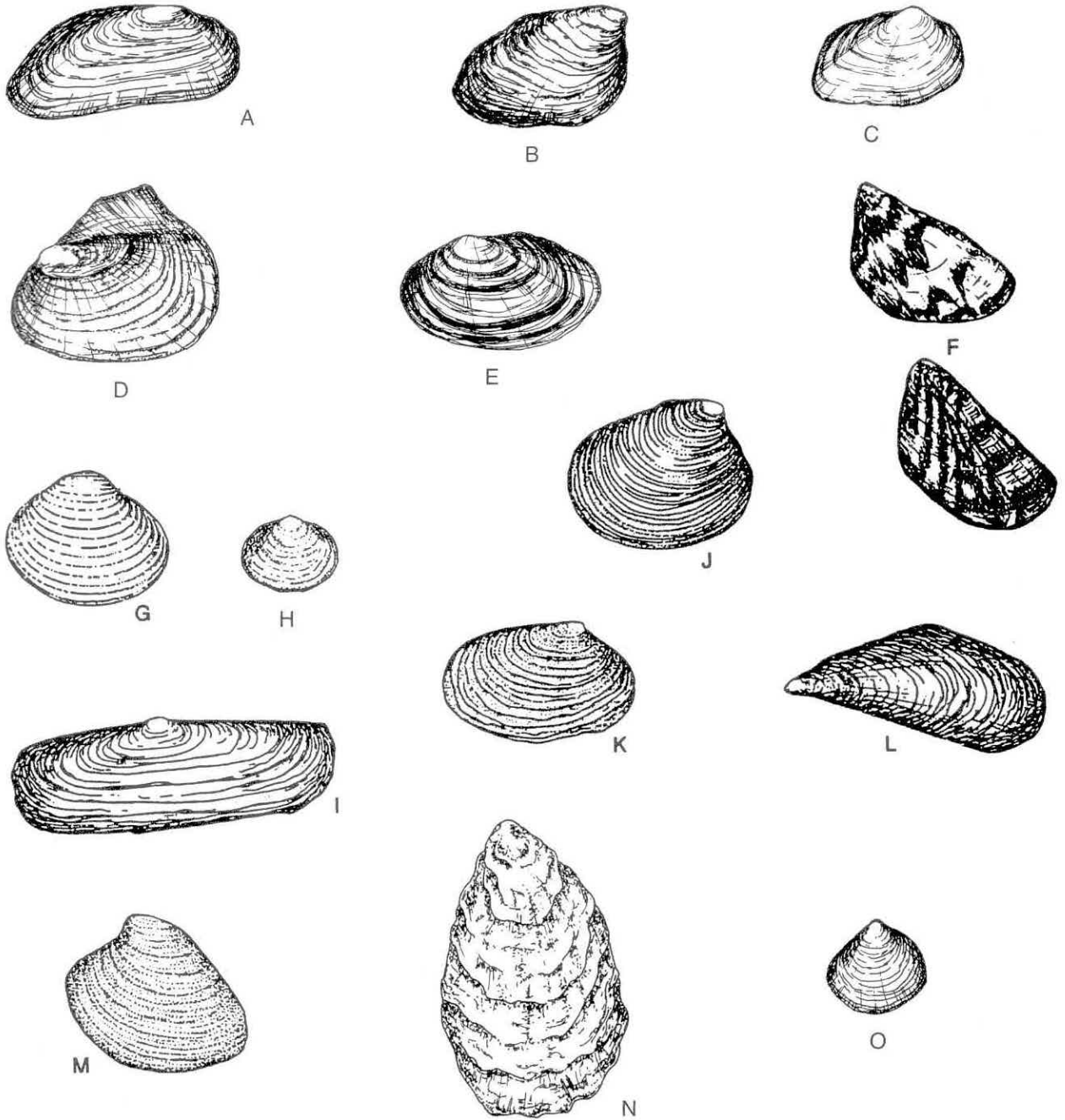


Plate 21. Bivalves (Phylum Mollusca, Class Pelecypoda).

Freshwater species:

- A—Spectacle case, *Margaritifera*, Family Margaritiferidae (10 cm)
- B—Pearly mussel, *Pleurobema*, Family Unionidae (10 cm)
- C—Pearly mussel, *Gonidea*, Family Unionidae (10 cm)
- D—Winged lampshell, *Proptera*, Family Lampsilinae (13 cm)
- E—Papershell, *Anodonta*, Family Anodontidae (14 cm)
- F—Zebra mussel (examples of color patterns), *Dreissena* (5 cm)
- G—Asiatic clam, *Corbicula*, Family Corbiculidae (4 cm)
- H—Fingernail clam, *Sphaerium*, Family Sphaeriidae (1 cm)

Marine species:

- I—Jackknife clam, *Tagelus*, Family Psammobiidae (6–10 cm)
- J—Quahog clam, *Mercenaria*, Family Veneridae (6–10 cm)
- K—Soft-shelled clam, *Mya*, Family Myidae (5–10 cm)
- L—Blue mussel, *Mytilus*, Family Mytilidae (6 cm)
- M—Rangia clam, *Rangia*, Family Matricidae (5 cm)
- N—Oyster, *Crassostrea*, Family Ostreidae (9 cm)
- O—Marsh clam, *Polymesoda*, Family Corbiculidae (4 cm)

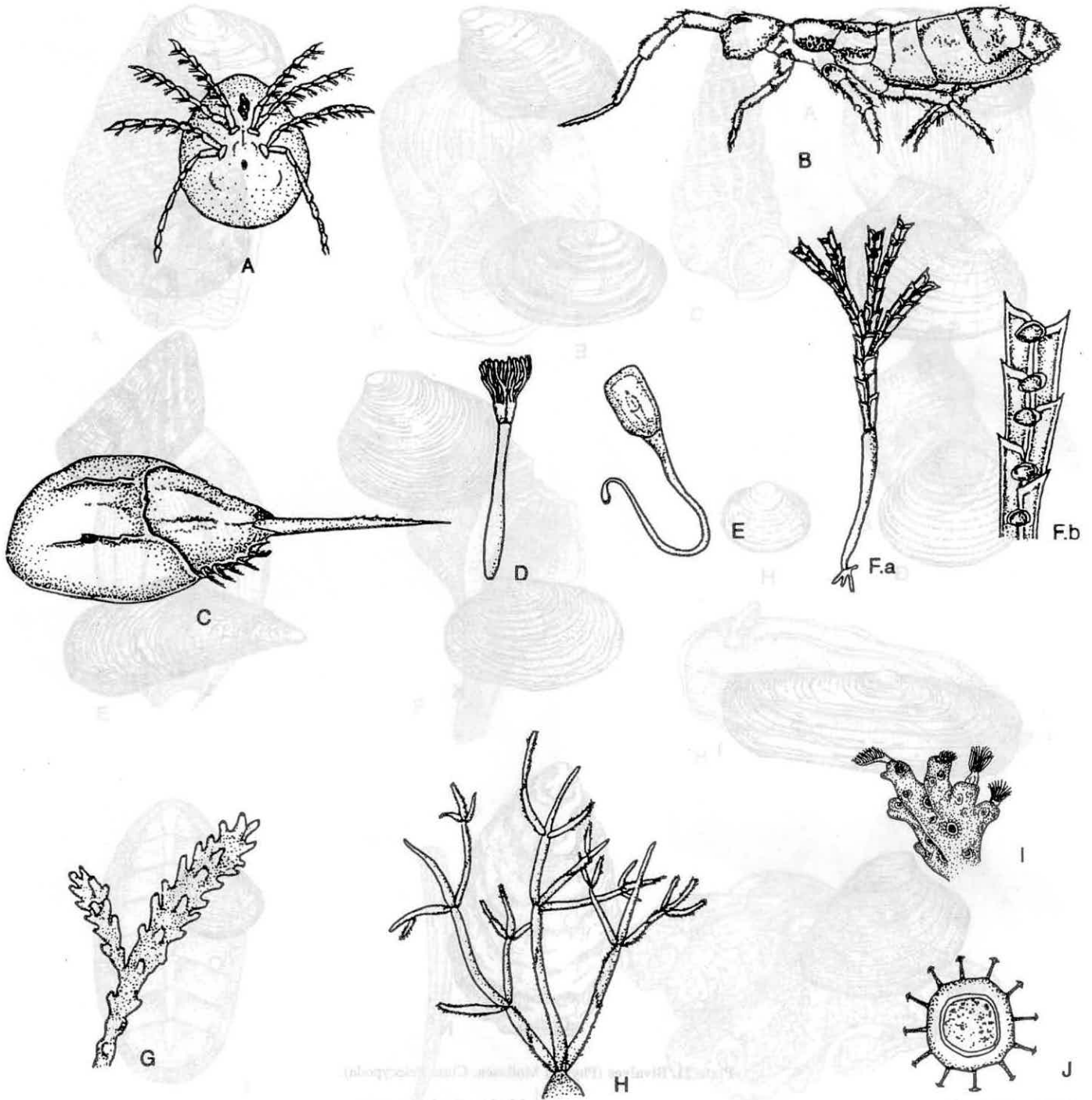


Plate 22. Miscellaneous invertebrates.

Arthropods (Phylum Arthropoda):

- A—Water mite, *Limnochares*, Class Arachnoidea, freshwater (3 mm)
 B—Springtail, *Orchesella*, Class Insecta, Order
 Collembola, freshwater (2 mm)
 C—Horseshoe crab, *Limulus*, Class Arachnoidea, marine (10–30 cm)
 D—*Phoronis*, Phylum Phoronidea, marine (2–4 cm)
 E—*Glottidia*, Phylum Brachiopoda, marine (3–5 cm)

Phylum Ectoprocta (Bryozoa):

- F—*Bugula*, a. colony, b. enlarged view, marine (1–3 cm)
 G—*Crisulipora*, calcareous colony, marine (1–3 cm)
 H—*Zoobotryon*, gelatinous colony, marine (20–100 cm)
 I—Jellyball, *Pectinatella*, young colony, freshwater (11 cm)
 J—*Pectinatella*, statoblast, freshwater (1 mm)

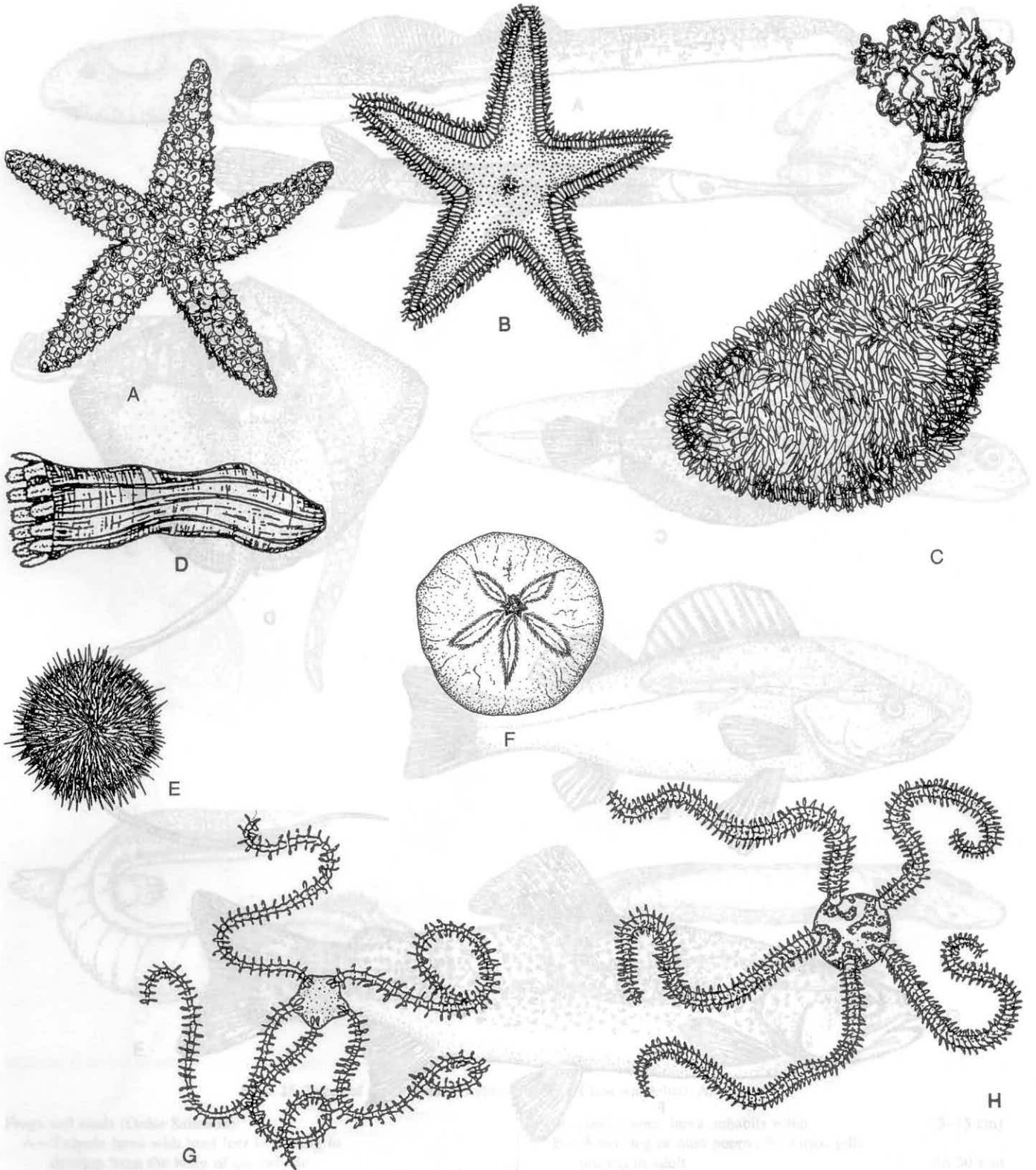


Plate 23. Echinoderm types (Phylum Echinodermata). All marine.

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|---|------------|--|--------------|
| A—Starfish, <i>Asterias</i> , Class Asteroidea | (15 cm) | E—Sea urchin, <i>Strongylocentrotus</i> , Class Echinoidea | (6 cm) |
| B—Sand starfish, <i>Astropecten</i> , Class Asteroidea | (10–20 cm) | F—Sand dollar, <i>Echinarachnius</i> , Class Echinoidea | (7 cm) |
| C—Sea cucumber, <i>Thyrene</i> , Class Holothuroidea | (10 cm) | G—Brittle star, <i>Amphiodia</i> , Class Ophiuroidea | (disk 15 mm) |
| D—Sea cucumber, <i>Leptosynapta</i> , Class Holothuroidea | (5–8 cm) | H—Brittle star, <i>Ophiopholis</i> , Class Ophiuroidea | (disk 15 mm) |

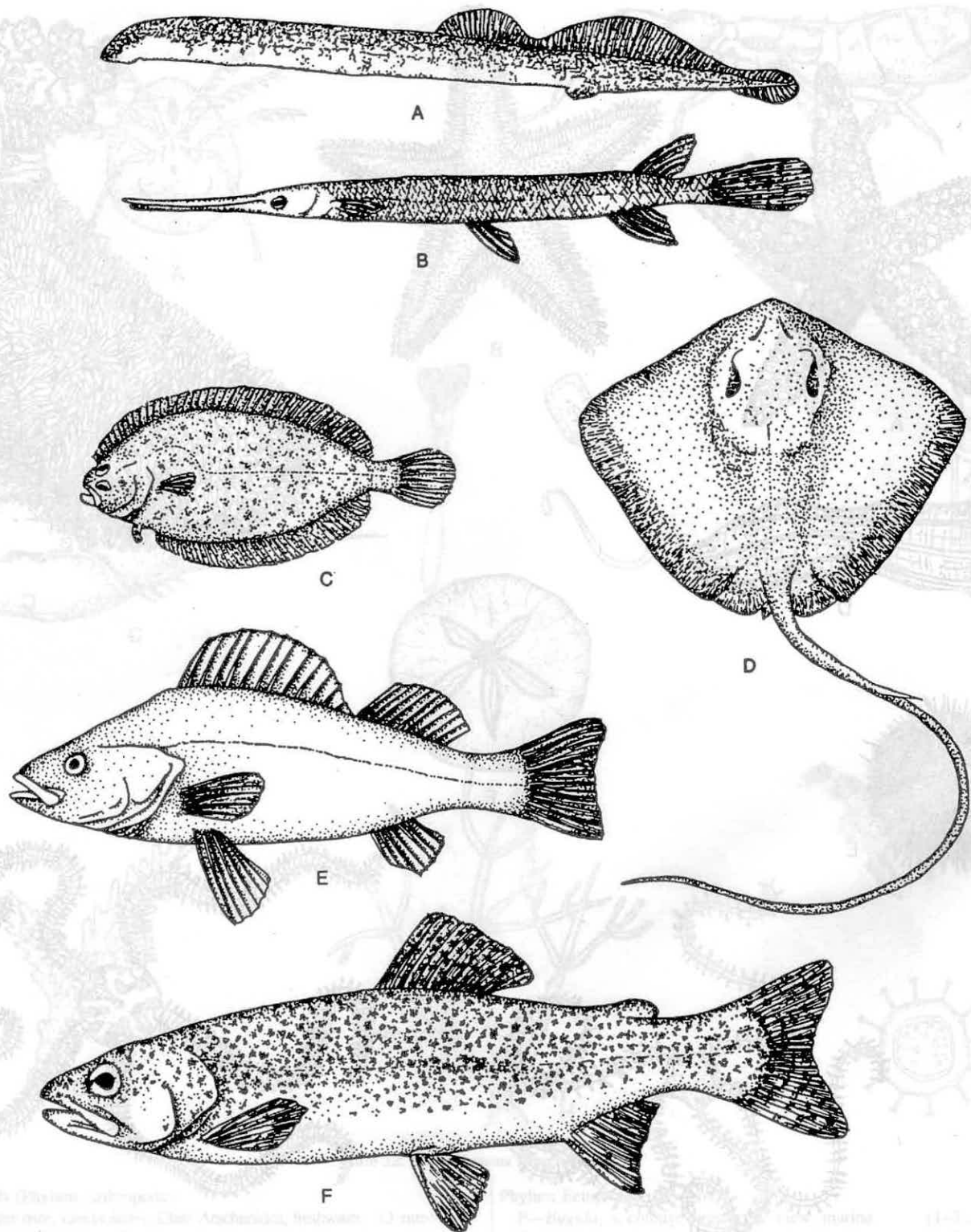


Plate 24. Some types of fishes (Phylum Chordata).

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|---|------------|--|---------|
| A—Jawless fish, lamprey, <i>Petromyzon</i> , Class Agnatha, freshwater | (30–45 cm) | D—Cartilage fish, stingray, <i>Dasyatis</i> , Class Chondrichthys, marine | (2 m) |
| B—Ganoid fish, long-nosed gar, <i>Lepisosteus</i> , Class Osteichthys, freshwater | (2.4 m) | E—Spiny-rayed fish, perch, <i>Perca</i> , Class Osteichthys, freshwater | (30 cm) |
| C—Flatfish, flounder, <i>Paralichthys</i> , Class Osteichthys, marine | (30–60 cm) | F—Soft-rayed fish, rainbow trout, <i>Salmo</i> , Class Osteichthys, freshwater | (30 cm) |

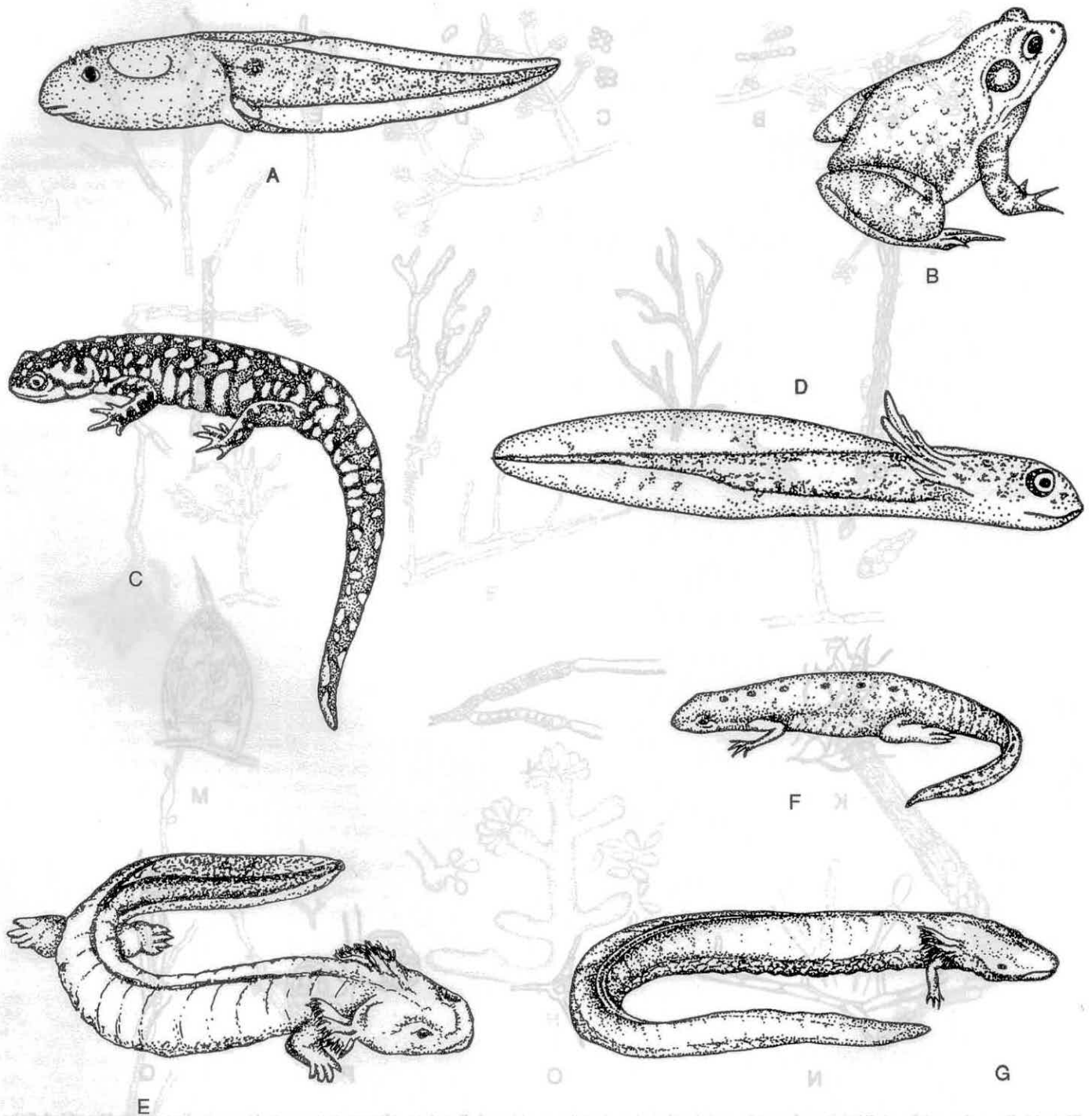


Plate 25. Types of amphibians (Phylum Chordata, Class Amphibia). All freshwater.

Frogs and toads (Order Salientia):

- A—Tadpole larva with hind legs beginning to develop from the body of the tadpole
- B—Frog, *Rana* (30 cm)

Salamanders (Order Caudata):

- C—*Ambystoma*, adult, typically terrestrial (20 cm)
- D—*Ambystoma*, larva, inhabits water (5–15 cm)
- E—Water dog or mud puppy, *Necturus*, gills present in adult (to 30 cm)
- F—Salamander with flat tail, *Notophthalmus* (9 cm)
- G—Salamander, *Siren*, with gills and front pair of legs present (1 m)

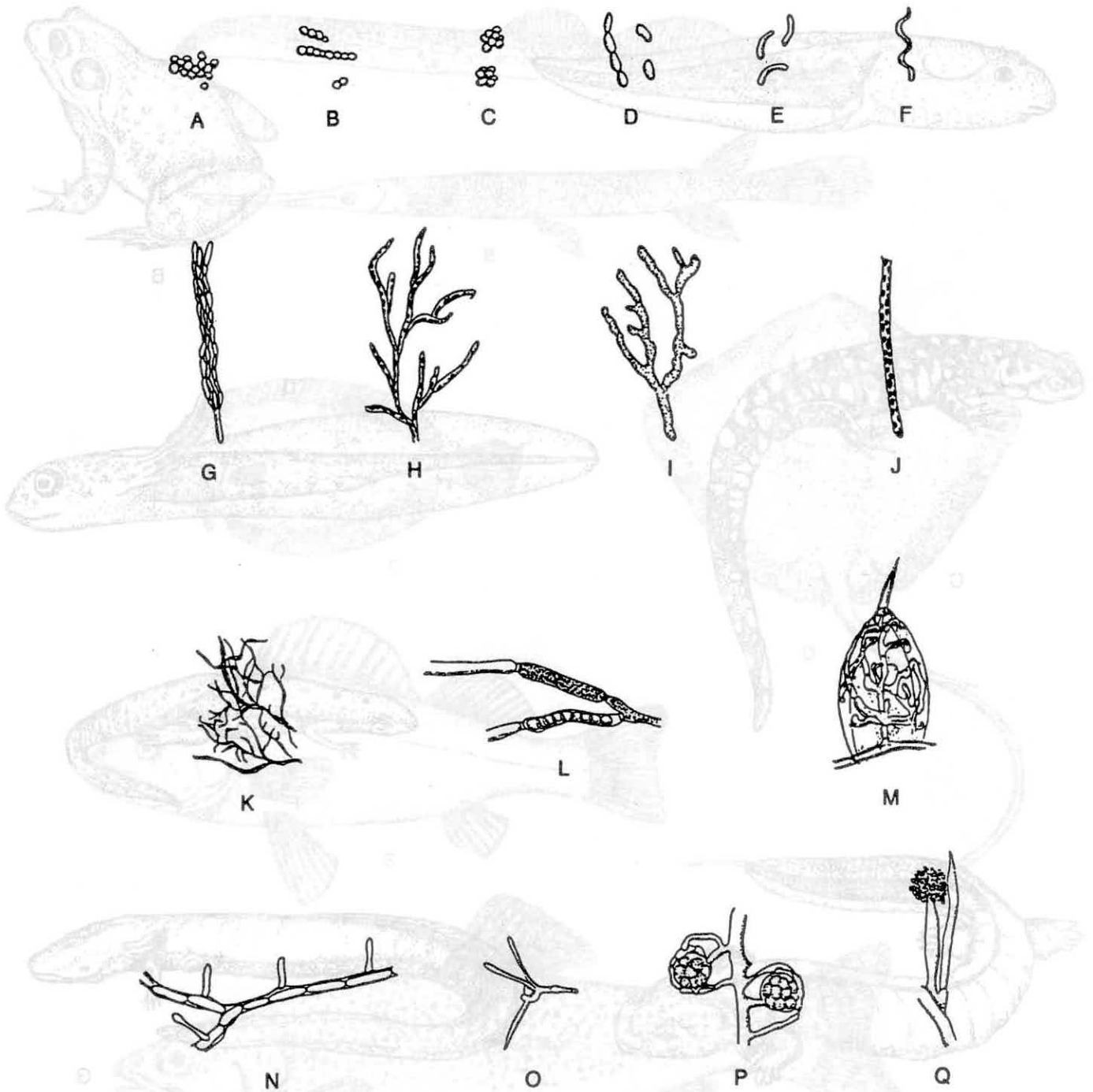


Plate 26. Bacteria and fungi. Diameter of most bacterial cells is less than 2 μm , although *Beggiatoa* (J) may range up to 16 μm in diameter and be of indefinite length. All freshwater inhabitants.

Bacterial cellular forms and arrangements:

- A—Micrococcus
- B—Streptococcus
- C—Sarcina
- D—Bacillus
- E—Vibrio
- F—Spirillum

Sewage organisms:

- G—*Sphaerotilus* cells
- H—*Sphaerotilus* growth form

I—*Zoogloea* growth form

J—*Beggiatoa* (sulfur bacterium)

K—An actinomycete growth form from compost

Fungi:

L—*Leptomitus*, showing zoospores and cellulose plugs

M—*Zoophagus* with rotifer on mycelial peg

(diam 3 μm)

N—*Zoophagus*, showing mycelial pegs

O—*Tetracladium*

(diam 2.5–3.5 μm)

P—*Achlya*, with oospores

Q—*Achlya*, with encysted oospores

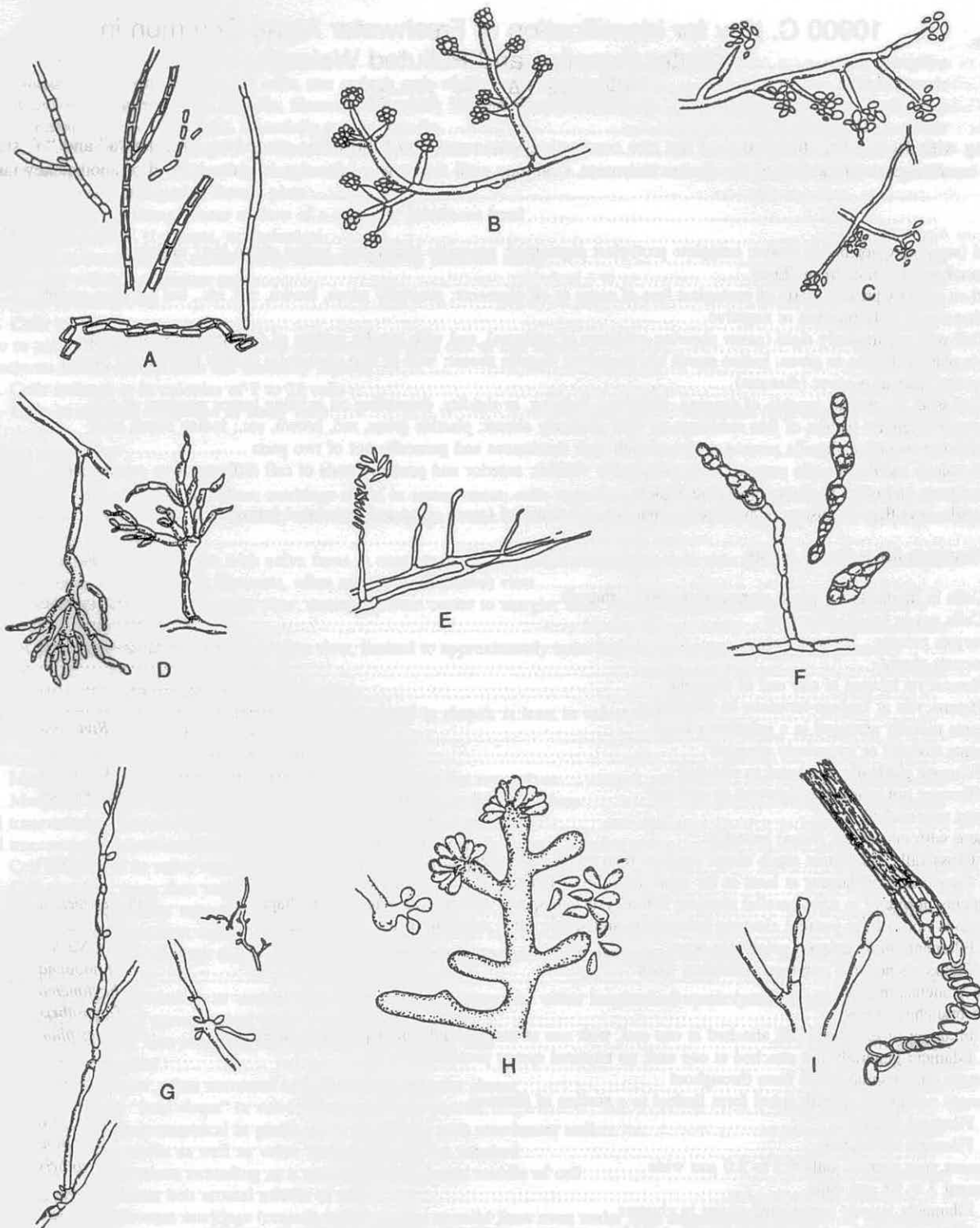


Plate 27. Fungi. All freshwater inhabitants.

- A—*Geotrichum candidum*
- B—*Trichoderma viride*
- C—*Exophiala jeanselmei*
- D—*Cladosporium cladosporioides*
- E—*Fusarium*

- colonies white
- colonies green
- colonies black
- colonies black
- colonies orange

- F—*Alternaria alternata*
- G—*Trichosporon cutaneum*
- H—*Pseudodallescheria boydii*
- I—*Klusterskaya splendens*

- colonies gray
- colonies white
- colonies white

Color plates of algae (Plates 28 through 35) follow page 10-167.

10900 C. Key for Identification of Freshwater Algae Common in Water Supplies and Polluted Waters* (Plates 1A, 1B, 28–35)

Beginning with 1a and 1b, choose one of the two contrasting statements and follow this procedure with the “a” and “b” statements of the number given at the end of the chosen statement. Continue until the name of the alga is given instead of another key number.

	<i>Refer to couplet No.</i>
1a. Plastid (separate color body) absent; complete protoplast pigmented; generally blue-green; iodine starch test† negative (cyanobacteria, blue-green algae)	4
1b. Plastid or plastids present; parts of protoplast free of some or all pigments; generally green, brown, red, etc., but not blue-green; iodine starch test† positive or negative	2
2a. Cell wall permanently rigid (never showing evidence of collapse), and with regular pattern of fine markings (striations, etc.); plastids brown to green; iodine starch test†negative; flagella absent; wall of two essentially similar halves, one placed over the other as a cover (diatoms)	29
2b. Cell wall, if present, capable of sagging, wrinkling, bulging, or rigidity, depending on existing turgor pressure of cell protoplast; regular pattern of fine markings on wall generally absent; plastids green, red, brown, etc.; iodine starch test† positive or negative; flagella present or absent; cell wall continuous and generally not of two parts	3
3a. Cell or colony motile; flagella present (often not readily visible); anterior and posterior ends of cell different from one another in contents and often in shape (flagellate algae)	51
3b. Nonmotile; true flagella absent; ends of cells often not differentiated (green algae and associated forms)	77
 1. Cyanobacteria (Blue-Green Algae)	
4a. Cells in filaments (or much elongated to form a thread)	5
4b. Cells not in (or as) filaments	23
5a. Heterocysts present	6
5b. Heterocysts absent	14
6a. Heterocyst located at one end of filament	7
6b. Heterocysts at various locations in filament	9
7a. Filaments radially arranged in a gelatinous bead	<i>Rivularia</i>
7b. Filaments isolated or irregularly grouped	8
8a. Filament gradually narrowed to one end	<i>Calothrix</i>
8b. Filament not gradually narrowed to one end	<i>Cylindrospermum</i>
9a. Filament unbranched	10
9b. Filament with occasional (false) branches	13
10a. Crosswalls in filament much closer together than width of filament	<i>Nodularia</i>
10b. Crosswalls in filament at least as far apart as width of filament	11
11a. Filaments normally in tight parallel clusters; heterocysts and spores cylindrical to long oval in shape	<i>Aphanizomenon</i>
11b. Filaments not in tight parallel clusters; heterocysts and spores often round to oval	12
12a. Filaments in a common gelatinous mass	<i>Nostoc</i>
12b. Filaments not in a common gelatinous mass	<i>Anabaena</i>
13a. False branches in pairs	<i>Scytonema</i>
13b. False branches, single	<i>Tolypothrix</i>
14a. Filament or elongated cell attached at one end, with one or more round cells (spores) at the other	<i>Chamaesiphon</i>
14b. Filament generally not attached at one end; no terminal spores present	15
15a. Filament with regular spiral form throughout	16
15b. Filament not spiral, or with spiral form limited to a portion of filament	17
16a. Filament septate	<i>Arthrospira</i>
16b. Filament nonseptate	<i>Spirulina</i>
17a. Filament very narrow, only 0.5 to 2.0 μm wide	<i>Schizothrix</i>
17b. Filament 3 to 95 μm wide	18
18a. Filaments loosely aggregated or not in clusters	19
18b. Filaments tightly aggregated and surrounded by a common gelatinous secretion that may be invisible	22
19a. Filament surrounded by wall-like sheath that frequently extends beyond the ends of the filament of cells; filament generally without movement	20
19b. Filament not surrounded by a wall-like sheath; filament may show movement	21
20a. Cells separated from one another by a space	<i>Johannesbaptistia</i>

* Source: PALMER, C.M. 1977. Algae and Water Pollution. Publ. No. 600/9-77-036, U.S. Environmental Protection Agency, Cincinnati, Ohio.

† Add 1 drop of Lugol's (iodine) solution, diluted 1:1 with distilled water. In about 1 min, if positive, starch is stained blue and later black. Other structures (such as nucleus, plastids, cell wall) also may stain, but turn brown to yellow.

Refer to
couplet No.

20b. Cells in contact with adjacent cells.....	<i>Lyngbya</i>	
21a. All filaments short, with less than 20 cells; one or both ends of filament sharply pointed.....	<i>Raphidiopsis</i>	
21b. Filaments long, with more than 20 cells; filaments commonly without sharp-pointed ends.....	<i>Oscillatoria</i>	
22a. Filaments arranged in a tight, essentially parallel bundle.....	<i>Microcoleus</i>	
22b. Filaments arranged in irregular fashion, often forming a mat.....	<i>Phormidium</i>	
23a. Cells in a regular pattern of parallel rows, forming a plate.....	<i>Merismopedia</i>	
23b. Cells not regularly arranged to form a plate.....		24
24a. Cells regularly arranged near surface of a spherical gelatinous bead.....		25
24b. Gelatinous bead, if present, not spherical.....		26
25a. Cells ovate to heart-shaped, connected to center of bead by colorless stalks.....	<i>Gomphosphaeria</i>	
25b. Cells round, without gelatinous stalks.....	<i>Coelosphaerium</i> type	
26a. Cells cylindric-oval.....	<i>Aphanothece</i>	
26b. Cells spherical.....		27
27a. Two or more distinct layers of gelatinous sheath around each cell or cell cluster.....	<i>Gloeocapsa</i>	
27b. Gelatinous sheath around cells not distinctly layered.....		28
28a. Cells isolated or in colonies of 2 to 32 cells.....	<i>Chroococcus</i>	
28b. Cells in colonies composed of many cells.....	<i>Anacystis (Microcystis, Polycystis)</i>	
2. Diatoms		
29a. Front (valve) view circular in outline; markings radial in arrangement; cells may form a filament (centric diatoms).....		30
29b. Front (valve) view elongate, not circular; transverse markings in one or two longitudinal rows; cells, if grouped, not forming a filament (pennate diatoms).....		32
30a. Cells in persistent filaments with valve faces in contact; therefore, cells commonly seen in side (girdle) view.....	<i>Melosira</i>	
30b. Cells isolated or in fragile filaments, often seen in front (valve) view.....		31
31a. Radial markings (striations), in valve view, extending from center to margin; short spines often present around margin (valve view).....	<i>Stephanodiscus</i>	
31b. Area of prominent radial markings, in valve view, limited to approximately outer half of circle, marginal spines generally absent.....	<i>Cyclotella</i>	
32a. Cell longitudinally symmetrical in valve view.....		33
32b. Cell longitudinally unsymmetrical (two sides unequal in shape), at least in valve view.....		49
33a. Raphe at or near the edge of the valve.....		34
33b. Raphe or pseudoraphe median or submedian.....		35
34a. Marginal, keeled raphe areas lie opposite one another on the two valves.....	<i>Hantzschia</i>	
34b. Marginal, keeled raphe areas lie diagonal to one another on the two valves.....	<i>Nitzschia</i>	
35a. Cell transversely symmetrical in valve view.....		36
35b. Cell transversely unsymmetrical (two ends unequal in shape or size), at least in valve view.....		44
36a. Cell round-oval in valve view, not more than twice as long as it is wide.....	<i>Cocconeis</i>	
36b. Cell elongate, more than twice as long as it is wide.....		37
37a. Cell flat (girdle face wide, valve face narrow).....	<i>Tabellaria</i>	
37b. Girdle and valve faces about equal in width.....		38
38a. Cell with several markings (septa) extending without interruption across the valve face; no marginal line of pores present.....	<i>Diatoma</i>	
38b. Cross-markings (striations or costae) on valve surface, interrupted by either longitudinal space (pseudoraphe), or line (raphe), or line of pores (carinal dots).....		39
39a. Cells attached side by side to form a ribbon of several to many cells.....	<i>Fragilaria</i>	
39b. Cells isolated or in pairs.....		40
40a. Cell narrow, linear, often narrowed to both ends; true raphe absent.....	<i>Synedra</i>	
40b. Cell commonly "boat-shape" in valve view; true raphe present.....		41
41a. Cell longitudinally unsymmetrical in girdle view; sometimes with attachment stalk.....	<i>Achnanthes</i>	
41b. Cell symmetrical in girdle as well as valve view; generally not attached.....		42
42a. Area without striations extending as a transverse belt around middle of cell.....	<i>Stauroneis</i>	
42b. No continuous clear belt around middle of cell.....		43
43a. Cell with coarse transverse markings (costae), which appear as solid lines even under high magnification.....	<i>Pinnularia</i>	
43b. Cell with fine transverse markings (striae), which appear as lines of dots under high magnification.....	<i>Navicula</i>	
44a. Cells attached together at one end only to form radiating colony.....	<i>Asterionella</i>	
44b. Cell not forming a loose radiating colony.....		45
45a. Cells in fan-shaped colonies.....	<i>Meridion</i>	
45b. Cells isolated or in pairs.....		46
46a. Prominent wall markings in addition to striations present just below lateral margins on valve surface of cell.....	<i>Surirella</i>	
46b. Wall markings along sides of valve limited to striations.....		47
47a. Cell elongate, sides almost parallel except for terminal knobs.....	<i>Asterionella</i>	

	<i>Refer to couplet No.</i>
47b. Sides of cell converging toward one end.....	48
48a. Cells bent in girdle view.....	<i>Rhoicosphenia</i>
48b. Cells straight in girdle view.....	<i>Gomphonema</i>
49a. Valves with transverse septa or costae.....	<i>Epihemia</i>
49b. Valves with no transverse septa or costae.....	50
50a. Raphe located almost through center of valve.....	<i>Cymbella</i>
50b. Raphe excentric, near concave edge of valve.....	<i>Amphora</i>
 3. Flagellate Algae	
51a. Cell in a loose, rigid conical sac (lorica); isolated or in a branching colony.....	<i>Dinobryon</i>
51b. Case or sac, if present, not conical; colony, if present, not branching.....	52
52a. Cells isolated or in pairs.....	53
52b. Cells in a colony of four or more cells.....	71
53a. Prominent transverse groove encircles cell.....	54
53b. Cell without transverse groove.....	56
54a. Cell with prominent rigid projections, one forward and two or three on posterior end.....	<i>Ceratium</i>
54b. Cell without several rigid polar projections.....	55
55a. Portions above and below transverse groove about equal.....	<i>Peridinium</i>
55b. Front portion distinctly larger than posterior portion.....	<i>Massartia</i>
56a. Cell with long bristles extending from surface plates.....	<i>Mallomonas</i>
56b. Cell without bristles and surface plates.....	57
57a. Cell protoplast enclosed in loose, rigid covering (lorica).....	58
57b. Cell with tight membrane or wall but no loose, rigid covering.....	60
58a. Lorica flattened; cell with two flagella.....	<i>Phacotus</i>
58b. Lorica not flattened; cell with one flagellum.....	59
59a. Lorica often opaque, generally dark brown to red; plastid green.....	<i>Trachelomonas</i>
59b. Lorica often transparent, colorless to light brown; plastid light brown.....	<i>Chrysococcus</i>
60a. Plastids brown to red to olive or blue-green.....	61
60b. Plastids grass green.....	64
61a. Plastids blue-green to blue.....	<i>Chroomonas</i>
61b. Plastids brown to red to olive green.....	62
62a. Plastid brown; one or two flagella.....	63
62b. Plastids red, red-brown, or olive green; two flagella.....	<i>Rhodomonas</i>
63a. Anterior end of cell oblique; two flagella.....	<i>Cryptomonas</i>
63b. Anterior end of cell rounded or pointed; one flagellum.....	<i>Chromulina</i>
64a. Cell with colorless rectangular wing.....	<i>Pteromonas</i>
64b. No wing extending from cell.....	65
65a. Cells flattened; margin rigid.....	<i>Phacus</i>
65b. Cell not flattened; margin rigid or flexible.....	66
66a. Pyrenoid present in the single plastid; no paramylon; margin not flexible; two or more flagella per cell.....	67
66b. Pyrenoid absent; paramylon present; several plastids per cell; margin flexible or rigid; one flagellum per cell.....	70
67a. Cells fusiform (tapering at each end).....	<i>Chlorogonium</i>
67b. Cells not fusiform, generally almost spherical.....	68
68a. Plastids numerous.....	<i>Vacuolaria</i>
68b. Plastids few, commonly one.....	69
69a. Two flagella per cell.....	<i>Chlamydomonas</i>
69b. Four flagella per cell.....	<i>Carteria</i>
70a. Cell flexible in form; paramylon a capsule or disk; cell elongate.....	<i>Euglena</i>
70b. Cell rigid in form; paramylon ring-shaped; cell almost spherical.....	<i>Lepocinclis</i>
71a. Plastids brown.....	72
71b. Plastids green.....	73
72a. Cells in contact with one another.....	<i>Synura</i>
72b. Cells separated from one another by space.....	<i>Uroglenopsis</i>
73a. Colony flat, one cell thick.....	<i>Gonium</i>
73b. Colony rounded, more than one cell thick.....	74
74a. Cells in contact with one another.....	75
74b. Cells separated from one another by space.....	76
75a. Cells radially arranged.....	<i>Pandorina</i>
75b. Cells all facing one direction.....	<i>Pyrobotrys (Chlamydotrys)</i>
76a. Cells more than 400 per colony.....	<i>Volvox</i>
76b. Cells less than 75 per colony.....	<i>Eudorina</i>

Refer to
couplet No.

4. Green Algae and Associated Forms

77a. Cells jointed together to form a net.....	<i>Hydrodictyon</i>	
77b. Cells not forming a net.....		78
78a. Cells attached side by side to form a plate or ribbon one cell wide and thick; number of cells commonly two, four, or eight.....	<i>Scenedesmus</i>	
78b. Cells not attached side by side.....		79
79a. Cells isolated or in nonfilamentous or nontubular thalli.....		80
79b. Cells in filaments or other tubular or threadlike thalli.....		111
80a. Cells isolated and narrowest at the center because of incomplete fissure (desmids).....		81
80b. Cells isolated or in clusters but without central fissure.....		84
81a. Each half of cell with three spinelike or pointed knobular extensions.....	<i>Staurastrum</i>	
81b. Cell margin with no such extensions.....		82
82a. Semicells with a median incision or depression.....		83
82b. Semicells with no median incision or depression.....	<i>Cosmarium</i>	
83a. Margin with rounded lobes.....	<i>Euastrum</i>	
83b. Margin with sharp-pointed teeth.....	<i>Micrasterias</i>	
84a. Cells elongate.....		85
84b. Cells round to oval or angular.....		92
85a. Cell radiating from a central point.....	<i>Actinastrum</i>	
85b. Cells isolated or in irregular clusters.....		86
86a. Cells with terminal spines.....	<i>Schroederia</i>	
86b. Cells without terminal spines.....		87
87a. Cells with colorless attachment area at one end.....	<i>Characium</i>	
87b. No attachment area at one end of cell.....		88
88a. Plastids two per cell; unpigmented area across center of cell.....	<i>Closterium</i>	
88b. Cell with plastid that continues across the center.....		89
89a. Cell 5 to 10 times as long as it is broad.....		90
89b. Cell 2 to 4 times as long as it is broad.....		91
90a. Pyrenoid absent, or one per cell.....	<i>Ankistrodesmus</i>	
90b. Pyrenoids several per cell.....	<i>Closteriopsis</i>	
91a. Cells semicircular; cell ends pointed but with no terminal spines.....	<i>Selenastrum</i>	
91b. Cells arcuate but less than semicircular; cell ends pointed and each with a short spine.....	<i>Closteridium</i>	
92a. Cells regularly arranged in a tight, flat colony.....	<i>Pediastrum</i>	
92b. Cells not in a tight, flat regular colony.....		93
93a. Cells angular.....		94
93b. Cells round to oval.....		95
94a. Two or more spines at each angle.....	<i>Polyedriopsis</i>	
94b. Spines none or less than two at each angle.....	<i>Tetraedron</i>	
95a. Cells with long, sharp spines.....		96
95b. Long, sharp spines absent.....		99
96a. Cells round.....		97
96b. Cells oval.....		98
97a. Cells isolated.....	<i>Golenkinia</i>	
97b. Cells in colonies.....	<i>Micractinium</i>	
98a. Each cell end has one spine.....	<i>Diacanthos</i>	
98b. Each cell end has more than one spine.....	<i>Chodatella</i>	
99a. Colony of definite regular form, round to oval.....		100
99b. Colony, if present, not a definite oval or sphere; or cells may be isolated.....		104
100a. Colony a tight sphere of cells.....		101
100b. Colony a loose sphere of cells enclosed by a common membrane.....		102
101a. Sphere solid, slightly irregular, no connecting processes between cells.....	<i>Planktosphaeria</i>	
101b. Sphere hollow, regular; short connecting processes between cells.....	<i>Coelastrum</i>	
102a. Cells round.....		103
102b. Cells oval.....	<i>Oocystis</i>	
103a. Cells connected to center of colony by branching stalk.....	<i>Dictyosphaerium</i>	
103b. No stalk connecting cells.....	<i>Sphaerocystis</i>	
104a. Oval cells, enclosed in a somewhat spherical, often orange-colored matrix.....	<i>Botryococcus</i>	
104b. Cells round, isolated or in colorless matrix.....		105
105a. Adjoining cells with straight, flat walls between their protoplasts.....		106
105b. Adjoining cells with rounded walls between their protoplasts.....		107
106a. Cells embedded in a common gelatinous matrix.....	<i>Palmella</i>	

	<i>Refer to couplet No.</i>
106b. No matrix or sheath outside of cell walls	<i>Phytoconis (Protococcus)</i>
107a. Cells loosely arranged in a large gelatinous matrix	<i>Tetraspora</i>
107b. Cells isolated or tightly grouped in a small colony	108
108a. Cells located inside of protozoa	<i>Zoochlorella</i>
108b. Cells not inside of protozoa	109
109a. Plastid filling $\frac{2}{3}$ or less of cell	110
109b. Plastid filling $\frac{3}{4}$ or more of cell	<i>Chlorococcum</i>
110a. Cell diameter 2 μ m or less; reproduction by cell division	<i>Nannochloris</i>
110b. Cell diameter 2.5 μ m or more; reproduction by internal spores	<i>Chlorella</i>
111a. Cells attached end to end in an unbranched filament	112
111b. Thallus branched, or more than one cell wide	119
112a. Plastids in form of one or more marginal spiral ribbons	<i>Spirogyra</i>
112b. Plastids not in form of spiral ribbons	113
113a. Filaments, when breaking, separating through middle of cells	114
113b. Filaments, when breaking, separating irregularly or at ends of cells	115
114a. Starch test positive; cell margin straight; one plastid, granular	<i>Microspora</i>
114b. Starch test negative; cell margin slightly bulging; several plastids	<i>Tribonema</i>
115a. Marginal indentations between cells	<i>Desmidium</i>
115b. No marginal indentations between cells	116
116a. Plastids, two per cell	<i>Zygnema</i>
116b. Plastid, one per cell (sometimes appearing numerous)	117
117a. Some cells with walls having transverse wrinkles near one end; plastid an irregular net	<i>Oedogonium</i>
117b. No apical wrinkles in wall; plastid not porous	118
118a. Plastid a flat or twisted axial ribbon	<i>Mougeotia</i>
118b. Plastid an arcuate marginal band	<i>Ulothrix</i>
119a. Thallus a flat plate of cells	<i>Hildenbrandia</i>
119b. Thallus otherwise	120
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120b. Thallus otherwise	121
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121b. Thallus otherwise	122
122a. Filament unbranched	<i>Schizomeris</i>
122b. Filament branched	123
123a. Branches in whorls (clusters)	124
123b. Branches single or in pairs	126
124a. Thallus embedded in gelatinous matrix	<i>Batrachospermum</i>
124b. Thallus not embedded in gelatinous matrix	125
125a. Main filament one cell thick	<i>Nitella</i>
125b. Main filament three cells thick	<i>Chara</i>
126a. Most of filament surrounded by a layer of cells	<i>Compsopogon</i>
126b. Filament not surrounded by a layer of cells	127
127a. End cell of branches with a rounded or blunt-pointed tip	128
127b. End cell of branches with a sharp-pointed tip	130
128a. Plastids green; starch test positive	129
128b. Plastids red; starch test negative	<i>Audouinella</i>
129a. Some cells dense, swollen, dark green (spores); other cells light green, cylindric	<i>Pithophora</i>
129b. All cells essentially alike, light to medium green, cylindric	<i>Cladophora</i>
130a. Filaments embedded in gelatinous matrix	131
130b. Filaments not embedded in gelatinous matrix	132
131a. Cells of main filament much wider than even the basal cells of branches	<i>Draparnaldia</i>
131b. No abrupt change in width of cells from main filament to branches	<i>Chaetophora</i>
132a. Branches very short, with no cross-walls	<i>Rhizoclonium</i>
132b. Branches long, with cross-walls	133
133a. Branches ending in an abrupt spine having a bulbous base	<i>Bulbochaete</i>
133b. Branches gradually reduced in width, ending in a long pointed cell, with or without color	<i>Stigeoclonium</i>

10900 D. Index to Illustrations

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Algae, marine	2A, 2B	<i>Bosmina</i>	11	Chrysophyta	1B	<i>Dichotomosiphon</i>	1B
Algae, red	2B	<i>Botrydium</i>	1B	Ciliates (Protozoa)	6	<i>Dictyosphaerium</i>	1A, 34
<i>Alona</i>	11	<i>Botryococcus</i>	32	Cirripedia	11	<i>Diffugia</i>	5A
<i>Alternaria</i>	27	<i>Brachionus</i>	8	Cladocera	11	<i>Dineutus</i>	17
<i>Ambystoma</i>	25	Brachiopoda	22	<i>Cladophora</i>	31, 33	<i>Dinobryon</i>	29, 30
Ammicolidae	19	Brittle star	23	<i>Cladosporium</i>	27	<i>Dinomonas</i>	4B
Amoebas (Protozoa)	5A,B	Bryozoa	22	Clams	21	<i>Diopatra</i>	10
<i>Amoeba</i> sp.	5A,B	Bubble snail	20	<i>Closteriopsis</i>	34	Diptera	16
Amphibians	25	Bugs, true	18	<i>Closterium</i>	29, 34	Dobsonflies	15
<i>Amphidinium</i>	35	<i>Bugula</i>	22	Cnidaria	7	Dragonflies	14
<i>Amphiodia</i>	23	<i>Bulbochaete</i>	33	<i>Cocconeis</i>	1B, 31	<i>Draparnaldia</i>	33
Amphipoda	12	<i>Bulla</i>	20	<i>Codium</i>	2A, 35	Drone fly	16
<i>Anabaena</i>	28, 29, 30	Bull whip	2A	<i>Coelastrum</i>	32	Duckweed	3A
<i>Anacystis</i>	28	<i>Busycon</i>	20	Coelenterates	7	<i>Dytiscus</i>	17
<i>Anatani</i>	12	Caddisflies	15	<i>Coelosphaerium</i>	28	<i>Echinarachnius</i>	23
Ancyliidae	19	<i>Callianassa</i>	12	Coleoptera	17	Echinoderms	23
<i>Anisonema</i>	4B	<i>Callinectes</i>	12	Collembola	22	Echinoidea	23
<i>Ankistrodesmus</i>	1A, 31, 34	<i>Calothrix</i>	31	<i>Colpoda</i>	6	Ectoprocta	22
Annelids	9, 10	<i>Cambarus</i>	12	<i>Compsopogon</i>	33	Eelgrass	28
<i>Anodonta</i>	21	<i>Campeloma</i>	19	Coontail	3B	<i>Eichhornia</i>	3A
<i>Anthophysa</i>	5B	<i>Cancer</i>	12	Copepod	11	<i>Elakathrix</i>	34
<i>Anthopleura</i>	7	<i>Capitella</i>	10	<i>Corallina</i>	2B	Electric light bug	18
<i>Antocha</i>	16	Capitellids	10	<i>Corbicula</i>	21	<i>Eleocharis</i>	3C
<i>Aphanizomenon</i>	1A, 28	<i>Carteria</i>	30	Corixidae	18	Elmidae	17
<i>Aphanotheca</i>	31	Cartilage fish	24	<i>Corydalis</i>	15	<i>Elodea</i>	3B
Apple snail	19	Cattail	3C	<i>Coscinodiscus</i>	1B	<i>Enochrus</i>	17
Arachnoidea	22	Caudata	25	<i>Cosmarium</i>	34	<i>Enteromorpha</i>	2A, 35
<i>Arcella</i>	5B	Cephalopoda	20	Crabs	12	<i>Ephemerella</i>	13
Arthropods	11-18, 22	<i>Ceratium</i>	28	Crane fly	16	Ephemeridae	13
<i>Arthrospira</i>	30	<i>Ceratophyllum</i>	3B	<i>Craspedacusta</i>	7	Ephemeroptera	13
<i>Asellus</i>	12	<i>Cercomonas</i>	4B	<i>Crassostrea</i>	21	<i>Epinebalia</i>	12
Asiatic clam	21	<i>Cerithidea</i>	20	Crawdad	12	<i>Epiphanes</i>	8
<i>Aspidisca</i>	6	<i>Chaetoceros</i>	35	Crayfish	12	<i>Eristalis</i>	16
<i>Astasia</i>	4B	<i>Chaetomorpha</i>	35	<i>Crisulipora</i>	22	<i>Euastrum</i>	32
<i>Asterias</i>	23	<i>Chaetophora</i>	33	<i>Crucigenia</i>	1A	<i>Euchlanis</i>	8
<i>Asterionella</i>	28, 29, 35	Chaetopterid	10	Crustaceans	11, 12	<i>Eudorina</i>	32
<i>Astropecten</i>	23	<i>Chaetopterus</i>	10	<i>Cryptomonas</i>	4A, 34	<i>Euglena</i>	30, 32
<i>Audouinella</i>	33	<i>Chamaesiphon</i>	31	<i>Culex</i>	16	<i>Euplotes</i>	6
<i>Azolla</i>	3A	<i>Champia</i>	2B	Culicidae	16	<i>Eutrepta</i>	35
<i>Bacillus</i>	26	<i>Chaoborus</i>	16	Cumacea	12	<i>Exophiala</i>	27
Backswimmer	18	<i>Chara</i>	33	Cyanobacteria	1A	Faucet snail	19
Bacteria	26	<i>Chauliodes</i>	15	Cyanophyta	1A	Feather duster worm	10
<i>Baetis</i>	13	Chironomidae	16	<i>Cybister</i>	17	<i>Ferrissia</i>	19
<i>Balanus</i>	11	<i>Chironomus</i>	16	<i>Cyclotella</i>	1B, 29, 31	Fiddler crab	12

Organism	Plate	Organism	Plate	Organism	Plate	Organism	Plate
<i>Filina</i>	8	<i>Hydrometra</i>	18	<i>Meridion</i>	31	Osteichthys.....	24
Fingernail clam.....	21	<i>Hydrophilus</i>	17	<i>Micractinium</i>	32	Ostracod.....	11
Fishflies.....	15	<i>Hydropsyche</i>	15	<i>Micrasterias</i>	31	<i>Ourococcus</i>	34
Fishes.....	24	Hydroptilidae.....	15	Micrococcus.....	26	Ostreidae.....	21
Flagellates, nonpigmented.....	4B, 5B	Ice cream cone worm.....	10	<i>Microcoleus</i>	31	<i>Oxyurostylis</i>	12
Flagellates, pigmented.....	4A,B	<i>Idotea</i>	12	<i>Microspora</i>	33	Oyster.....	21
Flatfish.....	24	Insects.....	13-18, 22	<i>Microthamnion</i>	1B	<i>Palmella</i>	29
Flatworms.....	9	<i>Isoperla</i>	13	Midges.....	16	<i>Pandorina</i>	28
Flies, two-winged.....	16	Isopoda.....	12	<i>Moina</i>	11	Papershell.....	21
Flounder.....	24	Jackknife clam.....	21	Mollusks, bivalves.....	21	<i>Paralichthys</i>	24
<i>Fragilaria</i>	29, 32	<i>Jassa</i>	12	Mollusks, snails.....	19, 20	<i>Paramecium</i>	6
Frogs.....	25	Jawless fish.....	24	<i>Monas</i>	5B	Pearly mussel.....	21
<i>Fucus</i>	2A	Jellyball.....	22	<i>Monostyla</i>	8	<i>Pectinaria</i>	10
Fungi.....	26, 27	Jellyfish.....	7	Moon snail.....	20	<i>Pectinatella</i>	22
<i>Fusarium</i>	27	<i>Kellicottia</i>	8	Mosquito.....	16	<i>Pediastrum</i>	32
<i>Gammarus</i>	12	Kelp.....	2A	<i>Mougeotia</i>	32	Pelecypoda.....	21
Ganoid fish.....	24	<i>Keratella</i>	8	Mud crab.....	12	<i>Pelomyxa</i>	5A
Gar, long-nosed.....	24	<i>Klasterskaya</i>	27	Mud puppy.....	25	<i>Pelvetia</i>	35
Gastropoda.....	19	Lamprey.....	24	<i>Musca</i>	16	<i>Peranema</i>	5B
<i>Geotrichum</i>	27	Lampsilinae.....	21	Muscidae.....	16	<i>Perca</i>	24
<i>Gerris</i>	18	<i>Lanx</i>	19	Mussels.....	21	Perch.....	24
Ghost shrimp.....	12	Leech.....	9	<i>Mya</i>	21	<i>Peridinium</i>	28, 35
Giant kelp.....	2A	<i>Lemanea</i>	31	<i>Myriophyllum</i>	3B	Periwinkle.....	20
<i>Gigartina</i>	2B	<i>Lemna</i>	3A	Mysidacea.....	11	Perlodidae.....	13
<i>Gloeocapsa</i>	30	<i>Lepisosteus</i>	24	<i>Mytilus</i>	21	<i>Petromyzon</i>	24
<i>Gloeotrichia</i>	1A	<i>Lepocinclis</i>	30	<i>Naegleria</i>	5A	<i>Phacotus</i>	31
<i>Glottidia</i>	22	<i>Leptocella</i>	15	Naiad.....	3B	<i>Phacus</i>	30, 32
<i>Golenkinia</i>	34	Leptoceridae.....	15	<i>Najas</i>	3B	Phaeophyta.....	2A, 31
Gomphidae.....	14	<i>Leptodora</i>	11	<i>Nannochloris</i>	35	<i>Philodina</i>	8
<i>Gomphonema</i>	30, 33	<i>Leptomitus</i>	26	<i>Narpus</i>	17	<i>Phormidium</i>	30, 33
<i>Gomposphaeria</i>	28, 32	<i>Leptostraca</i>	12	<i>Nassarius</i>	20	Phoronidea.....	22
<i>Gonidea</i>	21	<i>Leptosynpta</i>	23	Naticidae.....	20	<i>Phoronis</i>	22
<i>Gonium</i>	32	Lesser duckweed.....	3A	<i>Navicula</i>	29, 31	<i>Physa</i>	19
<i>Gonyaulax</i>	4B	<i>Lestes</i>	14	<i>Necturus</i>	25	<i>Phytoconis</i>	32
<i>Gracilaria</i>	2B	<i>Lethocerus</i>	18	Nematoda.....	9	Pickerelweed.....	3B
Grasses, marine.....	2B	Libellulidae.....	14	Nephtyid.....	10	Pilidae.....	19
Great duckweed.....	3A	<i>Limnocharis</i>	22	<i>Nephtys</i>	10	<i>Pinnularia</i>	31
<i>Gymnodinium</i>	4B	Limpets.....	19	Nereid.....	10	<i>Pista</i>	10
Gyrinidae.....	17	<i>Limulus</i>	22	<i>Nereis</i>	10	<i>Pithopora</i>	1B
<i>Haematococcus</i>	4A	<i>Lionotus</i>	6	<i>Nereocystis</i>	2A	<i>Planaria</i>	9
<i>Hagenius</i>	14	<i>Littorina</i>	20	<i>Nitella</i>	28	<i>Planktosphaeria</i>	34
<i>Haliclona</i>	7	<i>Lobomonas</i>	4A	<i>Nitzschia</i>	30, 35	Planorbidae.....	19
<i>Halosydna</i>	10	<i>Lymnaea</i>	19	<i>Nodularia</i>	32	Plants, higher.....	3A,B,C
<i>Hartmannella</i>	5A	<i>Lyngbya</i>	30, 33	<i>Notholca</i>	8	<i>Platydorina</i>	4A
Hellgrammite.....	15	<i>Macrocystis</i>	2A	<i>Notonecta</i>	18	Platyhelminthes.....	9
<i>Helocordulia</i>	14	<i>Macromia</i>	14	<i>Notophthalmus</i>	25	Plecoptera.....	13
<i>Hemigrapsus</i>	12	Maggot.....	16	<i>Obelia</i>	7	<i>Plectus</i>	9
Hemiptera.....	18	<i>Mallomonas</i>	28	<i>Ochromonas</i>	4A	<i>Pleodorina</i>	4B
Heptageniidae.....	13	<i>Manayunkia</i>	9	<i>Ochrotricha</i>	15	<i>Pleurobema</i>	21
<i>Hexagenia</i>	13	<i>Margaritifera</i>	21	<i>Octopus</i>	20	<i>Pleurocera</i>	19
<i>Hildenbrandia</i>	31	Marine worms.....	10	Odonata.....	14	<i>Pleuronema</i>	6
Hirudinea.....	9	<i>Marisa</i>	19	<i>Oedogonium</i>	33	<i>Plocamium</i>	2B
<i>Holmesimysis</i>	11	Marsh clam.....	21	<i>Oikomonas</i>	4B	<i>Polinices</i>	20
Holothuroidea.....	23	Marsh treader.....	18	Oligochaeta.....	9	<i>Polyarthra</i>	8
Horn snail.....	20	<i>Massartia</i>	34	Olive snail.....	20	Polychaeta.....	9, 10
Horseshoe crab.....	22	<i>Mastigamoeba</i>	5B	Onuphid.....	10	<i>Polydora</i>	10
Housefly.....	16	Matricidae.....	21	<i>Ophiopholis</i>	23	<i>Polyedriopsis</i>	34
<i>Hyalotheca</i>	1B	Mayflies.....	13	Ophiuroidea.....	23	<i>Polymesoda</i>	21
<i>Hydra</i>	7	Melongenidae.....	20	Orb snail.....	19	<i>Polyphemus</i>	11
<i>Hydrodictyon</i>	28	<i>Melosira</i>	29, 35	<i>Orchesella</i>	22	Polyplacophora.....	20
		<i>Mercenaria</i>	21	<i>Oscillatoria</i>	29, 30	<i>Pomacea</i>	19

Organism	Plate	Organism	Plate	Organism	Plate	Organism	Plate
Pond snail	19	<i>Sargassum</i>	2A	Statoblast, <i>Pectinatella</i>	22	<i>Trichosporon</i>	27
Pondweed	3B	Scale worm	10	<i>Staurastrum</i>	28, 31	<i>Tripyla</i>	9
<i>Pontederia</i>	3B	Scaphopoda	20	<i>Stauroneis</i>	32	<i>Trochospongilla gemmules</i>	7
Porifera	7	<i>Scenedesmus</i>	32, 34	<i>Stenelmis</i>	17	Trout	24
<i>Porphyra</i>	35	<i>Schizomeris</i>	1A	<i>Stenonema</i>	13	<i>Tubifex</i>	9
<i>Potamogeton</i>	3B	<i>Schizothrix</i>	34	<i>Stenoplax</i>	20	Tusk shell	20
Pouch snail	19	<i>Schroederia</i>	34	<i>Stephanodiscus</i>	32	<i>Typha</i>	3C
<i>Prasiola</i>	35	Scud	12	<i>Stephanoptera</i>	35	<i>Typosyllis</i>	10
<i>Proales</i>	8	<i>Scytosiphon</i>	35	<i>Stichococcus</i>	1B, 35	<i>Uca</i>	12
<i>Proptera</i>	21	Sea cucumbers	23	<i>Stigeoclonium</i>	29, 33	<i>Ulothrix</i>	31, 33
<i>Prorocentrum</i>	35	Sea lettuce	2A	Stingray	24	<i>Ulva</i>	2A, 35
Protozoa	4A,B, 5A,B	Sea slug	20	Stoneflies	13	Unionidae	21
Psammobiidae	21	Sea spider	12	<i>Streptococcus</i>	26	<i>Uroglenopsis</i>	21, 28
<i>Psephenus</i>	17	Sea urchin	23	<i>Strongylocentrotus</i>	23	<i>Vacuolaria</i>	34
<i>Pseudodallescheria</i>	27	Segmented worms	9, 10	<i>Stylonychia</i>	6	<i>Vallisneria</i>	2B
<i>Psychoda</i>	16	<i>Selenastrum</i>	1A	<i>Surirella</i>	31	<i>Valvata</i>	19
Pteridophyta	3A	Sewage fly	16	Sweet flag	3C	Vase sponge	7
<i>Pteromonas</i>	4A, 34	Shrimp	12	Syllids	10	<i>Vaucheria</i>	33
<i>Peronarcys</i>	13	<i>Sialis</i>	15	<i>Synchaeta</i>	8	Veneridae	21
Purple sponge	7	<i>Sigara</i>	18	<i>Synedra</i>	28, 29	Vibrio	26
Pycnogonid	12	<i>Simulium</i>	16	<i>Synura</i>	28	Viviparidae	19
<i>Pyrobotrys</i>	30	Simuliidae	16	Syrphidae	16	<i>Volvox</i>	28
Quahog clam	21	<i>Siren</i>	25	<i>Tabanus</i>	16	<i>Vorticella</i>	6
Rainbow trout	24	<i>Skeletonema</i>	1B, 35	<i>Tabellaria</i>	28, 29	Water boatman	18
<i>Rana</i>	25	Sludgeworm	9	Tadpole	25	Water dog	25
<i>Rangia</i>	21	Snails	19, 20	<i>Tagelus</i>	21	Water fern	3A
Rat-tailed maggot	16	Soft-rayed fish	24	Tanaidacea	12	Water hyacinth	3A
Ray	24	Soft-shelled clam	21	<i>Tarebia</i>	19	Watermeal	3A
<i>Rhizoclonium</i>	31	Sowbug	12	Terebellid	10	Water milfoil	3B
<i>Rhizosolenia</i>	1B	Spectacle case	21	<i>Tetracladium</i>	26	Water mite	22
<i>Rhodoglossum</i>	35	Spermatophytes	2B, 3A,B,C	<i>Tetraedron</i>	30	Water penny	17
<i>Rhodomonas</i>	31	<i>Sphaerium</i>	21	<i>Tetramitus</i>	4B	Water scavenger beetle	17
Rhodophyta	2B	<i>Sphaerocystis</i>	32	<i>Tetraspora</i>	32	Water strider	18
Riffle beetle	17	<i>Sphaerotilus</i>	26	<i>Tetrastrum</i>	1A	Water velvet	3A
River snail	19	Spicule types	7	Thiaidae	19	Waterweed	3B
<i>Rivularia</i>	29	Spike rush	3C	<i>Thyone</i>	23	<i>Westella</i>	1A
Rockweed	2A	Spionid	10	<i>Tigriopus</i>	11	Whirligig beetle	17
Rotifers	8	Spirillum	26	<i>Tintinnidium</i>	6	Winged lampshell	21
Roundworms	9	<i>Spirodela</i>	3A	<i>Tipula</i>	16	<i>Wolffia</i>	3A
<i>Sabella</i>	10	<i>Spirogyra</i>	29, 30	Toads	25	Worms	9, 10
Salamanders	25	<i>Spirotruncaria</i>	12	<i>Tolypothrix</i>	32	Zebra mussel	21
Salientia	25	Spiny-rayed fish	24	<i>Trachelomonas</i>	29	<i>Zoobotryon</i>	22
<i>Salmo</i>	24	<i>Spirulina</i>	34, 35	<i>Triaenodes</i>	15	<i>Zoogloea</i>	26
<i>Salvinia</i>	3A	Sponges	7	<i>Tribonema</i>	29	<i>Zoophagus</i>	26
Sand dollar	23	Sponge weed	2A	<i>Trichocerca</i>	8	<i>Zostera</i>	2B
Sand starfish	23	Springtail	22	<i>Trichoderma</i>	27	<i>Zygnema</i>	32
<i>Sarcina</i>	26	Starfishes	23	<i>Trichodesmium</i>	35		

10900 E. Selected Taxonomic References

The most useful references for the nonspecialist are listed below. These references are primarily regional and will aid the biologist in the identification of both freshwater and marine plants and animals. Each reference is listed once under the broadest classification, i.e., a general reference to the identification of invertebrates is listed under "Invertebrates, General" and is not repeated under each individual phylum. As a rule, more academic and specialized reports on a single genus or family are not listed; however, these often are listed in the bibliography of a cited reference.

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ALGAE COLOR PLATES



Plate 28. Taste and odor algae.

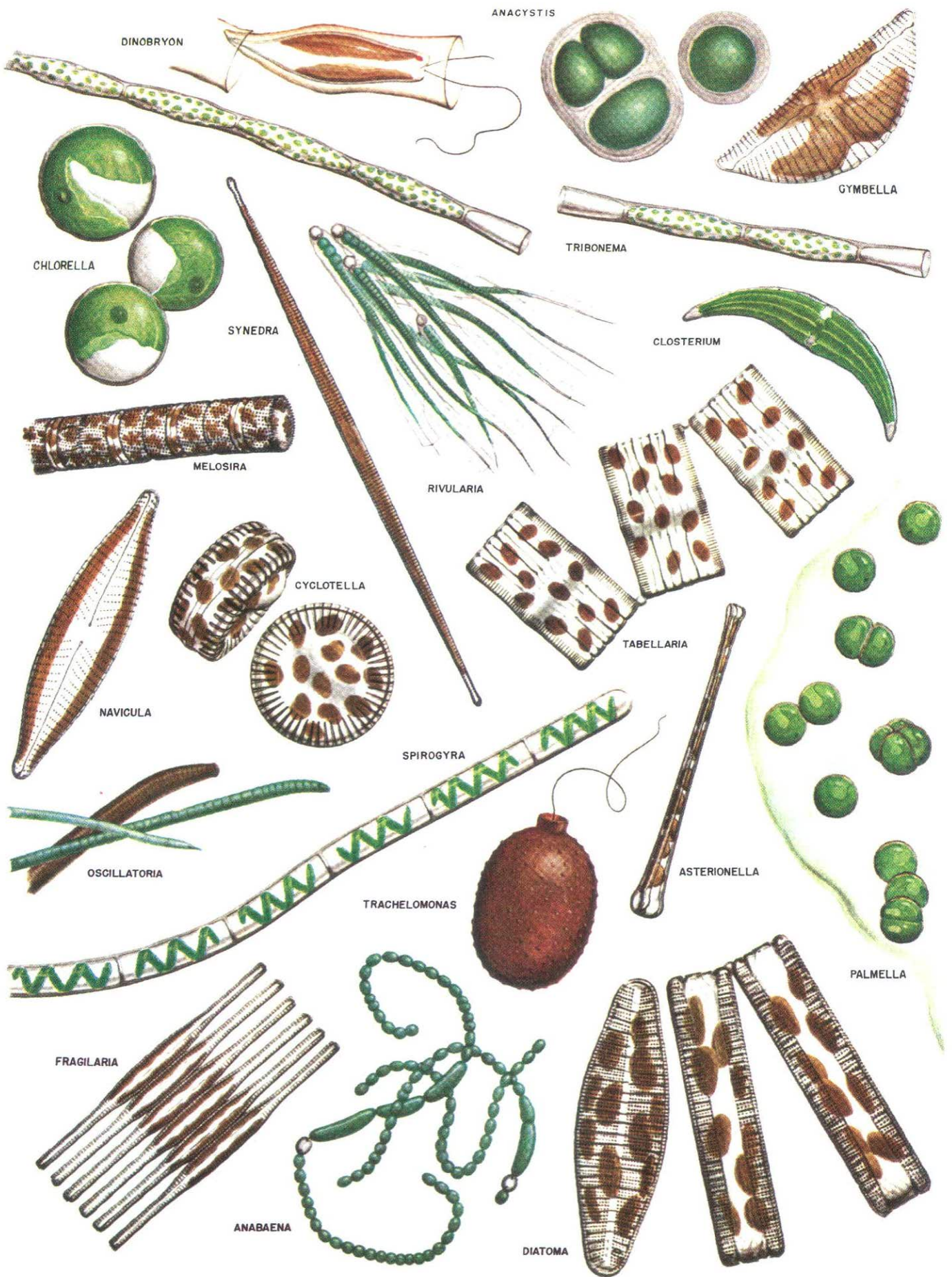


Plate 29. Filter- and screen-clogging algae.



Plate 30. Fresh-water pollution algae.

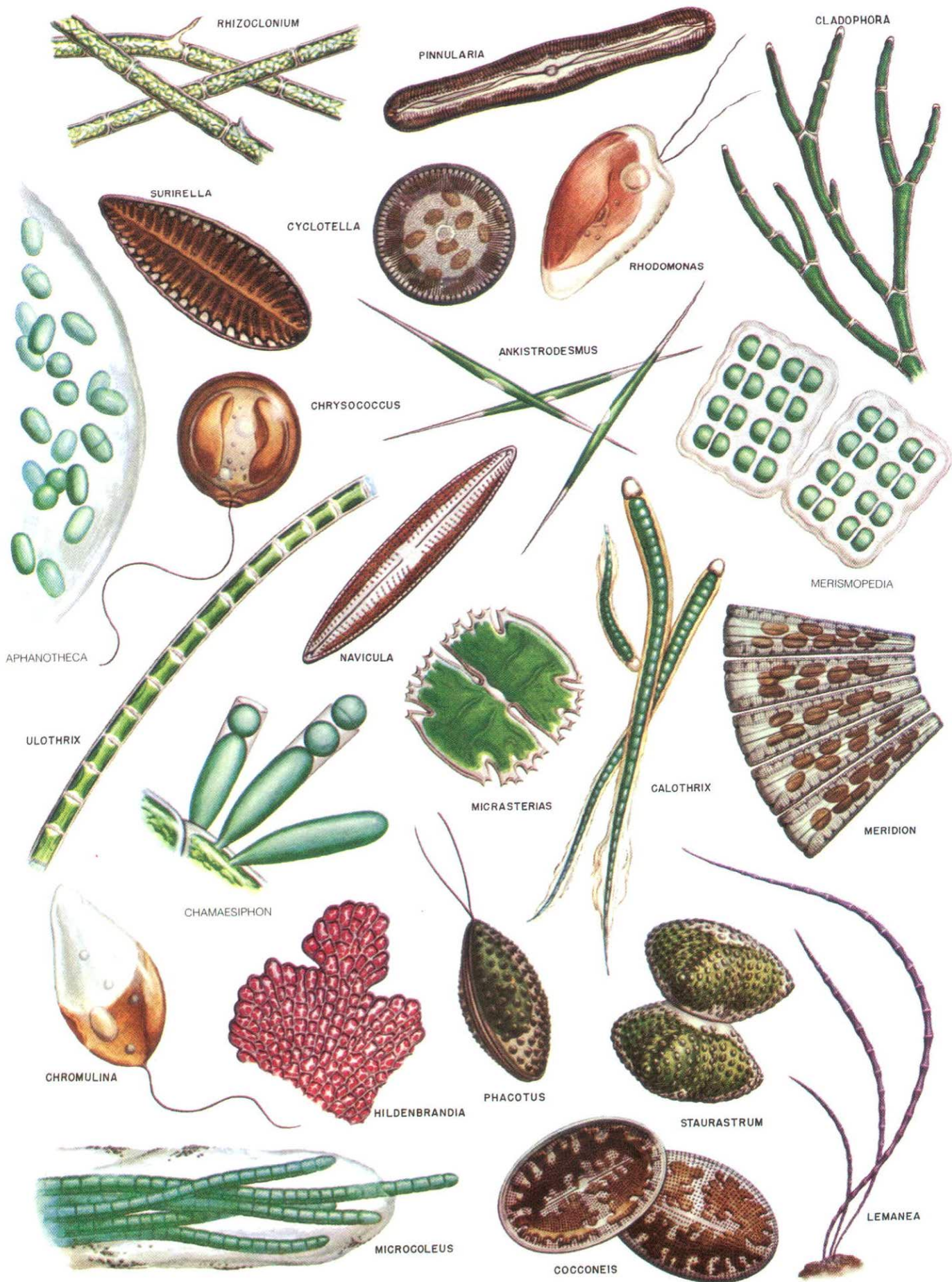


Plate 31. Clean-water algae.

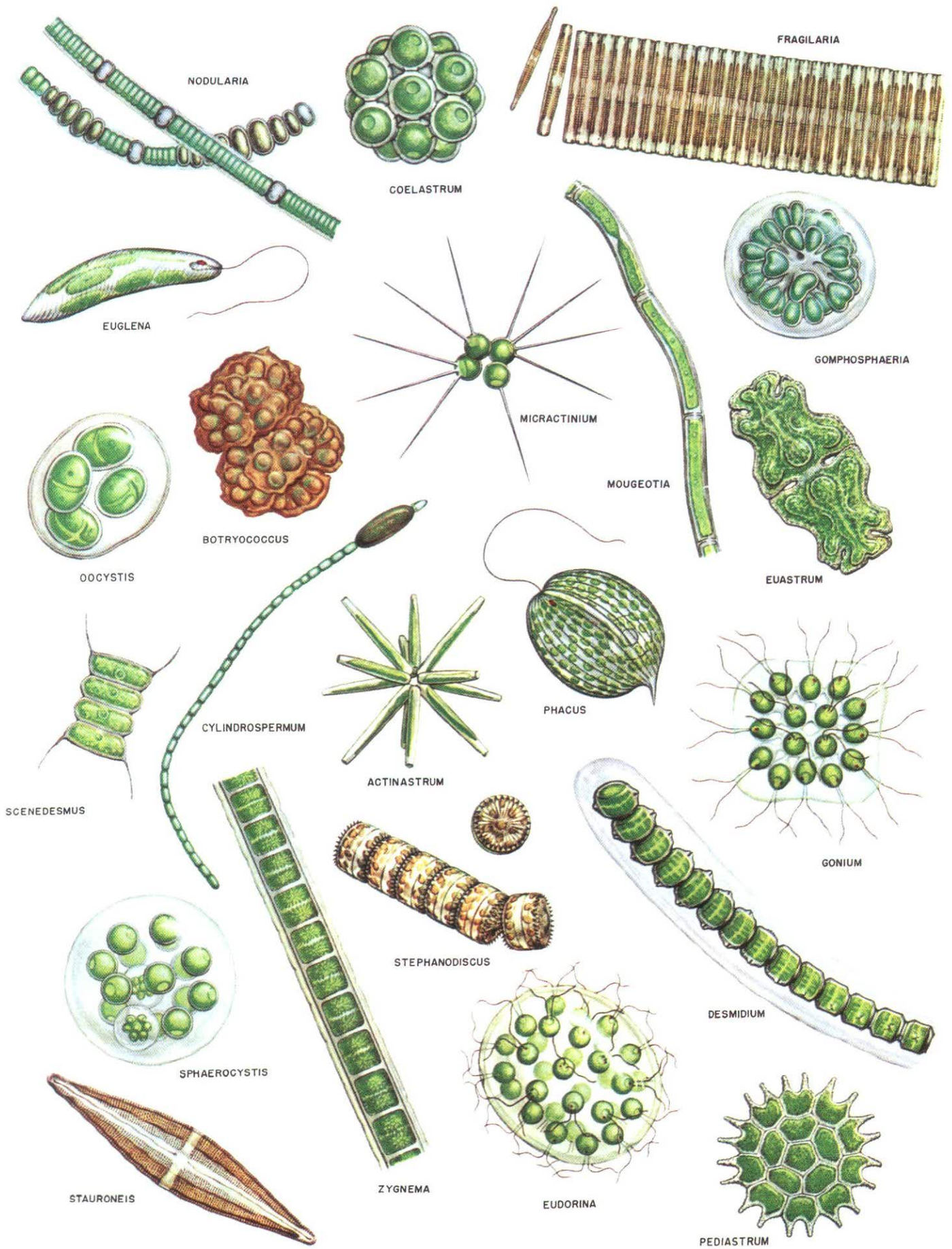


Plate 32. Plankton and other surface-water algae.



Plate 33. Algae growing on surfaces.

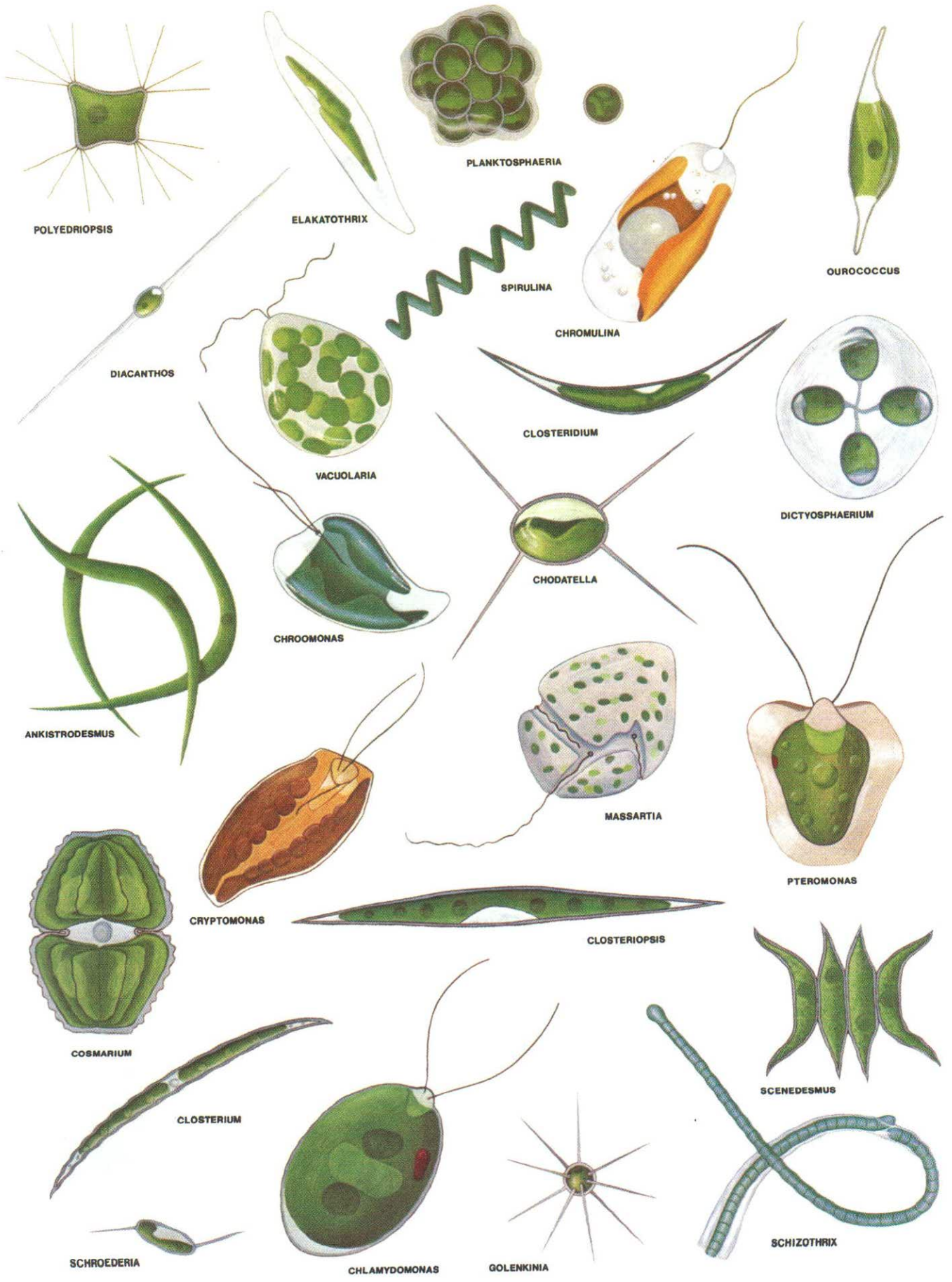


Plate 34. Wastewater-treatment-pond algae.



Plate 35. Estuarine pollution algae.