

## Chapter 13 The Aquatic and Semiaquatic Insect Orders

Collembola includes ametabolous insects that show many embryological features in common with the myriapods. While Collembola is no longer considered to be a member of the class Insecta it has always been included in Entomology textbooks. In the present study, we treat collembolans as semiaquatic insects.

There are 13 Orders of aquatic and semiaquatic insects. Excepting Collembola, the others can be divided into two groups based on individual development. **Hemimetabolous** insects are groups of insects in which the external form of the immature stages (nymphs) gradually approaches, through a series of instars, the form of the adults. They are also called **exopterygotes** because wing buds develop externally and are clearly visible throughout the nymphal stages. The last nymphal stage resembles the adult very closely but is not sexually mature. Hemimetabolous insects include five orders: Ephemeroptera, Odonata, Plecoptera, Orthoptera and Hemiptera. The other group is the **holometabolous** insects, in which the immature stages (or larvae) do not resemble the adults. Metamorphosis is complete from egg to larval, pupal and adult stages. In the pupal stage there is a marked change in external appearance. The development of wing buds takes place internally, so they are called **endopterygotes**. There are seven orders: Megaloptera, Neuroptera, Coleoptera, Diptera, Lepidoptera, Trichoptera and Hymenoptera.

Among the 13 aquatic and semiaquatic insect orders, stoneflies (order Plecoptera) exhibit basic morphological features of insects. So, they are ideal for illustrating the general external morphology of insects.

The body is divided into three major tagmata: **head, thorax and abdomen**. The head is the centre of sensation and ingestion. The sensory organs are the compound eyes, ocelli (simple eyes) and antenna (Fig. 1a). The basic chewing mouthparts consist of labrum (the upper lip), mandible, maxilla and labium (the lower lip) as shown in Fig. 2.

The thorax has three segments: prothorax, mesothorax and metathorax. It is the centre of locomotion. Each segment bears a pair of jointed legs. In Exopterygota, there are pair of developing wing pads on the meso- and metathoracic segments respectively. Larvae of Diptera lack jointed legs but may have one or more fleshy prolegs (Fig. 16). The jointed legs have five segments, including coxa, trochanter, femur, tibia, 1-5 subsegments of the tarsus and one or two claws at the end of the tarsus (Fig. 3). Gills may be present on the thoracic segments.

The abdomen is the centre of digestion, circulation and respiration. Stoneflies have ten abdominal segments, but some insects may have eight or nine segments. The abdomen of immature insects may bear various paired lateral appendages such as gills, prolegs and various projections. The last abdominal segment bears an anus. Mature nymphs of Ephemeroptera, Hemiptera, Odonata and Plecoptera bear the developing reproductive structures and a pair of cerci (Fig. 1b) at the end of the abdomen. These structures may be visible as a mid-dorsal supra-anal process and epiprocts and a pair of ventral paraprocts.

In Coleoptera and Hemiptera both immature and adult stages are aquatic, but in the other orders only the immatures are aquatic. Thus, keys for both the immature and adult stages of Hemiptera and Coleoptera have been constructed, whereas for the other 11 orders there are only keys to immature stages.

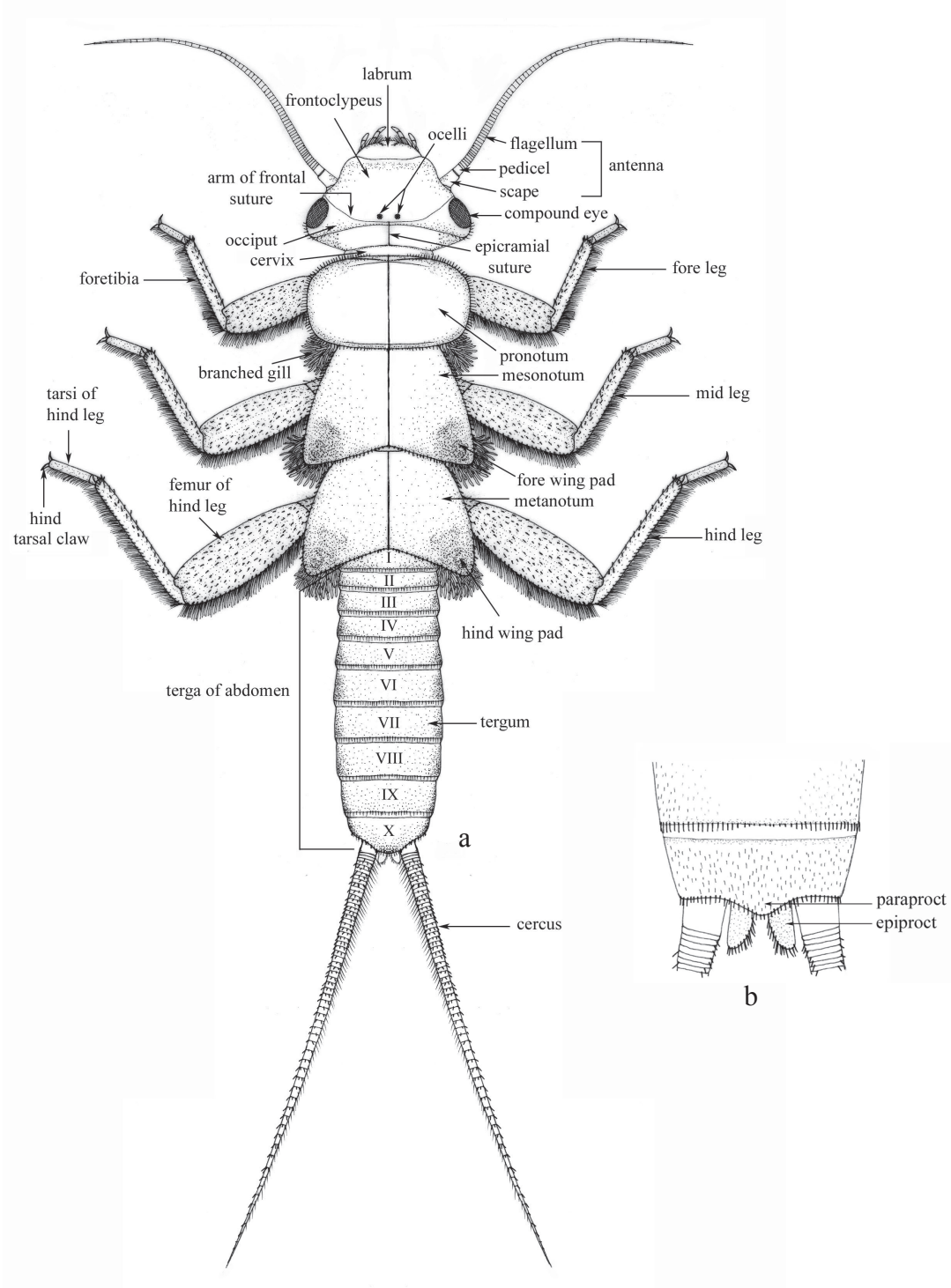


Fig. 1 Dorsal view (a) and ventral view of posterior end (b) of *Etrocorema nigrogeniculatum* nymph (Plecoptera, Perlidae).

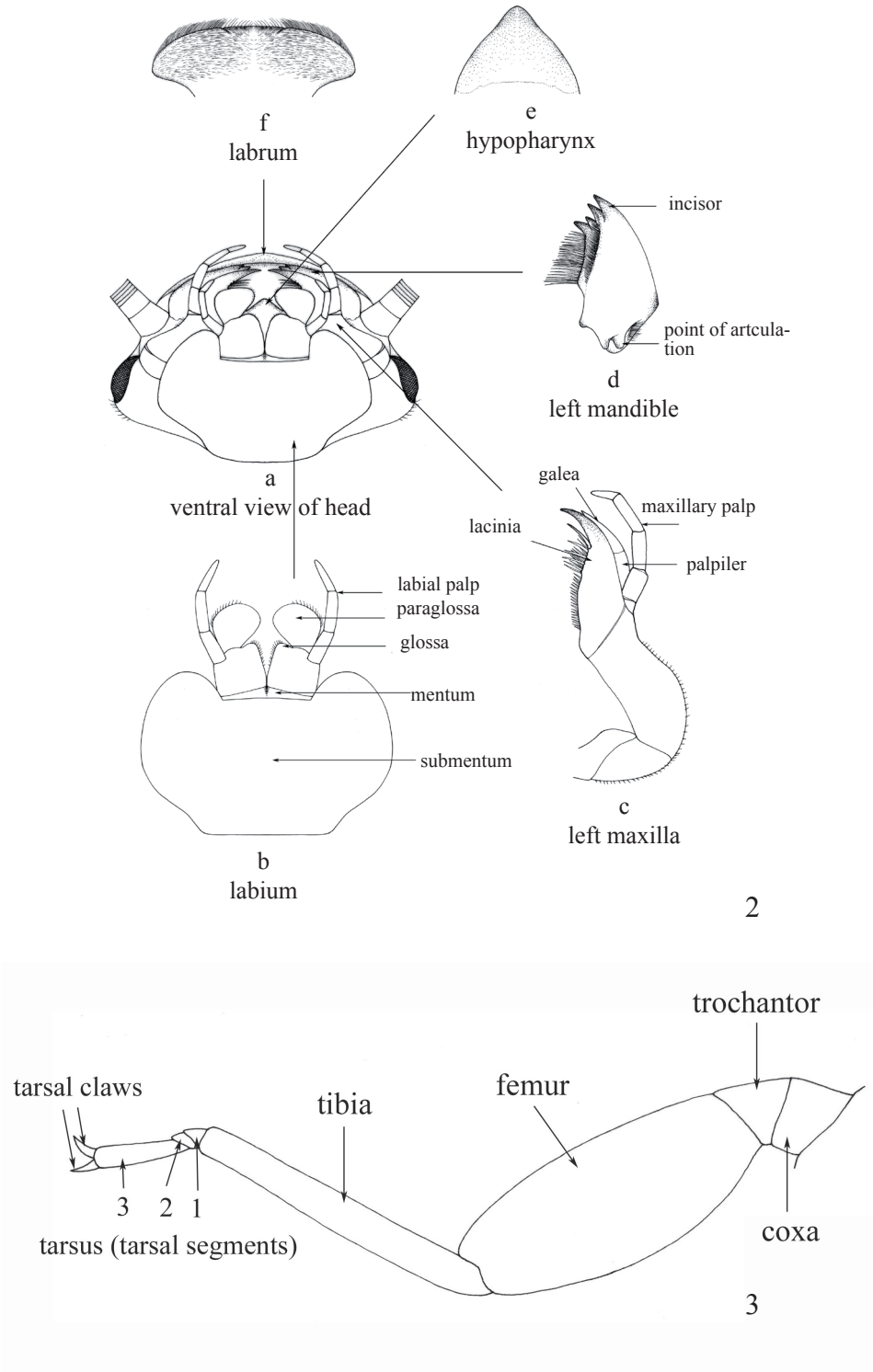


Fig. 2-3 2. Ventral view of head and mouthparts of *Etrocorema nigrogeniculatum*. nymph: a, ventral view of head; b, labium; c, left maxilla; d, left mandible; e, hypopharynx; f, labrum; 3. Hind leg of *Etrocorema nigrogeniculatum* nymph showing segments

*KEY TO AQUATIC INSECTS AND SEMIAQUATIC ORDERS OF INDOCHINA*

- 1 Body is in cocoon or body mummy-like; legs, wings and antennae fused or pressed against the body wall (Fig. 4) ..... pupa
- 1' Body is not in ocoon..... larvae... 2
  
- 2(1') Small insects, usually 1-2 mm; 4-6 abdominal segments, with forked spring apparatus under abdomen (Fig. 5) ..... COLLEMBOLA (springtails) (p. 101)
- 2' Large insects (usually); never with the forked spring-like apparatus..... 3
  
- 3(2') Head with piercing mouth-parts (Fig. 6) ..... HEMIPTERA (bugs) (p. 147)
- 3' Head with chewing mouthparts (Fig. 2) ..... 4
  
- 4(3') Wing buds present on thoracic segments (Fig. 9) ..... 5
- 4' Wing buds absent..... 8
  
- 5(4) Femur of hind legs enlarged and modified for jumping (Fig. 7a) (except BLABERIDAE (Fig. 7b); shore insects.....ORTHOPTERA (p. 135) (mole crickets and grass hoppers)
- 5' Hind legs normal shape and size; true aquatic insects..... 6
  
- 6(5') Elbowed mask-like labium covering mouth.....  
 ..... (Fig. 8) ODONATA (p. 125) (damselflies and dragonflies)
- 6' Mouth not covered by a mask-like labium ..... 7
  
- 7(6') Legs with a single tarsal claw, usually with 3 terminal filaments (Fig. 9) (rarely 2 filaments) .....EPHEMEROPTERA (p. 103) (mayflies)
- 7' Legs with two tarsal claws, 2 terminal filaments (Fig. 10).....  
 ..... PLECOPTERA (stoneflies) (p. 137)
  
- 8(4') Thoracic segments with 3 pairs of segmented legs (Fig. 11,12,13,14)..... 9
- 8' Segmented legs absent on thoracic segments (Fig. 16)..... 12
  
- 9(8) Fleshy legs with tiny hooks (crotchets) on the abdomen (Fig. 11).....  
 ..... LEPIDOPTERA (p. 213)
- 9' Without fleshy hook-bearing legs present on the abdomen..... 10
  
- 10(9') With 7-8 pairs of lateral abdominal gills; end of abdomen with 4 claws or a single terminal filament (Fig. 12)..... MEGALOPTRA and NEUROPTERA (p. 179)
- 10' Without gills or with dorsal or ventral abdominal gills; end of abdomen without claws or with 2 claws..... 11

- 11(10') End of abdomen with a pair of lateral hooked claws and prolegs (Fig. 13a); antenna 1 segment and usually very short (Fig. 13b).....TRICHOPTERA (caddisflies) (p. 181)
- 11' End of abdomen usually without hooked claws (Fig. 14a); antenna with more than 1 segment (Fig. 14b).....COLEOPTERA (beetles) (p. 217)
- 12(8') Larva headless, legless, body less than 2 mm; pupa up to 5 mm (Fig. 15a); both larva and pupa living as parasites inside insect eggs or insect bodies; producing a long ribbon that extend outside the case of host (Fig. 15b).....  
..... HYMENOPTERA (parasitic wasps) (p. 229)
- 12' Head and body vary (Fig. 16); free living ..... DIPTERA (true flies) (p. 231)

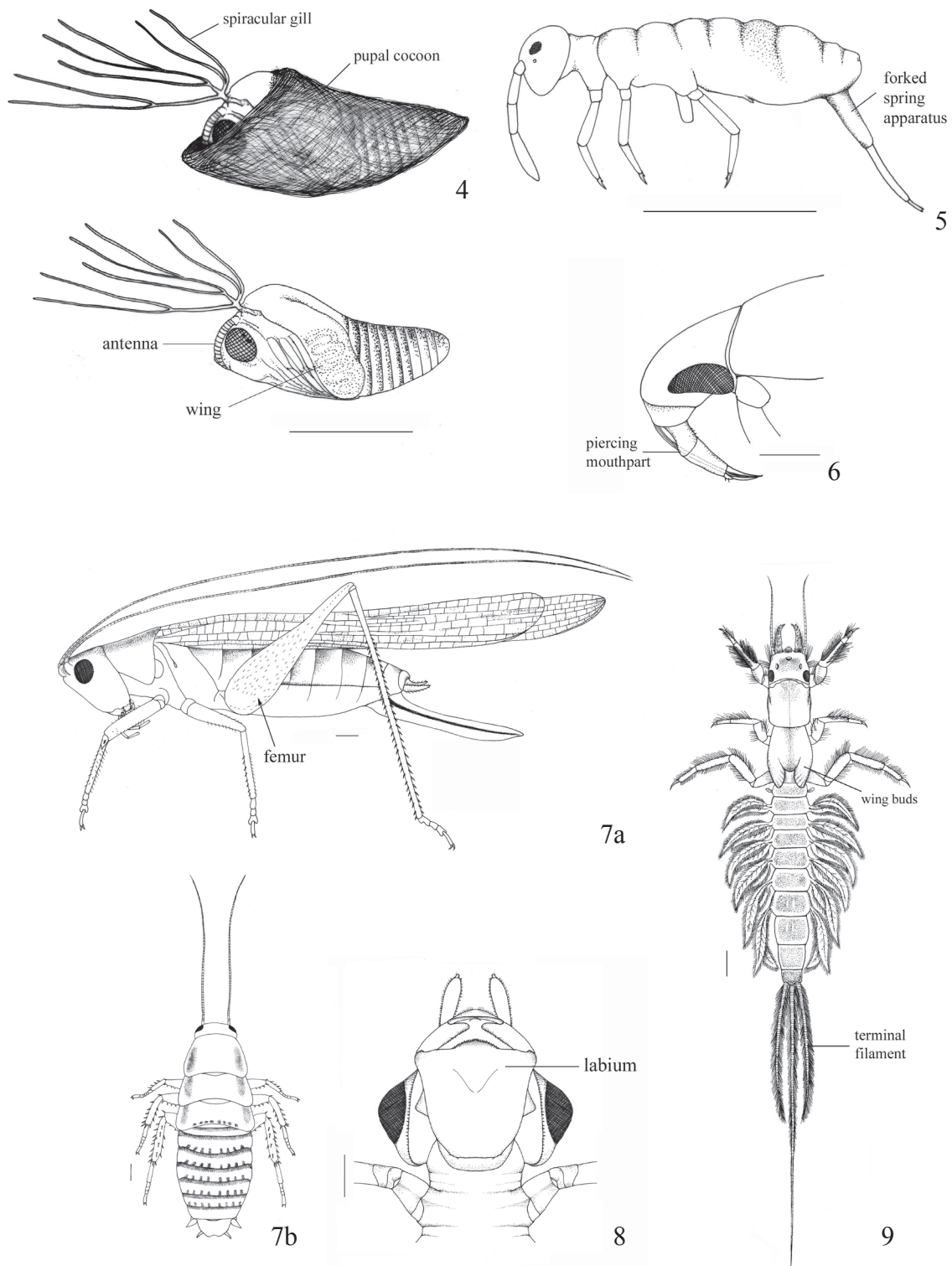


Fig. 4-9 4. Pupa of Simuliidae (Diptera); 5. Side view of springtail (Collembola); 6. Side view of head of Belostomatidae (Hemiptera); 7. Lateral view of female katydids (a) and dorsal view of Blaberidae (b) (Orthoptera); 8. Ventral view of head of Gomphidae (Odonata); 9. Dorsal view of nymph of Polymitarcyidae (Ephemeroptera).  
Scale: (4,6,7,8,9) 1 mm; (5) 0.5 mm

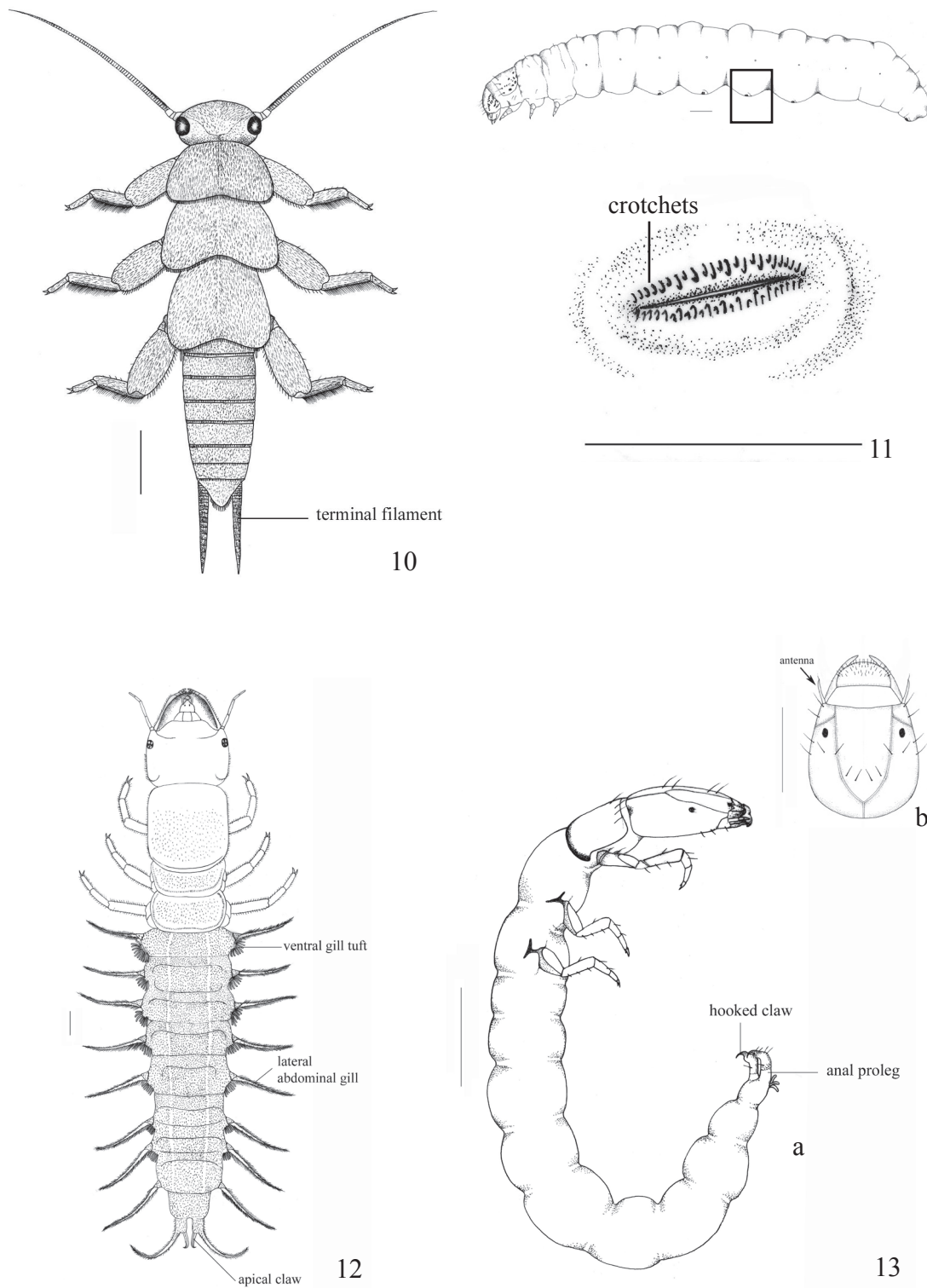


Fig. 10-13 10. Dorsal view of nymph of Peltoperlidae (Plecoptera); 11. Crotchets on proleg of *Elophila* sp. (Lepidoptera); 12. Dorsal view of larva of *Protohermes* sp. (Megaloptera); 13. Side view of Philopotamidae larva (a) and dorsal view of head of Leptoceridae larva (b) (Trichoptera). Scale: (10,12,13) 1 mm; (11) 0.5 mm.

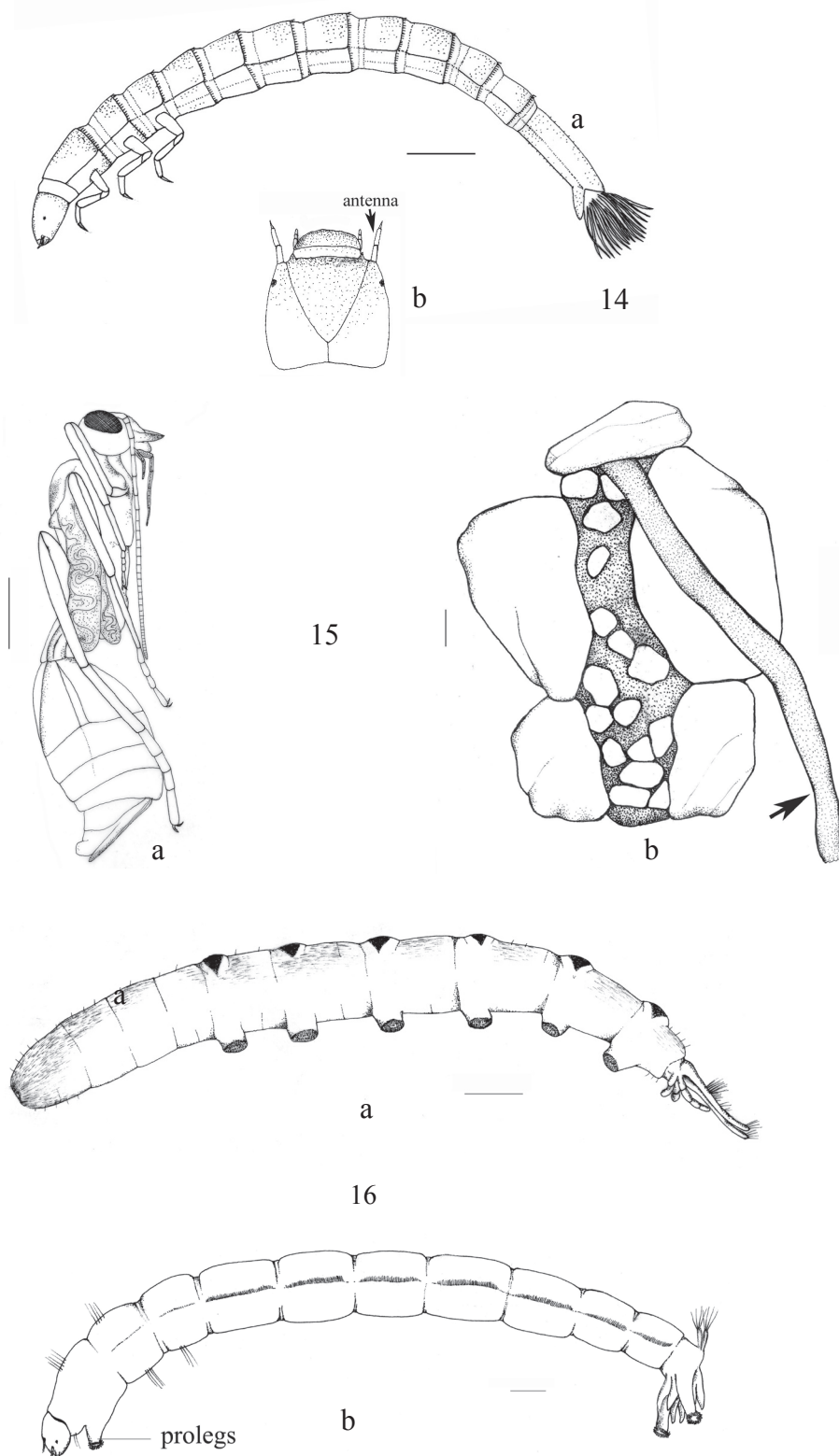


Fig. 14-15 14. Side view of larva (a) and dorsal view of head (b) of Elmidae (Coleoptera); 15 Pupa (a) of aquatic parasitoid (Hymenoptera), that has been removed from the pupalcase (b) of Goerid caddisfly and respiratory ribbon produced by the parasitoid; 16. Lateral view of tipulid (a) and chironomid larvae (b) (Diptera). Scale = 1 mm.