

Chapter 1 Major Groups of Freshwater Invertebrates

The International Code of Zoological Nomenclature (ICZN) defines a hierarchical classification system of the animal kingdom. The five principal taxonomic levels of the system are:

Phylum
 Class
 Order
 Family
 Genus
 Species

The 'species' is the basic taxonomic rank. When it is first described, each species is assigned a name comprising two parts, a generic name and a specific name. In the example of the biological name for humans, *Homo sapiens*, *Homo* is the generic name, and *sapiens* is the specific name. A genus includes related species, and many related genera are classified into families, and so on up the hierarchy. As a result, every description of a new species also implicitly places the species in the taxonomic hierarchy, thereby defining its place in the animal kingdom and how it relates to other species.

Two other groupings have become widely recognised: cohort and tribe. 'Cohort' is interposed between class and order, and 'tribe' between family and genus. However, this still is not sufficient to meet the needs of taxonomists. The addition of prefixes (sub or super) to the name of the taxon was introduced to increase categories in the classification system. For example, the genera in a family may be grouped in a number of subfamilies, and the family may in turn be a member of a superfamily. And more recently the prefix infra- was introduced for groups below the subgrouping.

However, the term 'invertebrate' does not imply any biological affinities, but rather is a loose grouping used by zoologists historically to include all multi-cellular animals without backbones. The major groups of invertebrates in this book are listed as follows¹:

Phylum Porifera
 Class Demospongiae
 Order Haploclerina
 Family Spongillidae

Phylum Cnidaria
 Class Hydrozoa
 Order Hydroida
 Family Hydridae
 Order Trachylina
 Family Petasidae

¹ * no further discussion; a = plankton; b = insufficient information; c = occurs only in temporary ponds

Phylum Platyhelminthes

Class Turbellaria

Order Tricladida

Family Planariidae

Phylum Rotifera^{*a}

Phylum Nematoda^{*b}

Phylum Nematomorpha^{*b}

Phylum Bryozoa (Ectoprocta)

Class Phylactolaemata

Family Lophopodidae

Family Fredericellidae

Family Plumatellidae

Phylum Annelida

Class Polychaeta^{*b}

Class Oligochaeta^{*b}

Class Hirudinea

Order Rhynchobdellida

Family Glossiphoniidae

Family Piscicolidae

Order Gnathobdellida

Family Hirudinidae

Order Pharyngobdellida

Family Erpobdellidae

Phylum Mollusca

Class Gastropoda

Subclass Prosobranchia

Order Mesogastropoda

Family Bityniidae

Family Hydrobiidae

Family Pilidae (Ampullariidae)

Family Stenothyridae

Family Thiaridae

Family Viviparidae

Order Neogastropoda

Family Buccidae

Subclass Pulmonata

Order Basematophora

Family Ancyliidae

- Family Lymnaeidae
- Family Planorbidae
- Class Pelecypoda
 - Subclass Heterodonta
 - Order Veneroida
 - Family Corbiculidae
 - Family Dreissenidae
 - Family Sphaeriidae
 - Subclass Pteriomorpha
 - Order Arcoida
 - Family Arcidae
 - Order Mytiloida
 - Family Mytilidae
 - Subclass Schizodontida
 - Order Unionoida
 - Family Amblemidae
- Phylum Arthropoda
 - Subphylum Chelicerata
 - Class Arachnida
 - Order Araneae
 - Family Agelenidae
 - Order Acarina^{*b}
 - Subphylum Crustacea
 - Subclass Branchiopoda
 - Order Anostraca^c
 - Family Streptocephalidae
 - Order Conchostraca^{*c}
 - Order Notostraca^{*c}
 - Order Cladocera^{*a}
 - Subclass Copepoda
 - Order Eucopepoda^{*a}
 - Order Branchiura
 - Family Argulidae
 - Subclass Ostracoda^{*b}
 - Subclass Malacostraca
 - Order Isopoda^{*b}
 - Order Amphipoda
 - Family Gammaridae

Order Decapoda

Family Atyidae

Family Palaemonidae

Family Parathelphusidae

Family Potamidae

Family Gecarcinucidae

Subphylum Uniramia

Class Insecta

Subclass Apterygota

Order Collembola

Family Isotomidae

Subclass Pterygota

Order Ephemeroptera

Family Baetidae

Family Behningiidae

Family Caenidae

Family Ephemerellidae

Family Ephemeridae

Family Euthyplocidae

Family Heptageniidae

Family Isonychidae

Family Leptophlebiidae

Family Neoephemeridae

Family Oligoneuriidae

Family Palingeniidae

Family Polymitarcyidae

Family Potamanthidae

Family Prosopistomatidae

Family Teloganellidae

Family Teloganodidae

Family Vietnamellidae

Order Odonata

Suborder Zygoptera

Family Amphipterygidae

Family Calopterygidae

Family Chlorocyphidae

Family Coenagrionidae

Family Euphaeidae

- Family Lestidae
- Family Megapodagrionidae
- Family Platycnemididae
- Family Platystictidae
- Family Protoneuridae
- Suborder Anisoptera
 - Family Aeshnidae
 - Family Cordulegastridae
 - Family Corduliidae
 - Family Gomphidae
 - Family Libellulidae
- Order Orthoptera
 - Family Acrididae
 - Family Blaberidae
 - Family Gryllidae
 - Family Gryllotalpidae
 - Family Tetrigidae
 - Family Tettigoniidae
 - Family Tridactylidae
- Order Plecoptera
 - Family Leuctridae
 - Family Nemouridae
 - Family Peltoperlidae
 - Family Perlidae
- Order Hemiptera (Suborder Heteroptera)
 - Infraorder Nepomorpha
 - Family Aphelocheiridae
 - Family Belostomatidae
 - Family Corixidae
 - Family Gelastocoridae
 - Family Helotrephidae
 - Family Micronectidae
 - Family Naucoridae
 - Family Nepidae
 - Family Notonectidae
 - Family Ochteridae
 - Family Pleidae
 - Infraorder Gerromorpha

- Family Gerridae
- Family Hebridae
- Family Hydrometridae
- Family Mesoveliidae
- Family Veliidae
- Infraorder Leptopodomorpha
 - Family Leptopodidae
 - Family Saldidae
- Order Megaloptera
 - Family Corydalidae
 - Family Sialidae
- Order Neuroptera^{*b}
- Order Trichoptera
 - Suborder Spicipalpia
 - Family Glossosomatidae
 - Family Hydrobiosidae
 - Family Hydroptilidae
 - Family Rhyacophilidae
 - Suborder Annulipalpia
 - Family Dipseudopsidae
 - Family Ecnomidae
 - Family Hydropsychidae
 - Family Philopotamidae
 - Family Polycentropodidae
 - Family Psychomyiidae
 - Family Stenopsychidae
 - Family Xiphocentronidae
 - Suborder Integripalpia
 - Family Apataniidae
 - Family Beraeidae
 - Family Brachycentridae
 - Family Calamoceratidae
 - Family Goeridae
 - Family Helicopsychidae
 - Family Lepidostomatidae
 - Family Leptoceridae
 - Family Limnephilidae
 - Family Limnocentropodidae

- Family Molannidae
- Family Odontoceridae
- Family Phryganeidae
- Family Phryganopsychidae
- Family Sericostomatidae
- Family Uenoidae
- Order Lepidoptera
 - Family Crambidae
- Order Coleoptera
 - Suborder Adephaga
 - Family Amphizoidae
 - Family Carabidae
 - Family Dytiscidae
 - Family Gyrinidae
 - Family Haliplidae
 - Family Hygrobiidae
 - Family Noteridae
 - Suborder Polyphaga
 - Family Chrysomelidae
 - Family Curculionidae
 - Family Dryopidae
 - Family Elmidae
 - Family Hydraenidae
 - Family Hydrochidae
 - Family Hydrophilidae
 - Family Hydroscaphidae
 - Family Lampyridae
 - Family Psephenidae
 - Family Ptilodactylidae
 - Family Scirtidae
 - Family Staphylinidae
- Order Hymenoptera
 - Family Agriotypidae
- Order Diptera
 - Suborder Nematocera
 - Family Blephariceridae
 - Family Ceratopogonidae
 - Family Chaoboridae

- Family Chironomidae
- Family Culicidae
- Family Dixidae
- Family Psychodidae
- Family Simuliidae
- Family Tipulidae
- Suborder Brachycera
 - Family Athericidae
 - Family Empididae
 - Family Ephydriidae
 - Family Stratiomyidae
 - Family Syrphidae
 - Family Tabanidae

Classification

Phylum Porifera

Nearly all of the 10,000 known species of sponges are marine forms, only about 100 species live in freshwater. All freshwater sponges belong to one family, Spongillidae in the order Haploclerina. They are usually found in clean water, and are found attached to any firm permanent substrates, such as rocks, submerged snags, shells of bivalves or man-made hard surfaces. The body of freshwater sponges is supported by spicules and has a leuconoid water canal system. A colony is easy to recognise because it is perforated by numerous small pores and a few large ones. Sponges produce a dormant structure called a gemmule which is resistant to unfavourable environmental conditions.

Phylum Cnidaria

The cnidarians are diverse and abundant in the sea, and they include jelly fishes, sea anemones and corals. Only a few genera in the class Hydrozoa occur in freshwater. They have two forms: sessile polyps, and free-swimming medusae. All cnidarians have radial symmetry and possess diploblastic bodies (the epidermis and the gastrodermis have mesoglea in between). Cnidarians have tiny, stinging organelles, called nematocysts, for capturing prey and defending themselves. Nematocysts are embedded in the body wall and are especially abundant on the tentacles. The nematocysts may be specialized for wrapping around small prey, sticking to surfaces, penetrating surface, or secreting toxin. The polyp form, or hydra, is a common cnidarian found attached to substrates in slowly moving water. The medusa form, or jelly fish, is rare in freshwater. All freshwater cnidarians are carnivorous and feed on small invertebrates such as water fleas and mosquitoes larvae.

Phylum Platyhelminthes

The platyhelminths include one primitive class of mostly free-living individuals (Class Turbellaria) and two classes of exclusively parasitic individuals (Class Trematoda and Class Cestoda). They are acoelomate, triploblastic and bilaterally symmetrical. The most well known free-living turbellarian is a triclad in the family Planariidae. Planarians are mainly carnivorous, feeding largely on small invertebrates. They use their anterior end to wrap around prey and then they extend the proboscis to ingest the body tissue of the prey. They usually glide around on rocks and debris in both running and standing waters.

Phylum Nematoda and Phylum Nematomorpha

The Nematoda and Nematomorpha are pseudocoelomate animals. Free-living nematodes in freshwater are tiny and can be recognized by their spindle shape. Nematomorpha, or horse-hair worms, are much larger and long and slender. Juveniles are parasitic in arthropods but adults are free-living. Adults do not feed; they live in freshwater habitats or in any wet or moist surroundings, surviving only long enough to reproduce.

Phylum Rotifera

Rotifers are tiny worm-like pseudocoelomates, ranging in size from 25 μm to 20 mm. The body is divided into three or four distinct regions: head, neck, trunk and foot. In some species the trunk is enclosed by a hardened lorica. The head bears a wheel organ called the corona. The rotifer is a filter-feeder; the cilia of the corona provides locomotory and feeding currents. The head is usually retracted into the trunk. Food particles enter the mouth to be ground up in the mastax before passing to the stomach where digestion occurs. Undigested food is expelled through the anus. Most rotifers are found in ephemeral ponds or rivers. They serve as a natural food for fishes and are also important aquaculture feed. They produce eggs, but most eggs develop without being fertilized (through parthenogenesis), and there are no males in some species.

Phylum Bryozoa

Bryozoans, or moss animals, are coelomate, colonial, sessile, lophophorate, filter feeders, usually fixed to a hard substrate. The colony consists of fine branching tubes with a plant-like growth form. Colonies are found on submerged substrate or on the underside of floating debris. Zygotes develop into free-swimming larvae which settle onto the substrate and begin budding zooids to form new colonies. Freshwater bryozoans produce resistant bodies called statoblasts. During dry seasons, most bryozoans die but the statoblasts remain viable. When the favourable conditions return, they hatch out and begin budding to form new colonies.

Phylum Mollusca

The phylum Mollusca is one of the largest animal phyla. Almost all molluscs have calcareous shells which are secreted by the mantle. Most molluscs have a foot, which is highly modified for a variety of functions in different groups. They have a true coelom, an open circulatory system and exchange gas across the gills, lungs, mantle or the body surface.

Phylum Mollusca contains six classes, but only two are found in freshwater—Gastropoda and Pelecypoda. These two classes are economically important, and many of the gastropods are intermediate hosts of animal parasites.

Phylum Annelida

Freshwater oligochaetes and freshwater leeches are members of the phylum Annelida. They are worm-like, with metamerically segmented bodies and a true coelom. The body wall is soft and covered with a cuticle. The circulatory system is closed, and gas exchange occurs across the skin and gills. Freshwater oligochaetes are small, long and slender worms. They usually crawl on the bottom or burrow into the soft mud. Mostly oligochaetes are free-living, and feed on algae and detritus. They are an important food source for fishes.

Freshwater leeches are members of class Hirudinea. They have a fixed number of segments, usually 34, and typically they have both an anterior and a posterior sucker. Many leeches are carnivores on small invertebrates; some are parasite, sucking blood from vertebrate hosts.

Phylum Arthropoda

Arthropoda is the most diverse phylum of animals. They compose at least 75% of all known animal species on Earth. The body is covered with an exoskeleton secreted by epidermal cells. The exoskeleton is mainly chitinous and functions as protection, support and an aid to movement. It is hard and rigid, and is moulted at intervals to allow the animal to increase its body size. Body segments are grouped into tagmata such as the head and trunk, or the head, thorax and abdomen. Arthropods bear jointed appendages that are modified for specialized functions. The nervous, muscular, and respiratory systems are well developed. The body cavity is reduced to a hemocoel in the open circulatory system. Arthropods have successfully colonised all types of habitats. Freshwater arthropods include shrimps, crabs, water fleas, ostracods, isopods, amphipods, aquatic and semiaquatic insects, water spiders and water mites. Insects are the major component of macroinvertebrates in running water. Arthropods are a natural food source for large invertebrates and fishes. They are also used for human food and they have high economic value. Some aquatic insects are sensitive to environmental changes while others are very tolerant. Many are used as bio-indicators of water quality or environmental assessment.

The following key is to the phyla, classes and orders of major freshwater invertebrates. Keys to lower taxonomic levels of each phylum are available in following chapters.

KEY TO PHYLA, CLASSES AND ORDERS OF MAJOR FRESHWATER INVERTEBRATES

- 1 Body enclosed by a calcareous shell (Fig. 1, 2)
PHYLUM MOLLUSCA (snails, clams, mussels) 2 (p. 41)
- 1' Body not enclosed in a calcareous shell 3
- 2(1) Body in a single shell (Fig. 1) CLASS GASTROPODA (p. 54)
- 2' Body in two shell (Fig. 2) CLASS PELYCYPODA (p. 67)
- 3(1) Segmented body 10
- 3' Unsegmented body 4
- 4(3') Colonial animal covering the surface of submerged objects such as rocks, logs,
 twigs and plants, or on floating materials 5
- 4' Animals not sessile 6
- 5(4) Colony form a rough mat with pores on the surface (Fig. 3a); skeleton composed of
 spicules (Fig. 3b); gemmule formation usually occurs (Fig. 3c); colony found only
 on stable submerged objects
PHYLUM PORIFERA, (p. 19) CLASS DEMOSPONGIAE (freshwater sponges)
- 5' Colony form a thin layer on both stable and floating materials (Fig. 4a); animals
 with a lophophore (Fig. 4b)PHYLUM BRYOZOA, (p. 33) (moss animals)
- 6(4') With radial symmetry, with nematocysts particularly on tentacles (Fig. 5b); polyp
 form attached to substrates (Fig. 5a), medusa form floating (Fig. 6)
 PHYLUM CNIDARIA, (p. 23) CLASS HYDROZOA (Hydras, freshwater jelly fish)
- 6' With bilateral symmetry 7
- 7(6') Size usually between 100 and 500 μm ; anterior end with disc-like, with corona
 (Fig. 7); body shape ranges from spherical to linear, body divided into 3 regions:
 head, trunk and foot (Fig. 7)PHYLUM ROTIFERA (p. 27)
- 7' Larger size, visible to naked eye 8
- 8(7') Elongate flattened body; anterior part with a pair of eyespots; proboscis on ventral
 side of body (Fig. 8); gliding movement on rock surface or among wood debris.....
PHYLUM PLATYHELMINTHES, (p. 25) CLASS TURBELLARIA (flatworms, planaria)
- 8' Body not flattened 9

- 9(8') Length less than 5 cm; spindle-shaped and transparent (Fig. 9)
 PHYLUM NEMATODA (p. 29)
- 9' Length more than 5 cm; thread-like; anterior and posterior end rounded; often
 coiled (Fig. 10); brown colour PHYLUM NEMATOMORPHA (p. 31)
- 10(3) Body with obvious jointed legs PHYLUM ARTHROPODA... 14 (p. 75)
- 10' Body without obvious jointed legs 11
- 11(10') Body with some jointed appendages (Fig. 11)
 CLASS INSECTA (pupae or dipteran larvae)
- 11' Body with no jointed appendages (Fig. 12,13)..... PHYLUM ANNELIDA... 12 (p. 37)
- 12(11') With anterior and posterior suckers (Fig. 12); body without setae.....
 CLASS HIRUDINEA (leeches) (p. 38)
- 12' Without suckers; body worm-like..... 13
- 13(12') Body without lateral appendages; segments with fine setae
 (Fig. 13) CLASS OLIGOCHAETA
- 13' Body with lateral appendages, segments with long setae..... CLASS POLYCHAETA
- 14(10) With 3 pairs of jointed legs; one pair of antenna.....
 SUBPHYLUM UNIRAMIA, CLASS INSECTA
- 14' With more than 3 pairs of jointed legs; either no antenna or 2 pairs of antennae .. 15
- 15(14') Four pairs of jointed legs; lacking antennae.....
 SUBPHYLUM CHELICERATA, CLASS ARACHNIDA... 16
- 15' More than 4 pairs of jointed legs; with 2 pairs of antennae
 SUBPHYLUM CRUSTACEA (p. 79)
- 16(15) Body with two sections - prosoma and opisthosoma (Fig. 14)
 ORDER ARANEAE (water spiders)
- 16' Body with one section (Fig. 15) ORDER ACARINA (water mites)

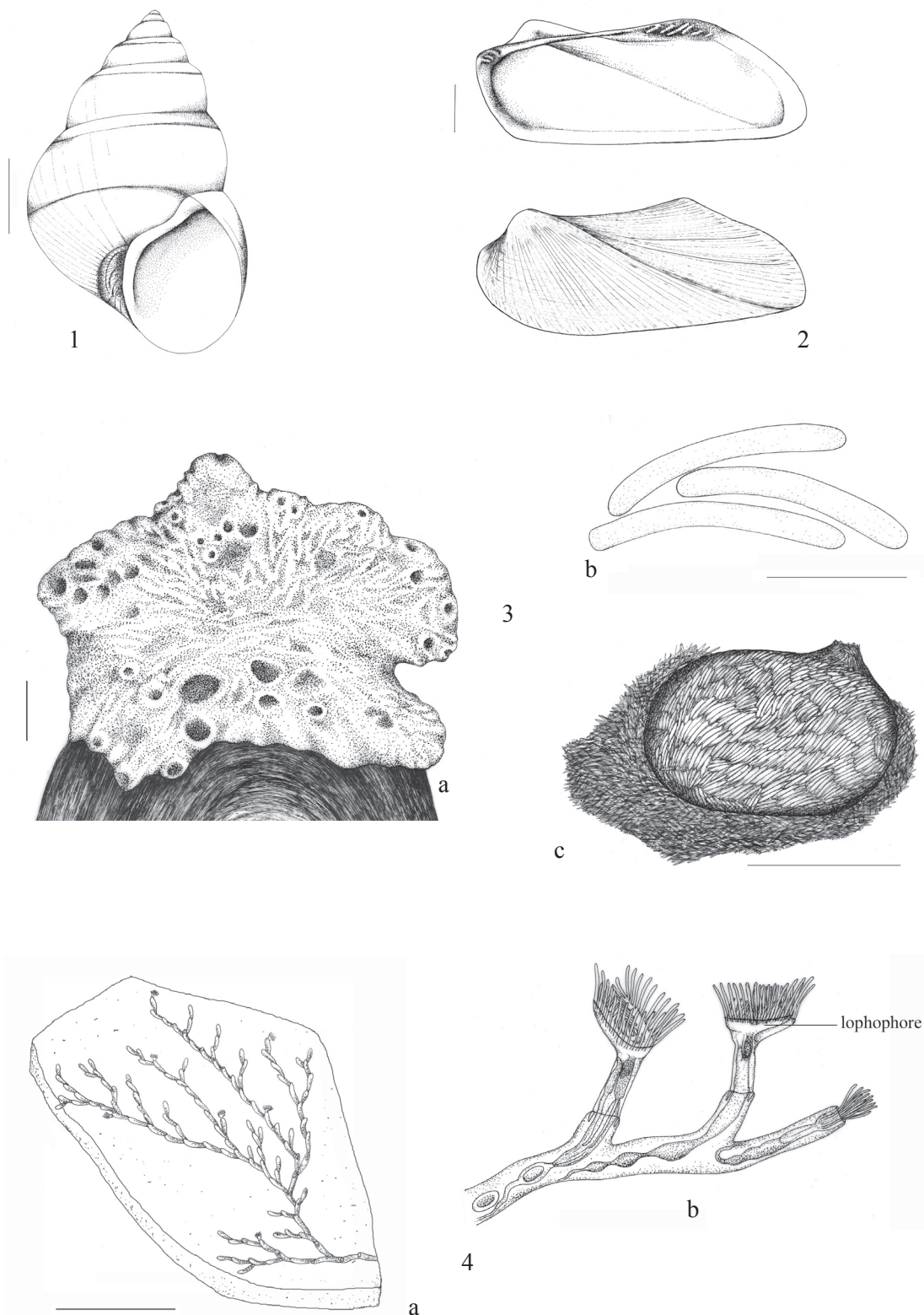


Fig. 1–4 1. Shell of gastropod (Gastropoda); 2. Shell of bivalve (Pelecypoda); 3. Colony form (a), spicule (b) and gemmule (c) of freshwater sponges; 4. Colonial form (a) and zooid (b) of freshwater bryozoan.
Scale: (3a) 5 mm; (1,2,4a) 1 mm, (3b,3c) 0.5 mm.

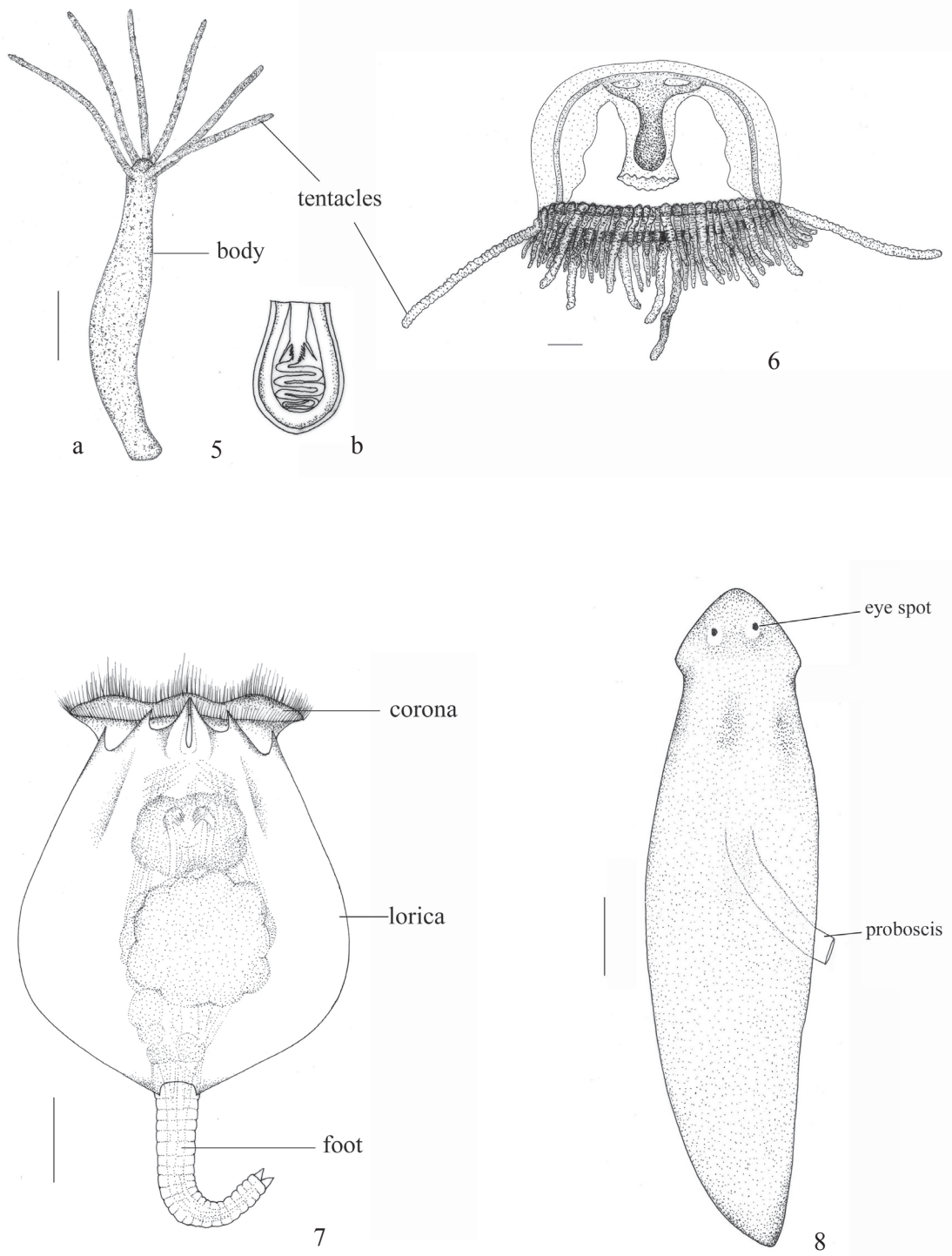
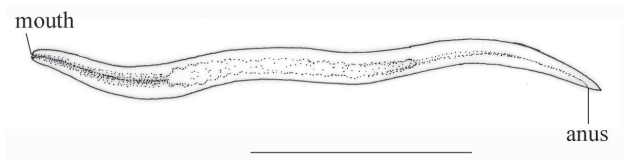
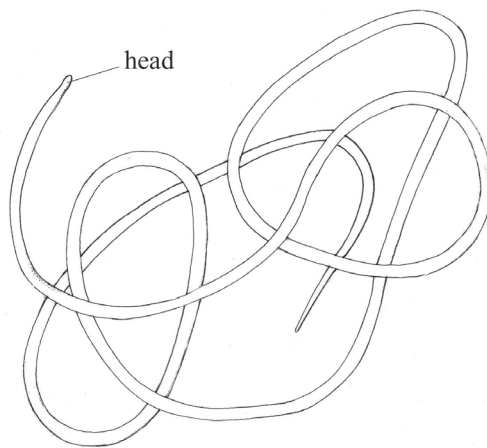


Fig. 5–8. 5. Structure of hydra (a) and nematocyst (b); 6. Freshwater jelly fish; 7. Structure of *Brachionus rubens* (Rotifera); 8. Dorsal view of planarian (Turbellaria).

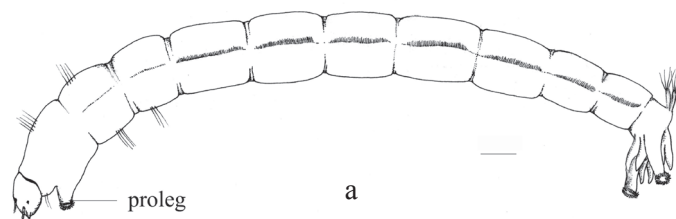
Scale: (6) 2 mm; (5,8) 1 mm, (7) 50 μ m.



9



10



11

Fig. 9–11 9. Structure of nematode (Nematoda); 10. Structure of horsehair worms (Nematomorpha); 11. Side view of chironomid larva (a) and pupa (b) (Chironomidae).
Scale: (10,11a-b) 1 mm; (9) 0.5 mm.

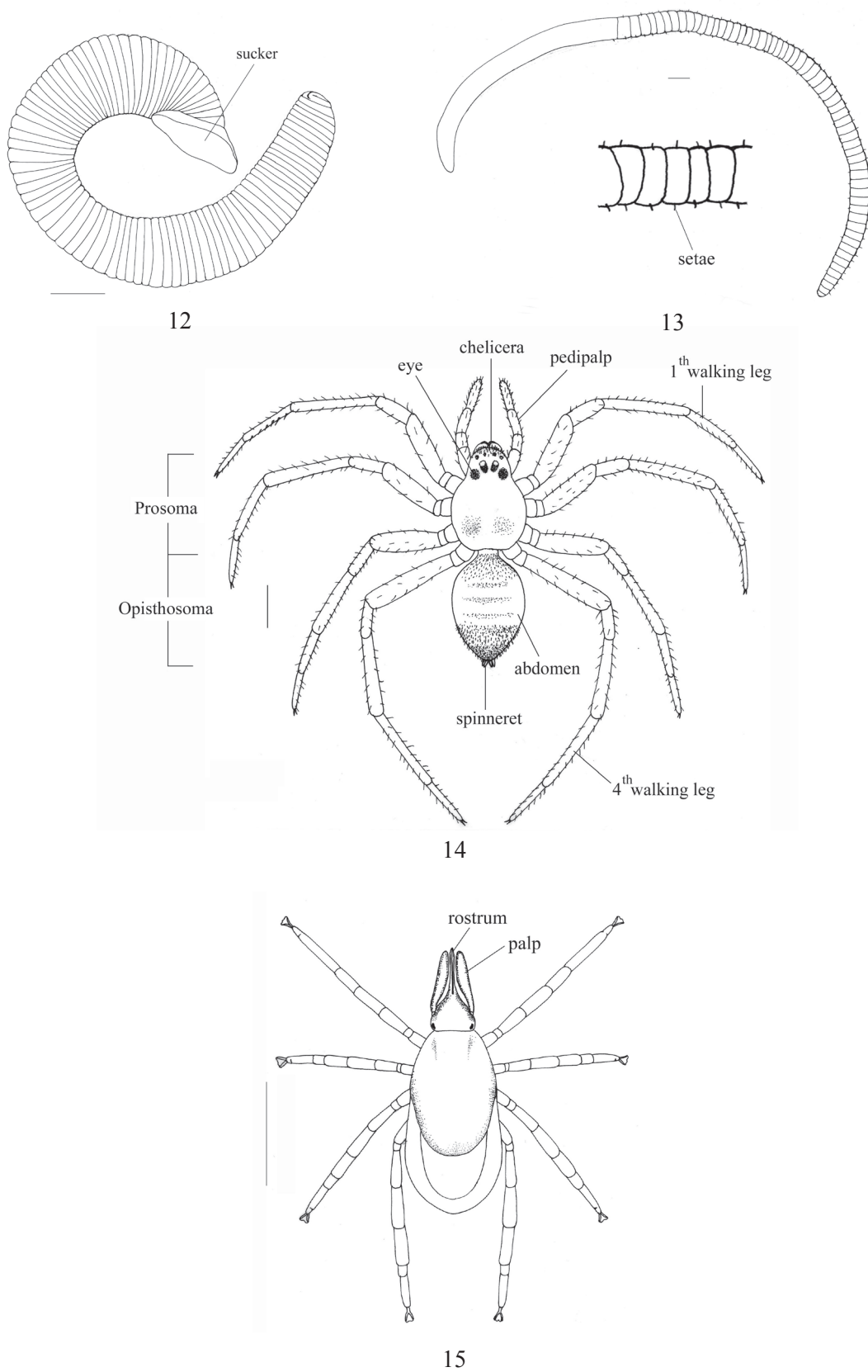


Fig. 12–15 12. Side view of leech (Hirudinea); 13. Side view of oligochaetes (Oligochaeta); 14. Dorsal view of spiders (Araneae); 15. Dorsal view of water mites (Acarina). Scale: (12) 5 mm; (13,14,15) 1 mm.