Chapter 3

Order Ephemeroptera

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ORDER EPHEMEROPTERA

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INTRODUCTION

Mayflies comprise a small order of insects, with approximately 3500 species, 450 genera, and 42 families (numbers updated based on Sartori & Brittain, 2015). The Neotropical realm, even with a relatively few families (16) is the most diverse in terms of genera and species (130 and 820, respectively). These numbers, however, increased exponentially in the last 10 years (Domínguez et al., 2014; Cardoso et al., 2015) and many species and probably some genera remain to be described. Cardoso et al. (2015), for example, predicted more than 11,000 species to occur Brazil alone, although their predictive model is possibly biased by the recent increase in species descriptions. Da-Silva & Salles (2012), on the other hand, estimated 600 undescribed species for the same country, while Sartori & Brittain (2015) estimate 1,000 undescribed species worldwide.

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The systematics of Ephemeroptera, and consequently the classification of this order, need a major revision. Based on morphology (McCafferty & Edmunds, 1979; McCafferty, 1991; Kluge, 2004), molecular evidence (Ogden & Whiting, 2005), and combined data (Ogden et al., 2009), several efforts have been made attempting to uncover the relationship among mayfly families. Despite that, higher classification of mayflies is still a matter of debate (Sartori & Brittain, 2015). While some historical groups were recovered by Ogden et al. (2009) (e.g., Furcatergalia, Fossoriae, Pannota), others were not supported as monophyletic (e.g., Setisura and Pisciforma), as a consequence, we avoid the use of taxa above the family group.

LIMITATIONS

There are several existing keys to South and Central American Ephemeroptera, but none so far that can be used for the whole Neotropical region. The first reliable keys that could be used for the region were in the "Mayflies of North and Central America" by Edmunds et al. (1976). It was intended for North and Central America, but included several genera with a distribution going well into the Neotropical region. Valuable as it was, it is now very outdated. The first generic keys for nymphs and adults made especially for continental South America were published by Domínguez et al. (1992). Since then, several versions and improvements (with different authors were published (Domínguez et al., 1995, 2001, 2006, 2009). With regards to specific keys, Heckman published in 2002 a book on South American Ephemeroptera, which unfortunately was plagued with errors (see Peters, 2007). More recently, Domínguez et al. (2006) published the book *Ephemeroptera of South America*, which included keys for genera and species and descriptions of all the known species for the region. Since its publication, around 20 genera and 180 species were described, so its keys must be used with caution. With regards to Central America, the chapter Ephemeroptera by Flowers & De la Rosa in the book *Macroinvertebrados de Costa Rica*, published in 2010, included generic keys for the nymphs recorded in the region. Finally, although outdated, Peters published in 1971 generic and specific keys for the Ephemeroptera of the Caribbean. The nymph keys provided here allow for the first time the determination of all known Neotropical mayfly genera. Nevertheless, it must be kept in mind that there are still several undescribed genera and species.

TERMINOLOGY AND MORPHOLOGY

Head: Variable in shape, but in general aspect similar to the head of most mandibulate insects. Compound eyes are well developed and located above the gena; in flattened nymphs they are very close to the posterolateral corners. Three ocelli, forming a characteristic triangle, are present on the vertex. An ecdysial inverted Y line, or epicranial suture, is also present on the vertex. Lateral ocelli are inserted above or at the end of the frontal suture. The filiform antennae are variable in length, from short (shorter or as long as the head capsule) to very long (longer than the body). Mouthparts are oriented anteriorly (prognathous) or ventrally (hypognathous), they are extremely important for distinguishing genera and species and bear the typical elements of the chewing type. The clypeus-labrum, forming the upper lip (clypeus can be fused to the frons in some taxa, e.g. Leptophlebiidae). The heavily sclerotized mandibles, consisting of outer and inner incisors, prostheca, and a molar area. Mandibular tusks, variable in length and armature, are present in some taxa. The maxillae is composed by the basal cardo and stipes and by the apical galea-lacinia, an area formed by the fusion of these two lobes. Denticles (also referred to as canines) and usually two rows of setae, variable in quantity and length, are present at the inner apex of the galea-lacinia. Three- or two-articulate maxillary palpi are present at the outer apex of the stipes. The labium is composed by the submentum, connected to the head, and the mentum, which bears the glossae, paraglossae (sometimes fused to each other) and the three-articulate labial palpi. Between mandibles and maxillae lies a pair of superlinguae and a central hypopharynx. Besides eyes and appendages, tubercles, or projections may be present on the dorsal surface of the head.

Thorax: Pronotum generally small in the shape of a transversal rectangular plate, well defined. Mesonotum and metanotum fused, not well distinguishable, bearing the wing pads (sometimes the hind wing pads are very small to absent). Wing pads may be fused to each other in varying degrees, and in the last stages the venation of the adult wing may be recognized. At the final period of the last larval stage, the developing wing folds inside the wing pad and wing characters turn out unobservable. The thorax has three distinct segments: the pro-, meso-, and the metathorax. Pleurae formed by small plates and membranous areas with little use in taxonomy, sterna with varying structure, sometimes with strong setae, or membranous gills arising from membranous areas between coxae and other thoracic sclerites. The main characters used in systematic are in the legs. The legs always present include coxae, trochanter, femur, tibia, uniarticulate tarsus, and single tarsal claw. Coxae and trochanter may show dorsal projections or membranous gills. Femora are the more complex structures showing many useful characters: general shape, setation on dorsal, and ventral surfaces, and on leading and posterior edges, presence of tubercles or projections, long food filtering setae, etc. Tibia and tarsus are generally long cylindrical or flat, sometimes strongly flattened in burrowing nymphs, with spurs or projections on distal apex, with varying setation mainly arranged as longitudinal rows on inner and outer margins. Tarsus are uniarticulate (except in one Chinese genus), and bears an apical large claw, with variable shape and denticulation. Denticles on tarsal claw, when present, are generally arranged in a longitudinal row along inner margin

(marginal denticles), sometimes are located on distal third and just at the side of the margin (submarginal subdistal denticles). In the legs, the thicker setae may be referred as "spines" or "chalaza." The structure and morphology of the legs are generally related to their habits: swimming, crawling, clinging, burrowing, filtering food, and gill protection.

Abdomen: Formed by 10 distinct segments, the long median filament (or terminal filament) is interpreted as derived from the 11th abdominal segment. The long distal cerci at each side of the terminal filament are the modified appendages of the 10th segment. All three caudal filaments are movable, annulated, and setated throughout their length. Abdominal segments are formed by two plates (the notum and the sternum); pleura has the form of a thin membrane separating them. Abdominal nota generally have spines, scales, and setae of systematic importance; the posterior margin may be denticulated, serrated, or smooth. Tubercles may be present on some nota, they may be median and single, or paired submedian. The lateral margins of abdominal nota form flanges in some groups, generally these flanges protect the gills from below, or more rarely are curved upwards forming a gill basket. Also the posterolateral corners of the segments are spiniform projecting in some groups forming posterolateral acute projections (or posterolateral spines). Segments I to VII generally bears the tracheal gills (one arising at each posterior corner), in some fossils gills even reached the IXth segment. Gills arise laterally or dorsolaterally in most groups but some have modified gills arising dorsally or even ventrally. Gills form the main surface to dissolved gas exchange, and thus are generally much more developed in groups inhabiting oxygen poor habitats. The abdominal tracheal gill is formed by a dorsal and a ventral thin cuticular layer with the trachea inside, showing different patterns of ramification and coloration. In most families each gill is formed by two lamellae, a dorsal and a ventral one, with many important characters including their shape, presence of filaments, number of tracheae, etc. Some groups show single laminate gills (formed by just one lamellae), for example the large family Baetidae, sometimes these gills are folded seeming composed by more than one lamella (e.g., *Callibaetis*). Gills are named after their respective segment, from I to VII, and sometimes in the keys (Leptohyphidae) the number of lamellae present in each gill is given as a "gill formula," for example 2/3/3/3/1, meaning that the first gill (in Leptohyphidae is the gill II) is formed by two lamellae, the following gill III is formed by three lamellae, and so on. Finally, paraprocts may be of importance for some groups (mainly Baetidae), these are paired small sclerited surrounding the annus and bearing different number of spines. The long cerci arise dorsally to the paraprocts, and bear setae of different length and thickness, in a similar form to the terminal filament.

MATERIAL PREPARATION AND PRESERVATION

The best way to preserve mayfly nymphs is to fix them in 80% ethanol, although molecular studies often require specimens preserved in 95% alcohol and stored in the refrigerator. In the field, and after that if necessary, ethanol must be replaced every time it becomes yellowish. They are fragile, especially antennae, legs, and gills, thus air bubbles must be removed from the vials during sample transportation from the field to the laboratory. For the identification of the nymphs at generic and specific levels, specimens must be dissected and mounted with body parts on slides. The slides can be mounted on permanent medium, with Euparal or Canada balsam, or on nonpermanent medium, with glycerin or alcohol gel. Then, the structures can be visualized in compound light microscope. For the preparation of slides, fine forceps and stylets are essential. Structures such as antennae, mouthparts, legs, abdominal segments, gills, paraprocts, and filaments are the most important and, therefore, are usually mounted on slides. These structures can be mounted on the same slide, but in distinct areas with their own cover glass, or in different slides when nymphs are too large.

KEYS TO THE ORDER EPHEMEROPTERA

Ephemeroptera: Families

1	Mandibular tusk present (Figs. 3.3, 4 A, 5 A); gills II–VII lanceolate, forked and with fringed margins (Fig. 3.3)	2
1'	Mandibular tusk absent (Figs. 3.6, 7 A, 10–20); gills II–VII variable (Figs. 3.10–20)	4
2(1)	Mandibular tusk usually shorter or as long as head, curved medially close to apex in dorsal view (Figs. 3.4 A, 5 A); fore tibia without distomedial spine (Figs. 3.4 B, 5 B); gills II to VII held dorsally	3
2'	Mandibular tusk distinctly longer than head, curved medially from base to apex in dorsal view (Fig. 3.3); fore tibia with distomedial spine (Fig. 3.23); gills II to VII held laterally (Fig. 3.3)	**Euthyplociidae [p. 66]**
3(2)	Tusks down curved to straight (Fig. 3.4 A); base of tusk with double row of filtering setae (Fig. 3.4 A); fore tibia and tarsus fused (Fig. 3.4 B), apex of hind tibia without an acute point (Fig. 3.4 C)	**Polymitarcyidae [p. 67]**
3'	Tusks upcurved (Fig. 3.5 A); base of tusk without double row of filtering setae (Fig. 3.5 A); fore tibia and tarsi not fused (Fig. 3.5 B), hind tibia end in an acute point (Fig. 3.5 C)	Ephemeridae, one genus: *Hexagenia*
4(1')	Fore leg, at least, with rows of filtering setae (Figs. 3.6, 7, 8 B)	5
4'	Fore leg without rows of filtering setae (Figs. 3.10–14, 16–20)	7

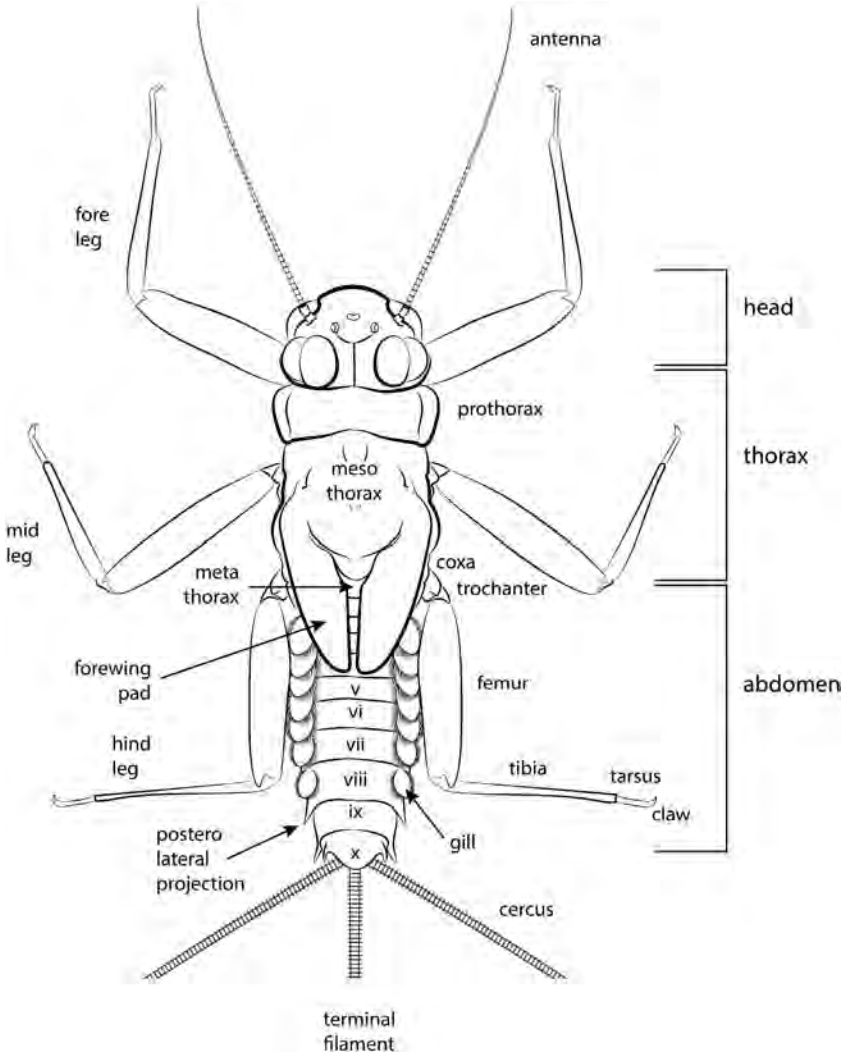

FIGURE 3.1 Schematic representation of a mayfly nymph in dorsal view. *Roman numbers* represent abdominal segments.

5(4)	Gills present (Fig. 3.7); fore legs only with filtering setal rows (Figs. 3.7 B, 8 B) 6
5'	Gills absent (Fig. 3.6); fore and mid legs with filtering setal rows (Fig. 3.6) ..... Coloburiscidae, one species *Murphyella needhami* Lestage [Andean-Patagonic Region]
6(5)	Gill I dorsal (Fig. 3.7 A); base of fore coxa with branched gills (Fig. 3.7 B) ..... Isonychiidae, one species *Isonychia sicca* (Walsh) [Neotropics]
6'	Gill I ventral (Fig. 3.8 A); base of fore coxa without gills (Fig. 3.8 B) ..... **Oligoneuriidae [p. 68]**
7(4')	Opercular gill present (Figs. 3.9–13) 8
7'	Opercular gill absent (Figs. 3.14, 16–20) 12
8(7)	Gill II opercular (gill I reduced or absent) (Figs. 3.10–13); terminal filaments without secondary swimming setae (primary setae sometimes present) 9
8'	Gill I opercular (Fig. 3.9); terminal filaments with primary and secondary swimming setae (i.e., row of setae present on inner and outer margin) ..... Onsicigrastridae, *Siphlonella ventilans* Needham & Murphy [Andean-Patagonic Region]
9(8)	Gill I absent (Figs. 3.11–13); operculate gill without dorsal forked crest (Figs. 3.11–13) 10
9'	Gill I present, filiform (Fig. 3.10); operculate gill with dorsal forked crest (Fig. 3.10) ..... **Caenidae [p. 69]**
10(9)	Head anterior margin never densely bordered with setae (Figs. 3.12, 13); femora of fore and mid legs usually not dilated (Figs. 3.12, 13); abdominal tubercles usually absent (if present usually single, except in some species of *Leptohyphes*) (Figs. 3.12, 13) 11
10'	Head anterior margin densely bordered with setae (Fig. 3.11 A); femora of all legs dilated (Fig. 3.11); abdominal tubercles present, paired (Fig. 3.11) ..... Melanemerellidae, one species: *Melanemerella brasiliana* Ulmer [Atlantic Forest]
11(10)	Posterolateral projections of gill bearing segments bent dorsally, forming a gill chamber (Fig. 3.12); tubercles present on all tagma (Fig. 3.12) ..... Coryphoridae, *Coryphorus aquilus* Peters [Mostly restricted to the Amazon]

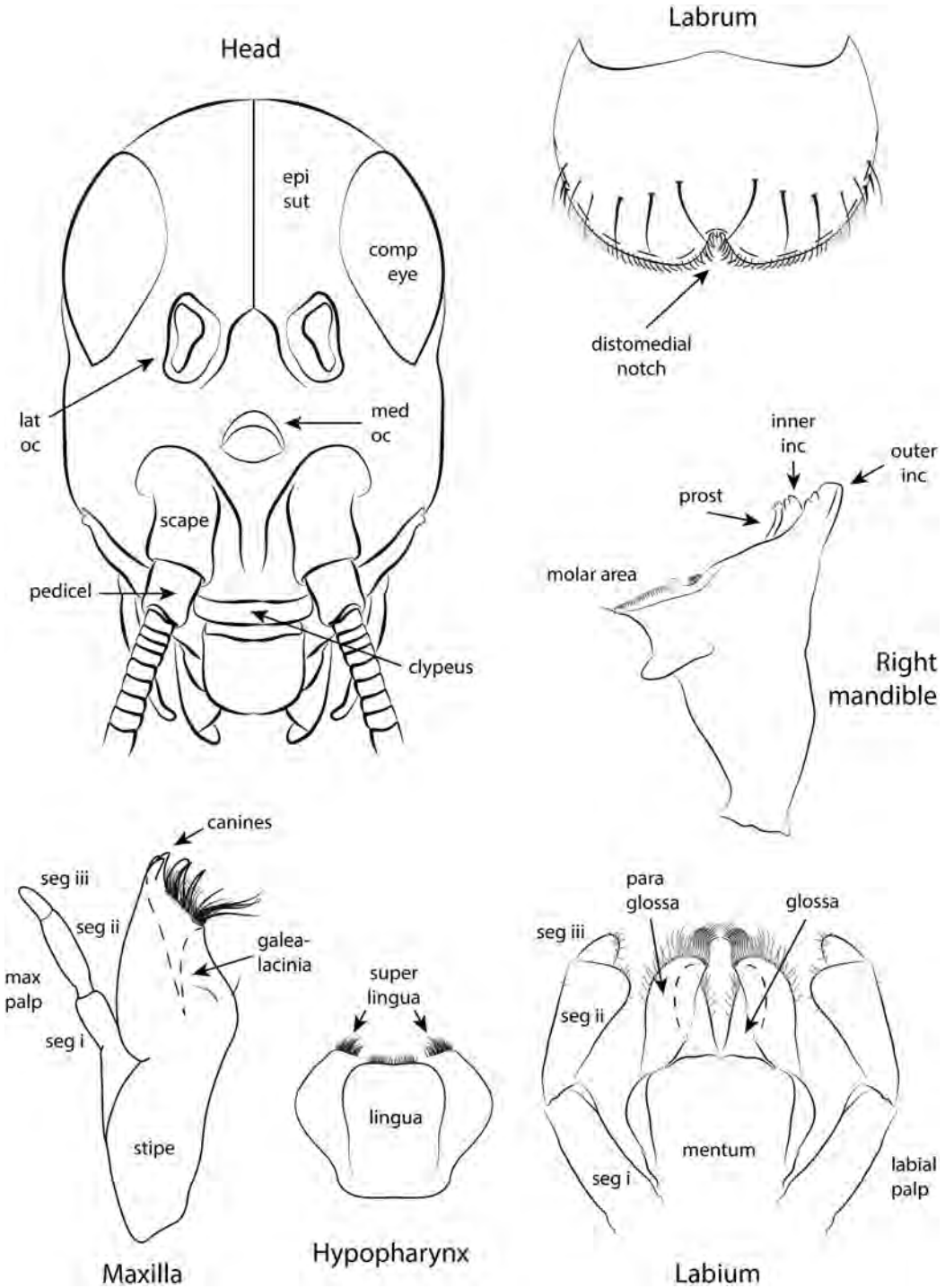

FIGURE 3.2 Schematic representation of a mayfly head (frontal view) and mouthparts. Abbreviations as follows: head (*comp eye*, compound eye; *epi sut*, epicranial suture; *lat oc*, lateral ocellus; *med oc*, median ocellus); right mandible (*outer inc*, outer incisors; *inner inc*, inner incisors; *prost*, prostheca); maxilla (*max palp*, maxillary palp; *seg i, ii, and iii*, maxillary palp segments i, ii, and iii); labium (*seg i, ii, and iii*, labial palp segments i, ii, and iii).

11’	Posterolateral projections of gill bearing segments not upcurved to form gill chamber (Fig. 3.13); tubercles usually absent, when present restricted to one or two tagma (except *Loricyphes*) (Fig. 3.13).....	**Leptohyphidae [p. 79]**
12(7’)	Head never enlarged (may be wide, but flat in this case) (Figs. 3.15–21 A, 22 A); maxillary and labial palpi with two or three articles … 13	
12’	Head enlarged (Fig. 3.14); maxillary and labial palpi multiarticulate..... [Andean-Patagonian region]	**Ameletopsidae [p. 83]**

FIGURE 3.3 Dorsolateral view of a nymph of *Campylocia* (Euthyplociidae).

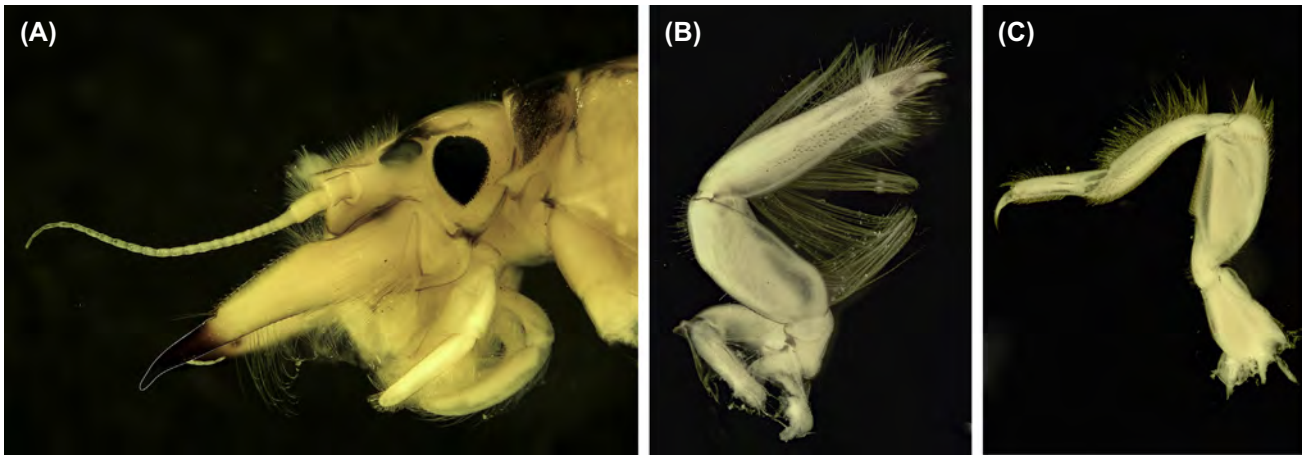

FIGURE 3.4 Nymphal structures of *Tortopsis* (Polymitarcyidae): (A) head (lateral view); (B) fore leg; and (C) hind leg.

13(12)	Body usually depressed, head prognathous (body hydrodynamic in some Leptophlebiidae) (Figs. 3.16, 17); gills with dorsal and ventral lamella (Figs. 3.16, 17) 14
13'	Body hydrodynamic, pisciform (Figs. 3.19, 20); gills with a single lamella (folds, however, may be present) (Figs. 3.19, 20)..... 15
14(13)	Mandibles and labrum visible in dorsal view (Fig. 3.15) ..... **Leptophlebiidae [p. 88]**
14'	Mandibles and labrum concealed by head in dorsal view (Fig. 3.18)..... **Heptageniidae [p. 86]**
15(13')	Epicranial suture with lateral branch located below lateral ocelli (Fig. 3.21 A); distal lobe of femora ventrally oriented (Fig. 3.21 B). ..... **Baetidae [p. 107]**
15'	Epicranial suture with lateral branch located on or above lateral ocelli (Fig. 3.22 A); femora without a distal lobe (Fig. 3.22 B) ..... Nesameletidae, one species: *Metamonius anceps* (Eaton) [Andean-Patagonic Region]

Euthyplociidae: Genera

Modified from Domínguez et al. (2006). The most diversified Neotropical genus is *Campylocia*, with five species (Gonçalves et al., 2017). They are the largest living mayflies, with body lengths reaching up to 35 mm (Edmunds et al., 1976). Euthyplociidae nymph do not burrow, they are crawlers and live under rocks or among pebbles and leaf packs in areas with slow to intermediate current of streams.

1	Antenna distinctly longer than tusk; fore tibial projection length ~1/2−1/3 tarsus (Figs. 3.23 A, B) 2
1'	Antenna length shorter or subequal to tusk; fore tibial projection length ~1/4 tarsus (Fig. 3.23 C)..... *Campylocia*
2(1)	Fore tibial projection length ~1/3 tarsus (Fig. 3.23 B)..... *Mesoplocia*
2'	Fore tibial projection length ~1/2 tarsus (Fig. 3.23 C)..... *Euthyplocia* [Neotropics. Nearctic]

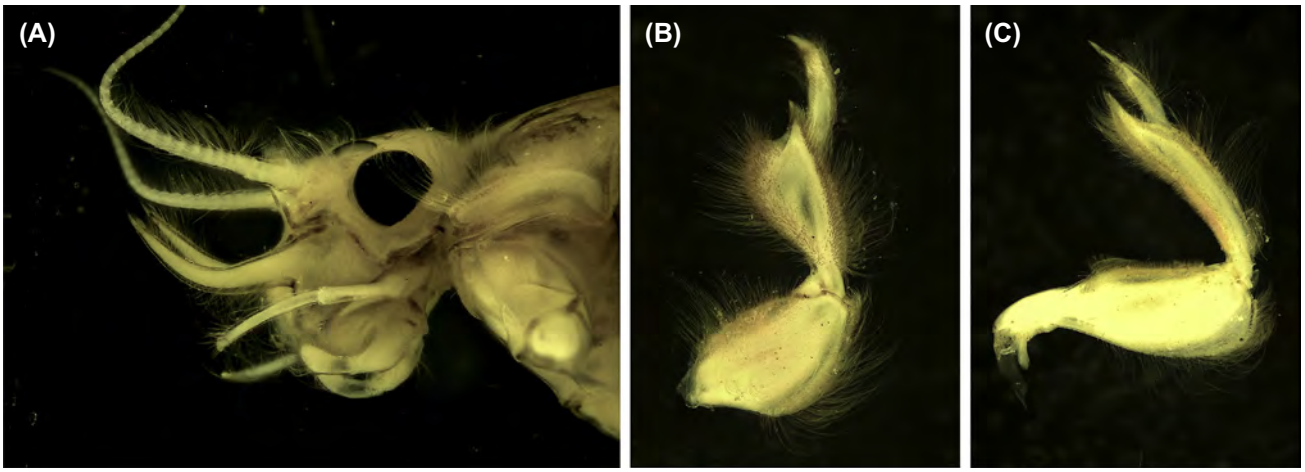

FIGURE 3.5 Nymphal structures of *Hexagenia* (Ephemeridae): (A) head (lateral view); (B) fore leg; and (C) hind leg.

FIGURE 3.6 Habitus of a living nymph of *Murphyella needhami* Lestage (Coloburiscidae).

Polymitarcyidae: Genera

Modified from Molineri et al. (2015). The nymphs make U-shaped burrows (Molineri, 2010). *Asthenopus*, at least in the Amazon, often build tunnels in wood debris and Asthenopodinae may be miners in plant tissue, such as *Eichhornia* and *Typha* (Domínguez et al., 2006). Some *Campsurus* species build silk cases on rocky substrates (Molineri et al., 2010).

1	Head dorsally mostly glabrous, without large tufts of tightly grouped short setae (Figs. 3.24 A, B); occiput roundly convex (Fig. 3.24 A); apex of left mandibular tusk with 3−4 pointed processes (Fig. 3.24 A) (**Asthenopodinae**) 2
1’	Head dorsally with dense patches of short setae, mainly anteriorly to lateral ocelli (Figs. 3.25 A, B); occiput flat, subquadrate in dorsal view (Fig. 3.25 B); apex of left mandibular tusk with one pointed process (Fig. 3.25 A) (**Campsurinae**) 4
2(1)	Mandibular tusks robust, stout, with one or more tubercles on medial margin (Figs. 3.27, 28 A, 29 A, 30) 3
2’	Mandibular tusks relatively long and slender, without tubercles or large spines on medial margin (Fig. 3.26) ..... *Hubbardipes*
3(2)	Mandibular tusks without large subbasal tubercle on medial margin (Fig. 3.28 A); fore tarsal claw with double row of denticles (Fig. 3.28 B) ..... *Asthenopodes*
3’	Mandibular tusks with a large subbasal tubercle on medial margin (Fig. 3.29 A); foretarsal claw with single row of denticles (Fig. 3.29 B) ..... *Asthenopus*

FIGURE 3.7 Nymphal structures of *Isonychia* (Isonychiidae): (A) head and thorax lateral view; and (B) fore leg.

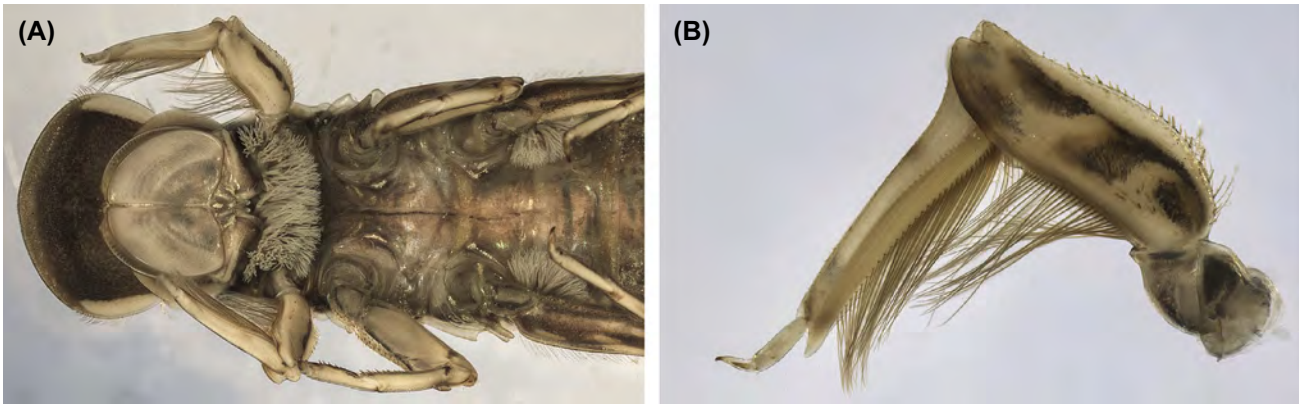

FIGURE 3.8 Nymphal structures of *Oligoneuria* (Oligoneuriidae): (A) head and thorax, ventral view; and (B) fore leg.

4(1')	Mandibular tusks median margin distal third with one or two prominent tubercles; mandibles outer margin with few long setae (Figs. 3.30 B, C); abdominal gill I with a single lamella 5
4'	Mandibular tusks median margin with prominent basal or subbasal tubercle (rarely absent), few to many apical crenulations; mandibles outer margin with numerous setae (Fig. 3.30 A); abdominal gill I bifurcated..... *Campsurus*
5(4')	Mandibular tusks median margin with two tubercles (submedian and subapical) (Fig. 3.30 B); distal projection of foretibia-tarsus 2/5 the length of claw ..... *Tortopus*
5'	Mandibular tusks median margin with a single subapical tubercle (Fig. 3.30 C); distal projection of foretibia-tarsus length 2/3 claw ..... *Tortopsis*

Oligoneuriidae: Genera

Half of this family's diversity comes from the Neotropics, where 30 species in five genera have been reported. *Homoeoneuria* are psammophilous, while the remaining Neotropical genera are clingers, living on wood debris, overhanging branches, dead leaves, or rocks. *Lachlania* and *Homoeoneuria* are the only genera with a distribution that extends from South to Central and North America.

1	Epimera and episterna not projected laterally (Fig. 3.31); abdominal segments with posterolateral projection restricted to segments VIII to IX (Fig. 3.31)..... 2
1'	Epimera and episterna projected laterally (Fig. 3.32); abdominal segments I–IX with posterolateral projections (Fig. 3.32)..... 3

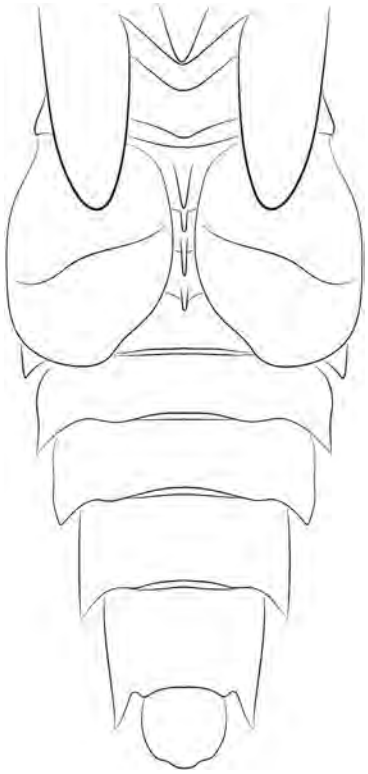

FIGURE 3.9 Fore wing pad and abdomen of *Siphlonella ventilans* Needham and Murphy (Oniscigastridae).

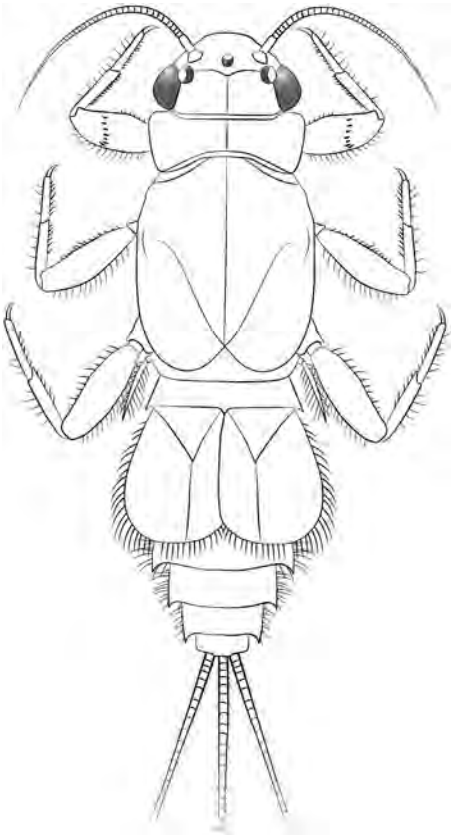

FIGURE 3.10 Habitus of *Caenis* nymph (Caenidae).

2(1)	Head anteriorly with distinct pointed projection (Fig. 3.33); compound eyes clearly separated (Fig. 3.33); gills oval, broad (Fig. 3.31); mid and hind coxae short ..... *Fittkauneuria*
2’	Head without projection (Fig. 3.34 A); compound eyes almost contiguous (Fig. 3.34 A); gills lanceolate, narrow (Fig. 3.34 B); mid and hind coxae enlarged (Fig. 3.34 C) ..... *Homoeoneuria*
3(1’)	Terminal filament absent (Fig. 3.32) ..... *Lachlania*
3’	Terminal filament present ..... *Oligoneuria*

Caenidae: Genera

This family is cosmopolitan with approximately 240 species in 28 genera, 40 species in five genera are known from the Neotropics. The most common and abundant genus is *Caenis*, with nearly 30 species. *Allorethocus* and *Brasilocaenis* Puthz are endemic to South America, *Insulibrachys* to Cuba, while *Latineosus* is present in South and Central America. *Caenis* is usually associated with roots and leaf debris, and is common in stagnant water, but can also be found in depositional areas of lotic systems. Leaf debris in rivers is a common habitat for *Brasilocaenis*, while sandy river bottom, especially when covered with a thin silt layer, is habitat for *Allorethocus*.

1	Three ocellar tubercles (Figs. 3.36, 37); foreleg clearly shorter than mid and hind legs 2
1’	Ocellar tubercles absent (Fig. 3.35); foreleg similar in length to mid and hind legs (Fig. 3.35) 4
2(1)	Ocellar tubercles conical and without dense, long setae (Fig. 3.37) ..... 3 [continental South America]
2’	Ocellar tubercles broadly cylindrical, with apex somewhat truncate, and with apical portion covered with dense, long setae (Fig. 3.36) ..... *Insulibrachis* [Caribbean]
3(2)	Maxillary palp article II length >2.0× article I (Fig. 3.38 A); posterolateral projection VI moderately curved medially but not nearly parallel with posterior margin of tergum VI (Fig. 3.38 B) ..... *Alloretochus*

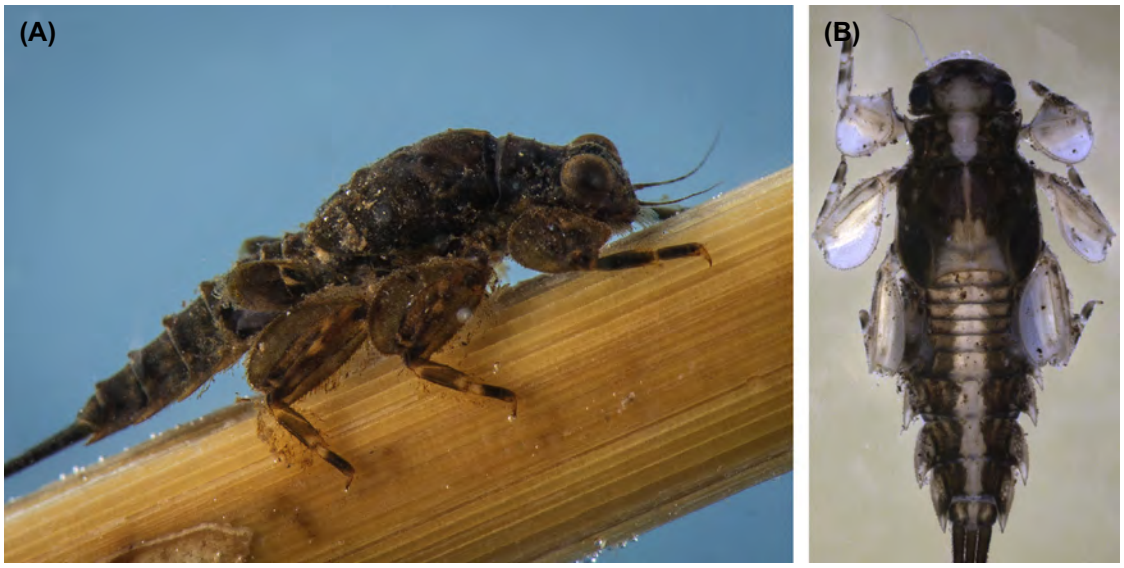

FIGURE 3.11 Habitus of *Melanemerella brasiliana* Ulmer (Melanemerellidae) nymph: (A) lateral view of living specimen; and (B) dorsal view.

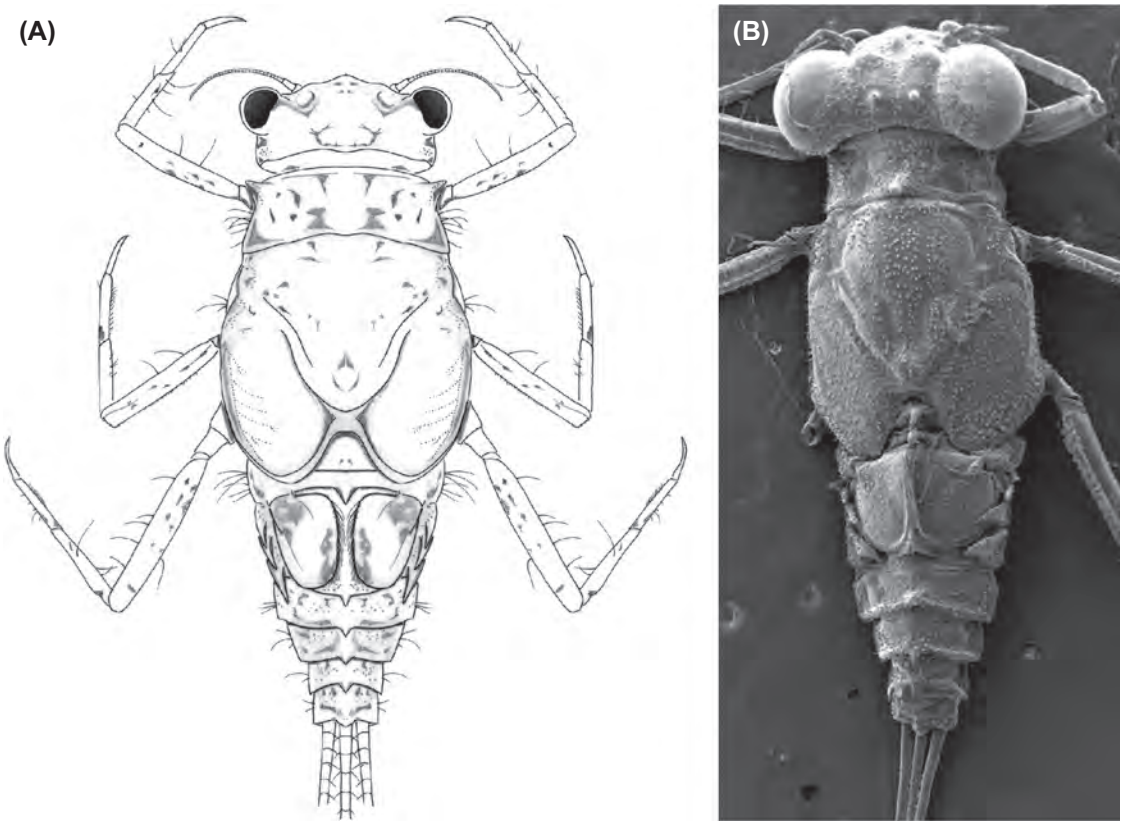

FIGURE 3.12 Habitus of *Coryphorus aquilus* Peters (Coryphoridae) nymph: (A) dorsal view of female, drawing; and (B) dorsal view of male, SEM picture.

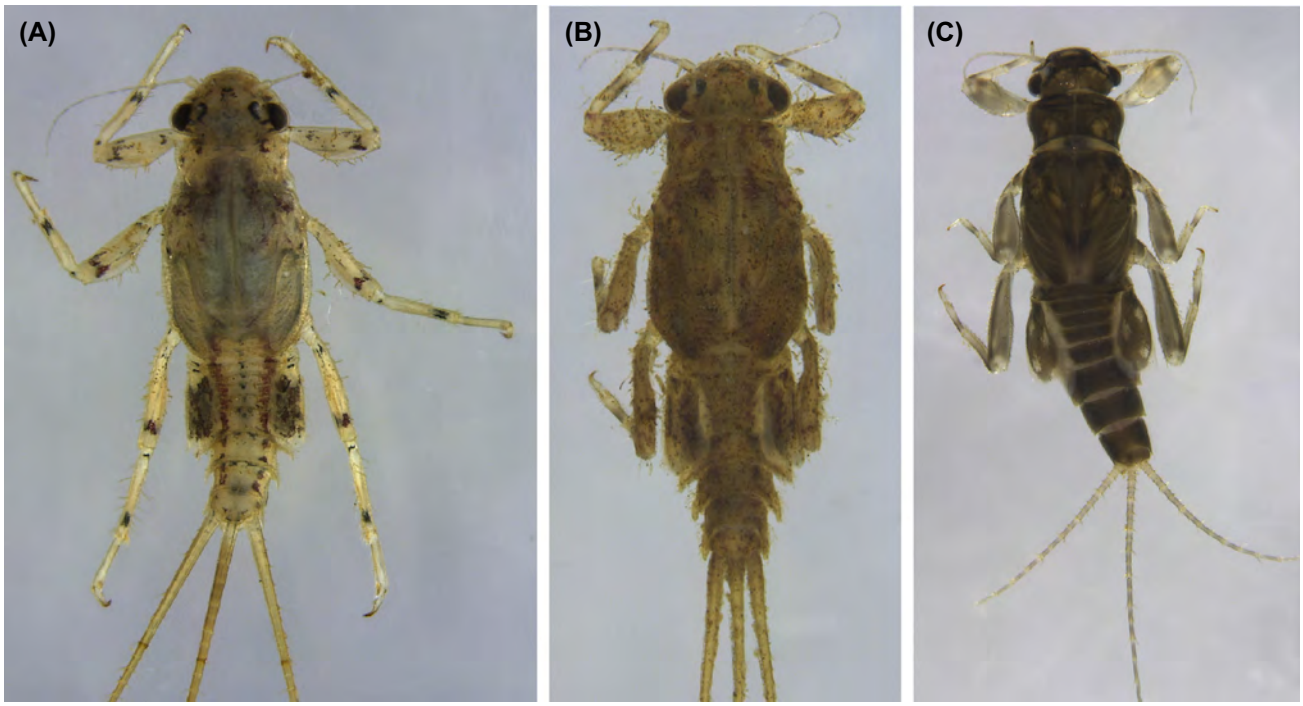

FIGURE 3.13 Habitus of Leptohyphidae nymphs: (A) *Tricorythodes*; (B) *Cabecar*; and (C) *Vacupernius*.

FIGURE 3.14 Habitus of a living nymph of *Chiloporter eatoni* (Lestage) (Ameletopsidae).

FIGURE 3.15 Head of nymph of *Hermanella mazama* (Nascimento, Mariano, and Salles) (Leptophlebiidae), dorsal view.

FIGURE 3.16 Habitus of a living nymph of *Hylister* (Leptophlebiidae).

FIGURE 3.19 Habitus of a living nymph of *Metamonius anceps* (Eaton) (Nesameletidae).

FIGURE 3.17 Habitus of a living nymph of *Fittkaulus* (Leptophlebiidae).

FIGURE 3.20 Habitus of a living nymph of *Cloeon smaeleni* Lestage (Baetidae).

FIGURE 3.18 Head of nymph of *Epeorus* (Heptageniidae), lateral view.

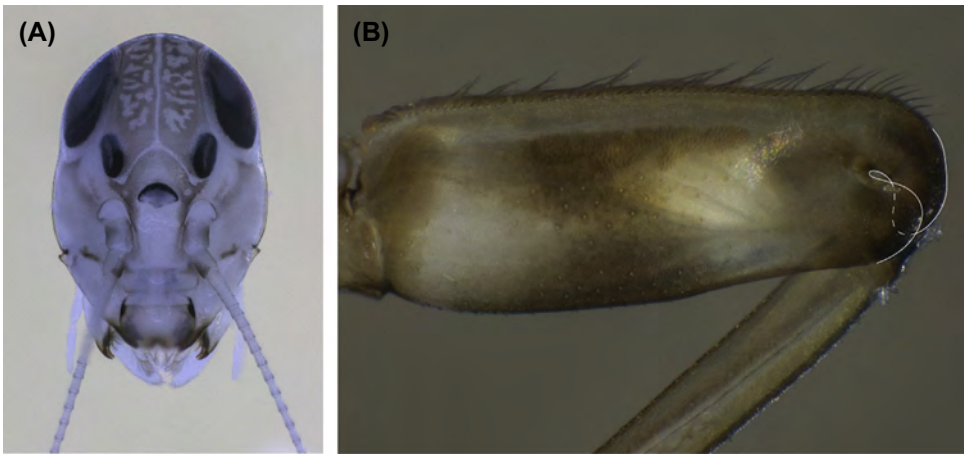

FIGURE 3.21 Nymphal structures of Baetidae: (A) head of *Cryptonympha*, frontal view; and (B) anterior surface of leg of *Camelobaetidius rufiventris* Boldrini and Salles.

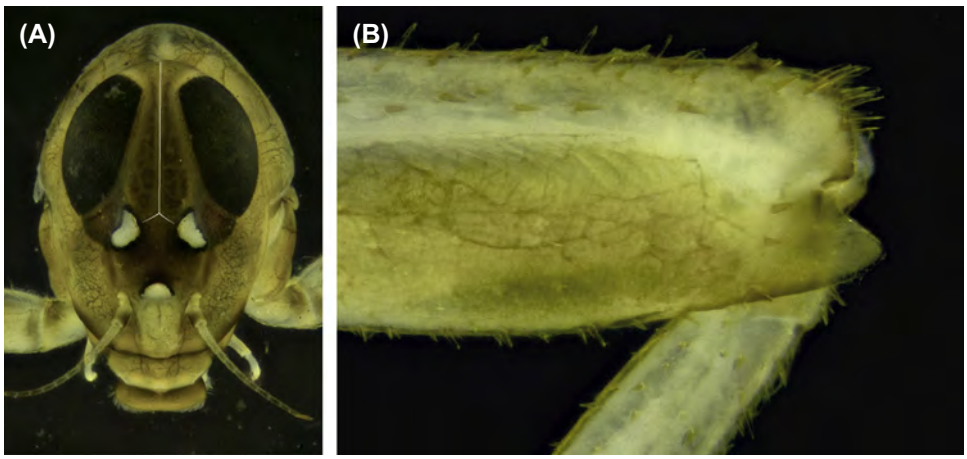

FIGURE 3.22 Nymphal structures of *Metamonius anceps* (Eaton) (Nesameletidae): (A) head, frontal view; and (B) anterior surface of leg.

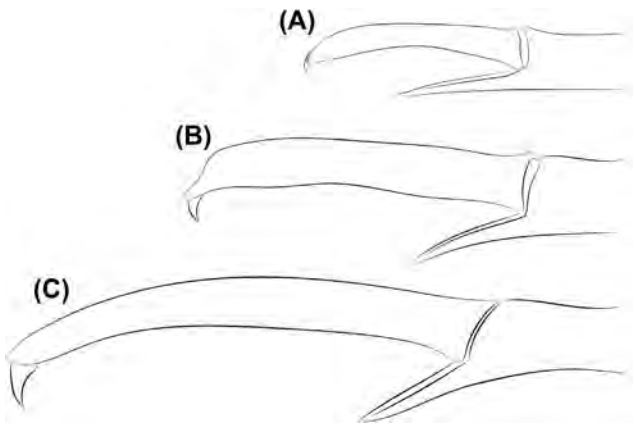

FIGURE 3.23 Partial view of fore tibiae and tarsi of Euthyplociidae nymphs: (A) *Euthyplocia*; (B) *Mesoplocia*; and (C) *Campylocia*.

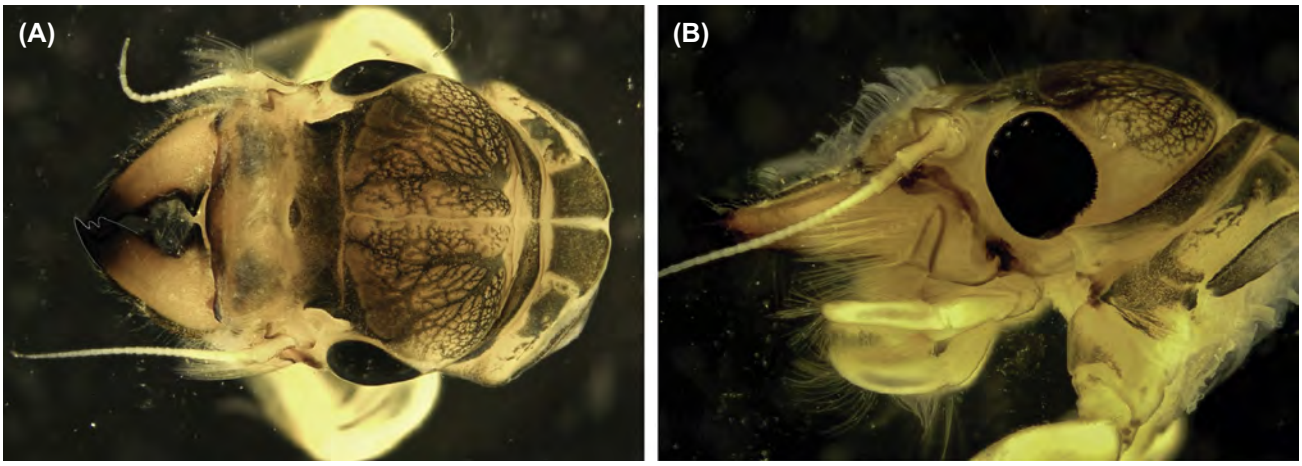

FIGURE 3.24 Nymphal head of *Asthenopus* (Polymitarcyidae): (A) dorsal view; and (B) lateral view.

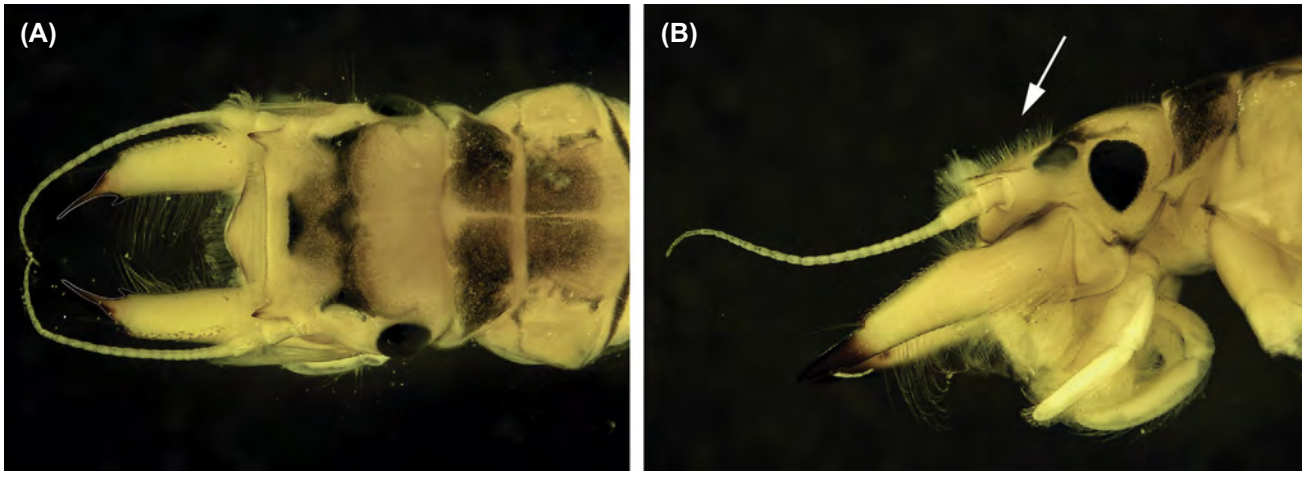

FIGURE 3.25 Nymphal head of *Tortopsis* (Polymitarcyidae): (A) dorsal view; and (B) lateral view. *White arrow* showing patch of dense setae.

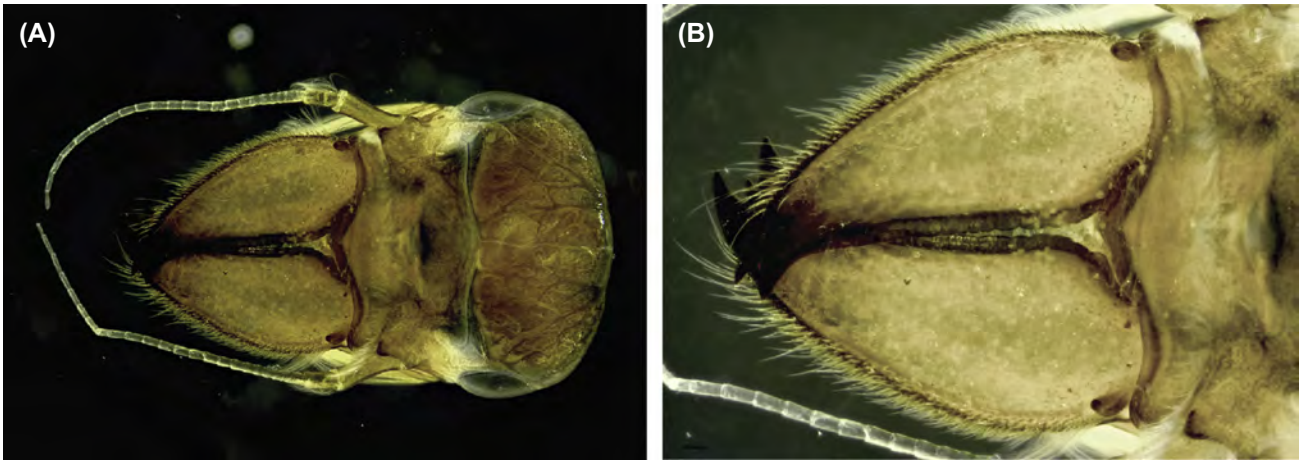

FIGURE 3.26 Nymphal head of *Hubbardipes* (Polymitarcyidae): (A) dorsal view; and (B) detail of mandibular tusks, dorsal view.

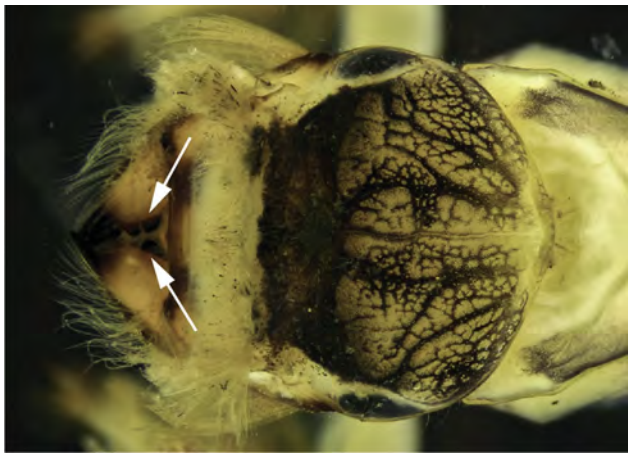

FIGURE 3.27 Nymphal head of *Asthenopus* (Polymitarcyidae), dorsal view. *White arrows* showing subbasal tubercle.

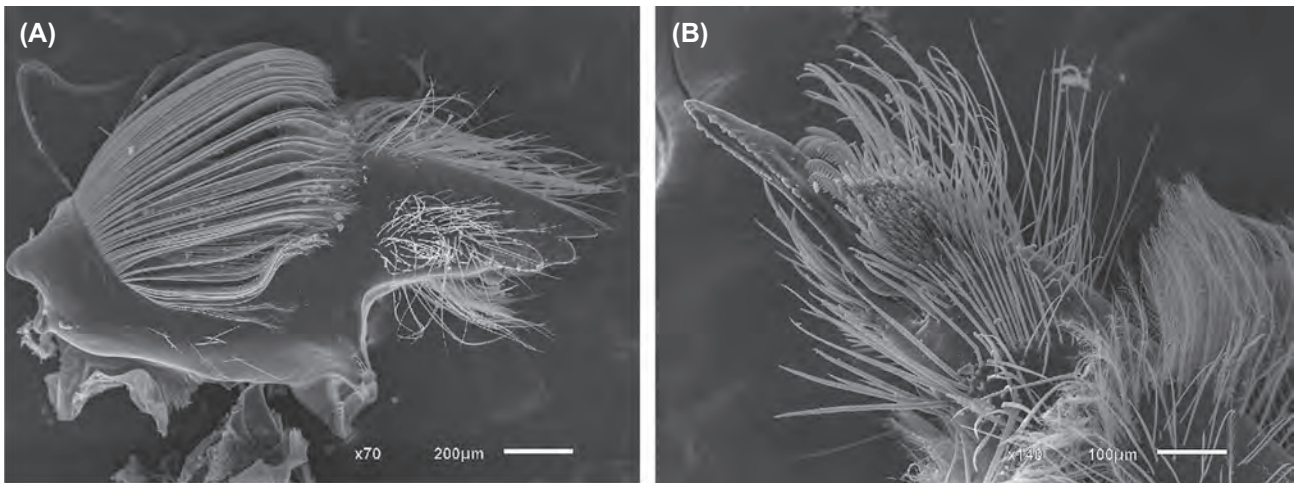

FIGURE 3.28 Nymphal structures of *Asthenopodes* (Polymitarcyidae), SEM pictures: (A) right mandible; and (B) fore leg.

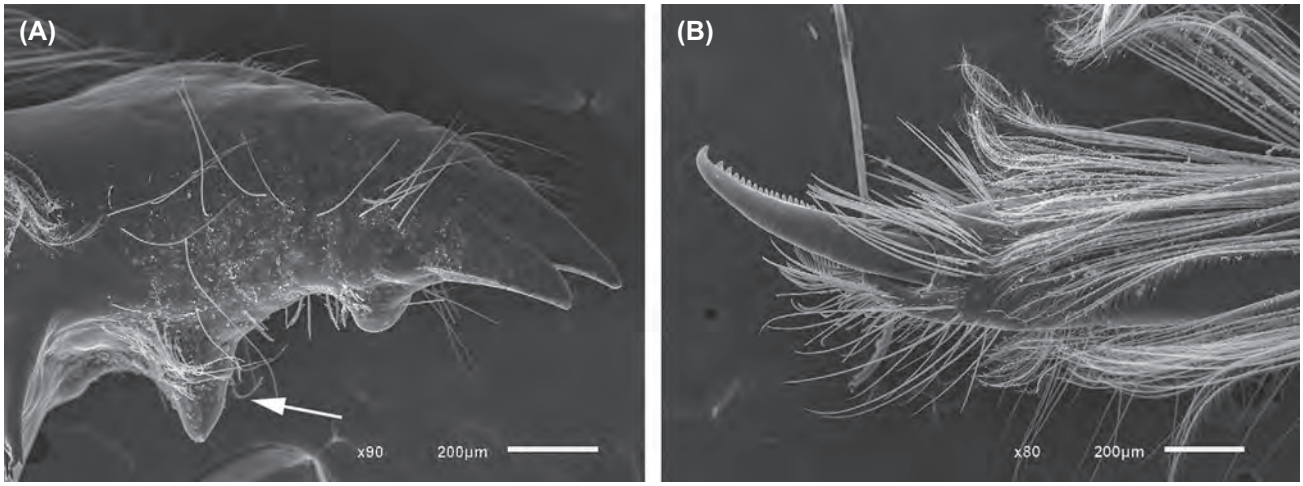

FIGURE 3.29 Nymphal structures of *Asthenopus* (Polymitarcyidae), SEM pictures: (A) right mandible; and (B) fore leg. *White arrow* showing subbasal tubercle.

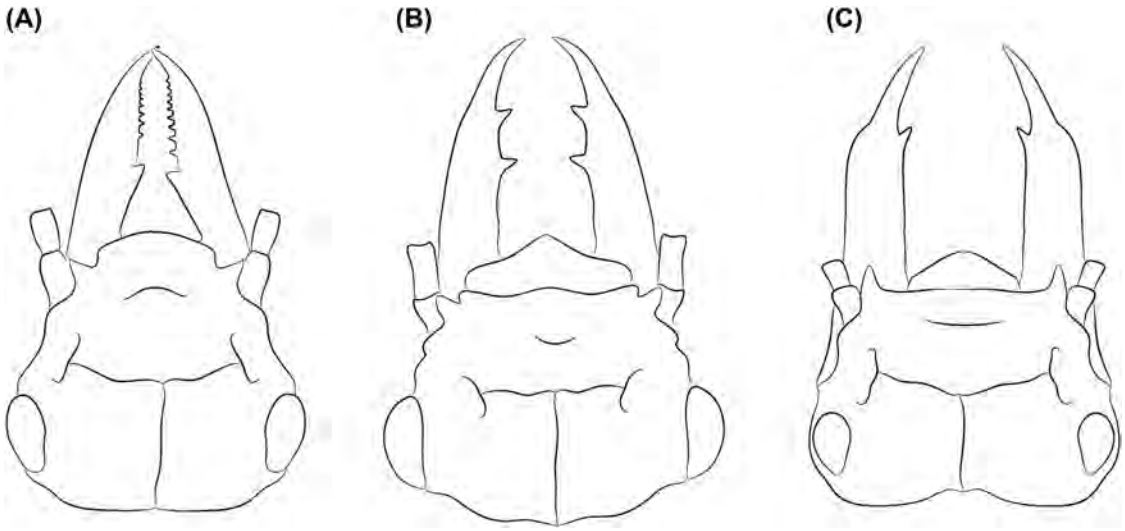

FIGURE 3.30 Schematic drawing of Polymitarcyidae heads: (A) *Campsurus*; (B) *Tortopus*; and (C) *Tortopsis*.

FIGURE 3.31 Habitus of *Fittkauneuria* (Oligoneuriidae) nymph. *Black arrows* showing posterolateral projections of abdominal segments VIII and IX.

FIGURE 3.32 Habitus of *Lachlania* (Oligoneuriidae) nymph. *White arrows* showing lateral projections of epimera and episterna.

FIGURE 3.33 Head of *Fittkauneuria* (Oligoneuriidae) nymph, frontal view.

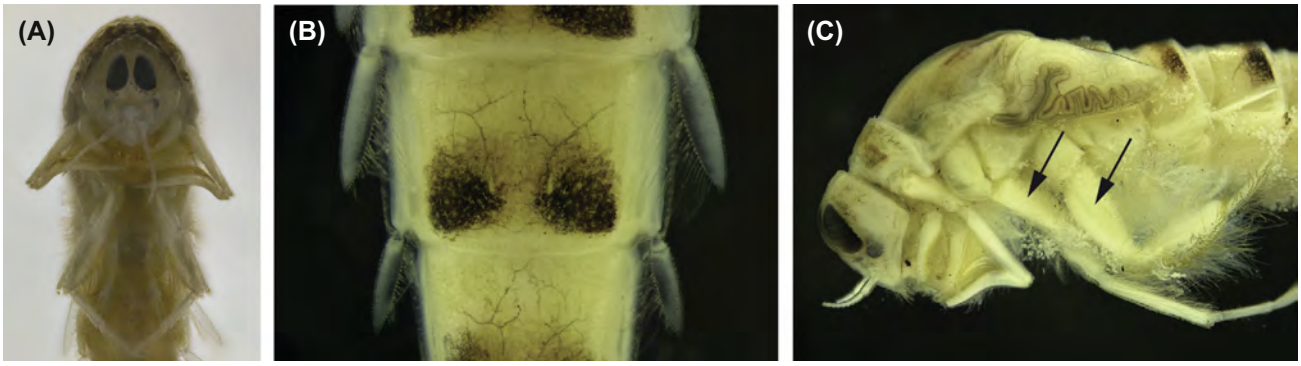

FIGURE 3.34 Nymphal structures of *Homoeoneuria* (Oligoneuriidae): (A) frontal view of head and partial view of thorax; (B) abdominal terga VI, VII and VIII; and (C) lateral view of head, thorax, and abdominal segments I and II. *Black arrows* showing elongate coxae.

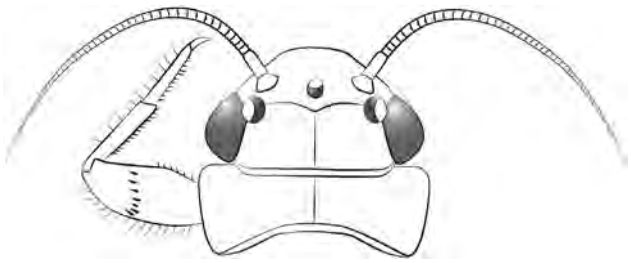

FIGURE 3.35 Head, prothorax and left fore leg of *Caenis* (Caenidae) nymph.

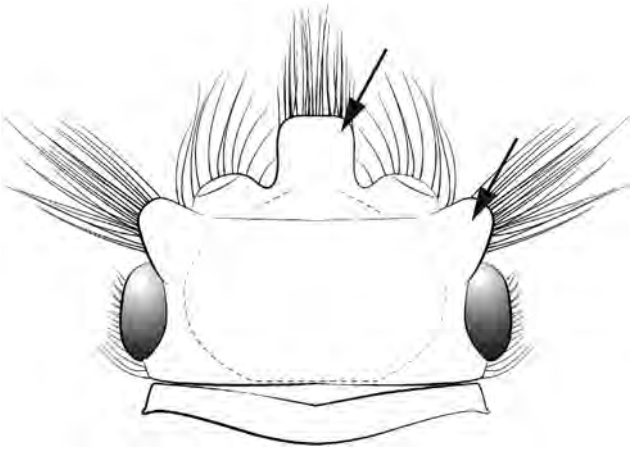

FIGURE 3.36 Head of *Insulibrachis* (Caenidae) nymph. *Arrows* showing ocelar tubercles. *After Sun & McCafferty (2008).*

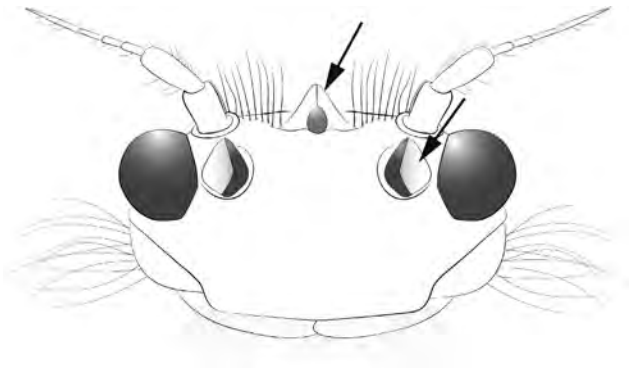

FIGURE 3.37 Head of *Latineosus sigillatus* (Molineri) (Caenidae) nymph. *Arrows* showing ocelar tubercles.

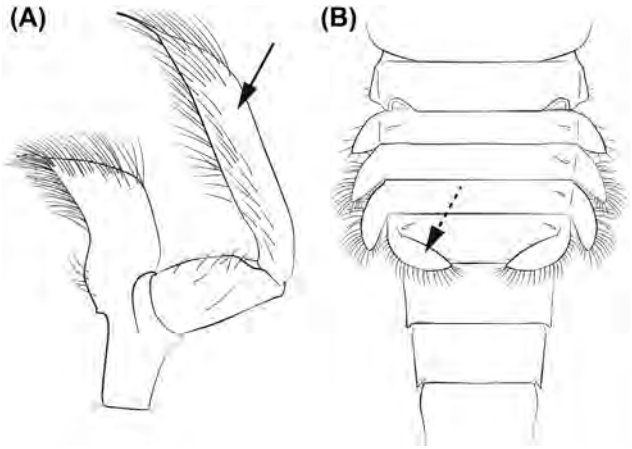

FIGURE 3.38 Nymphal structures of *Allorethocus* (Caenidae): (A) maxilla; and (B) abdominal segments I to VIII. *Solid arrow* showing second segment of maxillary palp, *dashed arrow* showing posterolateral projection of abdominal segment VI. *After Sun & McCafferty (2008).*

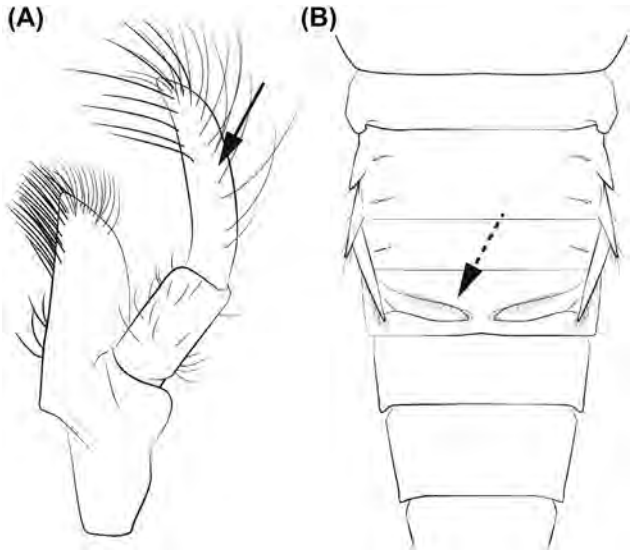

FIGURE 3.39 Nymphal structures of *Latineosus* (Caenidae): (A) maxilla; and (B) abdominal segments I to VIII. *Solid arrow* showing second segment of maxillary palp, *dashed arrow* showing posterolateral projection of abdominal segment VI. *After Sun & McCafferty (2008).*

3’	Maxillary palp article II 1.5−1.8× length of article I (Fig. 3.39 A); segment VI posterolateral projection of distally nearly parallel with posterior margin of tergum VI (Fig. 3.39 B) ..... *Latineosus*
4(1’)	Coxae of mid and hind leg with or without a semicircular projection (Fig. 3.40; operculate gill without short and robust spines (Fig. 3.42); segments IV−VII posterolateral projection short, not reaching half of following segment ..... *Caenis*
4’	Coxae of mid and hind leg with triangular projection (Fig. 3.41); operculate gill dorsal surface with short and robust spines (Fig. 3.43); segments IV−VII posterolateral projection long, reaching half of following segment..... *Brasilocaenis*

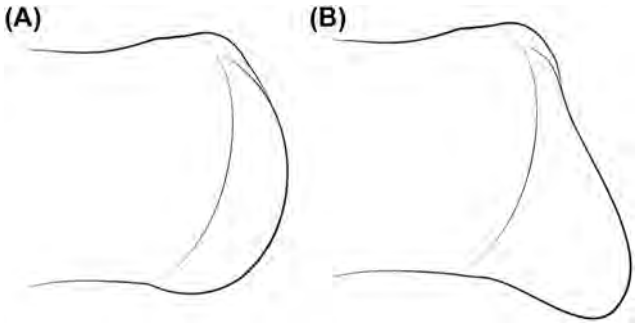

FIGURE 3.40 Mesocoxal processes of *Caenis* (Caenidae) nymphs: (A) *C. fittkaui* Malzacher; and (B) *C. pflugfelderi* Malzacher. *Adapted from Malzacher (1986).*

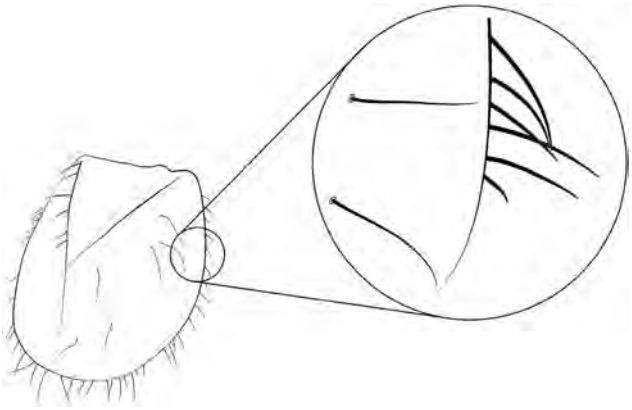

FIGURE 3.42 Operculate gill of *Caenis* (Caenidae) nymph.

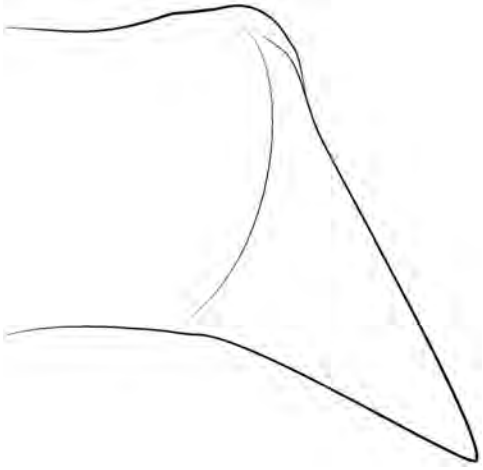

FIGURE 3.41 Mesocoxal processes of *Brasilocaenis irmleri* Puthz (Caenidae) nymph. *Adapted from Malzacher (1986).*

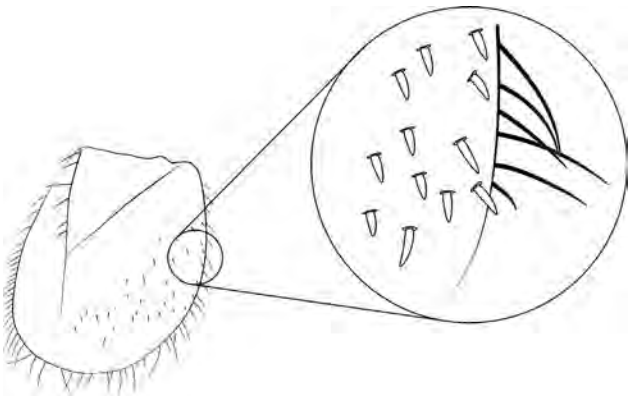

FIGURE 3.43 Operculate gill of *Brasilocaenis* (Caenidae) nymph.

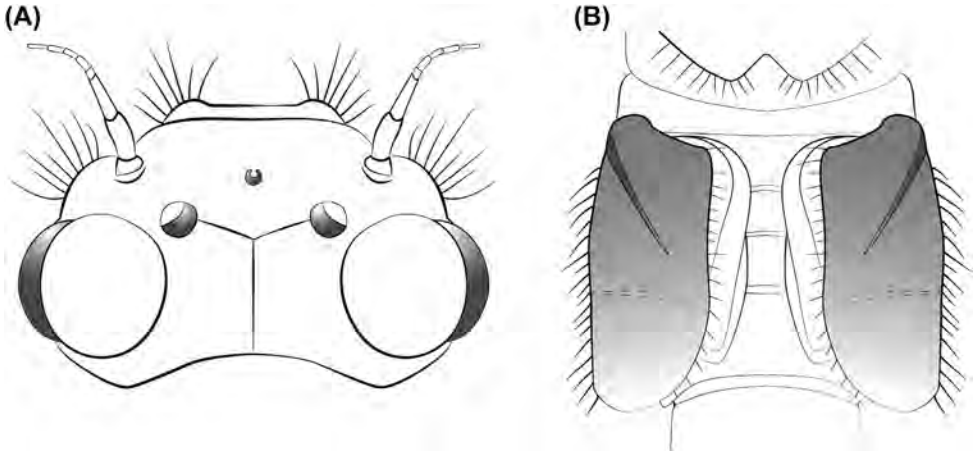

FIGURE 3.44 Nymphal structures of *Leptohyphodes inanis* (Pictet) (Leptohyphidae): (A) head of male; and (B) abdominal segments I to VII.

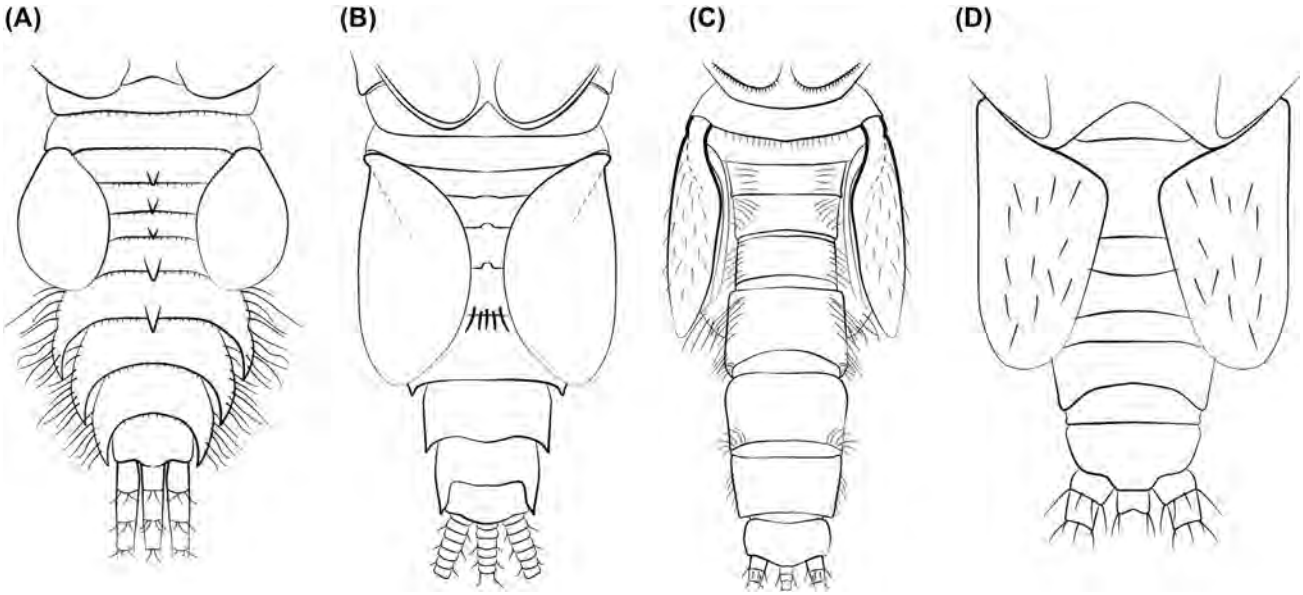

FIGURE 3.45 Abdomen of Leptohyphidae nymphs, dorsal view: (A) *Tricorythopsis*; (B) *Ableptemetes*; (C) *Haplohyphes*; and (D) *Tricorythodes*.

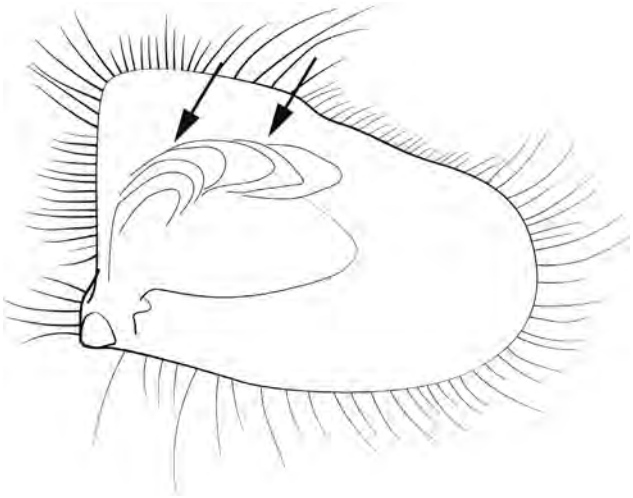

FIGURE 3.46 Operculate gill of of *Leptohyphodes inanis* (Pictet) (Leptohyphidae), ventral view. *Arrows* showing imbricated lobes.

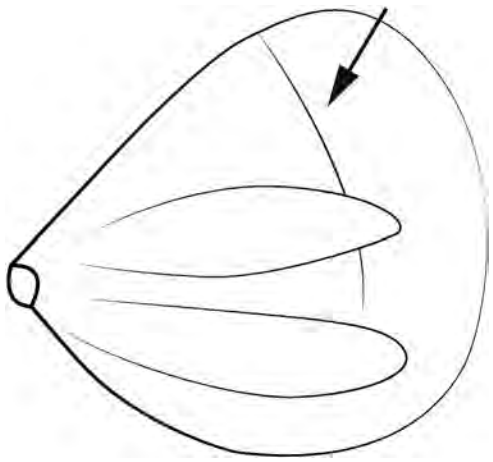

FIGURE 3.47 Operculate gill of of *Amanahyphes* (Leptohyphidae), ventral view. *Arrow showing* transverse submedian line.

Leptohyphidae: Genera

This New World family is one of the most diverse. Of the 150 species, nearly 130 species have been described from the Neotropics. Some of the 15 genera that comprises the family, 11 are endemic to the Neotropics. The distribution of some Neotropical genera, however, is much more restricted. *Leptohyphodes* (Atlantic Forest), *Amanahyphes* (Amazon Basin) and *Haplohyhes* (Andes). Nymphs are typical crawlers and can be found in a wide variety of habitats, from slow to fast currents, from organic to inorganic substrata, but always restricted to lotic systems.

1 Eyes of male enlarged, sometimes divided (Fig. 3.44 A); operculate gills subquadrate to semitriangular, meeting or almost meeting medially (Fig. 3.44 B); gills present on abdominal segments II–V 2

1' Eyes of male small, blackish, and not divided; operculate gills triangular, semitriangular, or oval, never meeting medially (Fig. 3.45); gills present on abdominal segments II–VI 3

2(1) Operculate gills semitriangular and without transverse line (Fig. 3.44 B); gill ventral lamellae with margins fringed with small imbricated lobes (Fig. 3.46); eyes of male mature nymph with whitish or yellowish upper portion ..... *Leptohyphodes*

FIGURE 3.48 Nymph of *Loricyphes froehlichi* Molineri & Mariano (2015) (Leptohyphidae), lateral view. *After Molineri & Mariano (2015).*

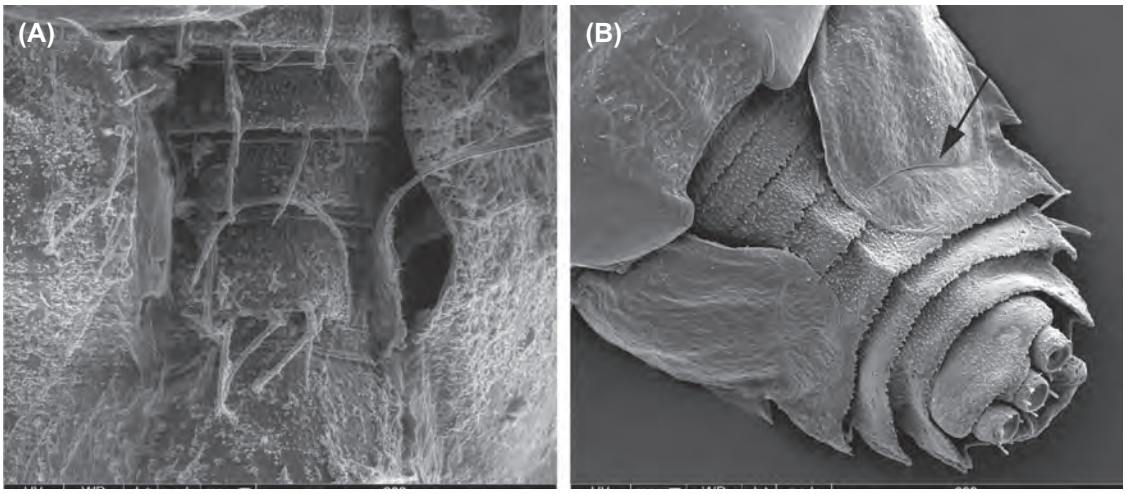

FIGURE 3.49 Abdominal terga and operculate gills of Leptohyphidae nymphs, SEM pictures: (A) *Tricorythodes*; (B) *Tricorythopsis*.

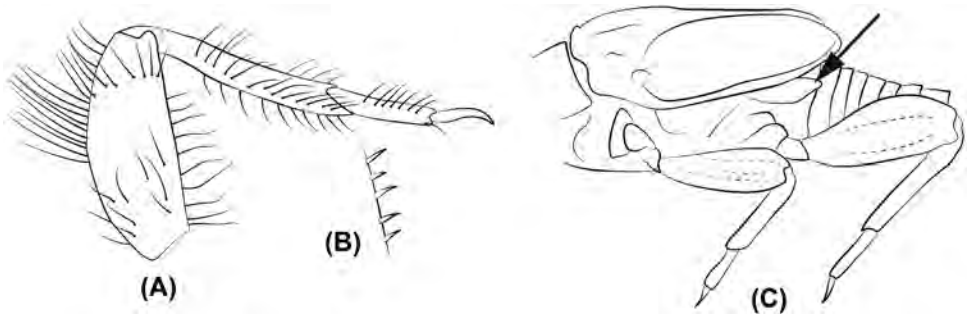

FIGURE 3.50 Nymphal structures of *Haplohyphes* (Leptohyphidae): (A) fore leg; (B) detail of medial margin of femur; and (C) partial view of thorax and abdomen, lateral view. *Arrow showing* hind wing pad.

2'	Operculate gills subquadrate to fusiform and with a transverse submedian line (Fig. 3.47); gills not fringed (Fig. 3.47); eyes of male mature nymph blackish	*Amanahyphes*
3(1)	Tubercles absent, rarely present but not in all three tagma at the same time (except one species of *Leptohyphes*, but tubercles are blunt and paired in the abdomen)	4
3'	Head, thorax and abdomen with acute tubercles (Fig. 3.48)	*Loricyphes*
4(3)	At least abdominal terga I–V with smooth posterior margin (Fig. 3.49 A)	5
4'	Abdominal terga I–X with tiny spines along posterior margin (Fig. 3.49 B)	8
5(4)	Abdomen base much wider than apex (Fig. 3.45 D); profemora anterior margin without spines (Fig. 3.51 A), if present, setaform (Fig. 3.51 B) or spatulate (Fig. 3.51 C); hind wing pads absent	6
5'	Abdomen base slightly wider than apex (Fig. 3.45 C); profemora anterior margin with long setae and stout spines on leading edge (Figs. 3.50 A, B); hind wing pads present (Fig. 3.50 C)	*Haplohyphes*

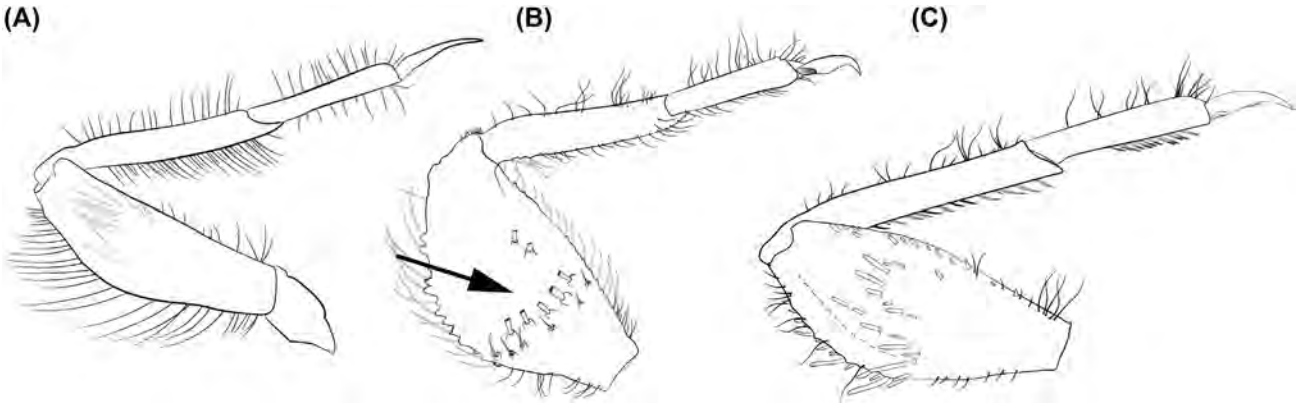

FIGURE 3.51 Fore legs of Leptohyphidae nymphs: (A) *Tricorythodes*; (B) *Cabecar*; and (C) *Macunahyphes*.

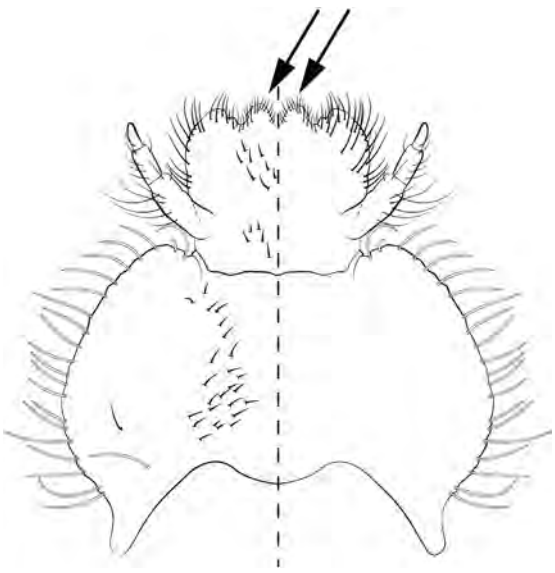

FIGURE 3.52 Labium of *Cabecar* (Leptohyphidae). *Arrows* showing glossae.

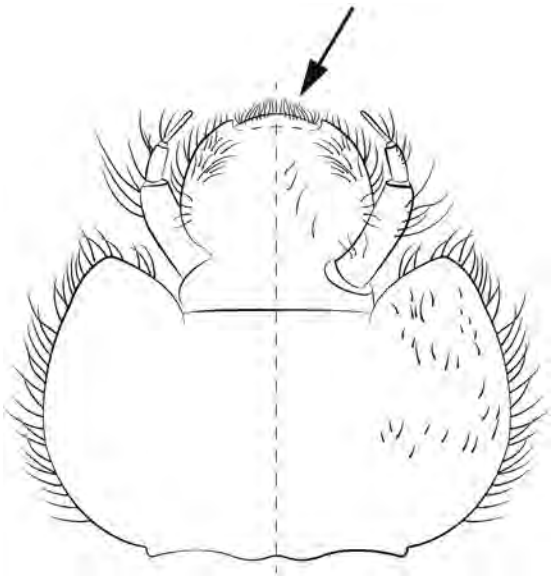

FIGURE 3.53 Labium of *Macunahyphes* (Leptohyphidae). *Arrows* showing glossae. *After Dias et al. (2005).*

6(5)	Femora with relatively short spatulate setae (Figs. 3.51 B, C) 7
6'	Femora with thin and long setae only (Fig. 3.51 A) ..... *Tricorythodes*
7(6)	Pronotum and mesonotum with anterolateral projections; middle and hind femora with a longitudinal row of 5–9 spatulate setae; glossae small but separate and distinguishable (Fig. 3.52) ..... *Cabecar*
7'	Pronotum and mesonotum without anterolateral projections; middle and hind femora with numerous spatulate setae on the dorsal face; glossae fused (Fig. 3.53) ..... *Macunahyphes*
8(4)	Operculate gills oval or semioval (Figs. 3.54 B–D) 9
8'	Operculate gills subtriangular (Fig. 3.54 A); rare ..... *Ableptemetes* [Mexico and Central America]
9(8)	Operculate gills oval or suboval but never with weak transverse line (Figs. 3.54 C, D); operculate gill with three lamella (Figs. 3.54 C, D) 10
9'	Operculate gills oval frequently with a median or subapical weak transverse line (Figs. 3.49 B, 54 B) (except *T. rondoniensis* and *T. spongicola*); operculate gill with five lamella (Fig. 3.54 B) ..... *Tricorythopsis*
10(9)	Operculate gills without basal spine (Fig. 3.54 D); caudal filaments not as below; dorsum of middle and hind femora dorsally without longitudinal ridge or transverse row of spines near base (Fig. 3.57) 11
10'	Operculate gills with basal spine (Fig. 3.54 C); caudal filaments with darker articles basally (female) or medially (male) (Fig. 3.55); middle and hind femora dorsum generally with a longitudinal ridge and with a transverse of spine row near base (Fig. 3.56) ..... *Leptohyphes*
11(10)	Profemora dorsally distal 1/3 or more with transverse dorsal row of spatulate setae (Fig. 3.59) 12

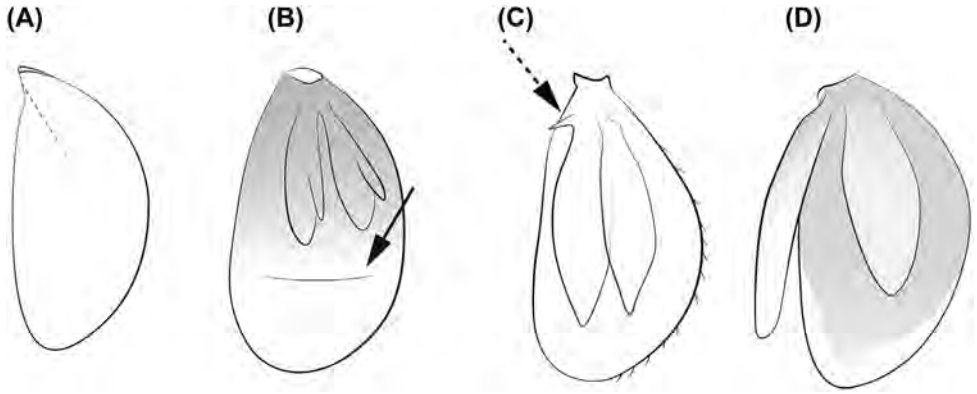

FIGURE 3.54 Operculate gills of Leptohyphidae nymphs, ventral view: (A) *Ableptemetes*; (B) *Tricorythopsis*; (C) *Leptohyphes*; and (D) *Traverhyphes*.

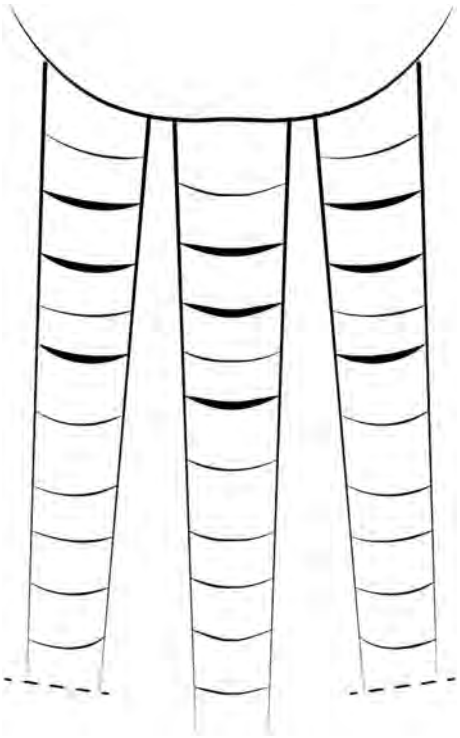

FIGURE 3.55 Caudal filaments of *Leptohyphes* (Leptohyphidae) female nymph.

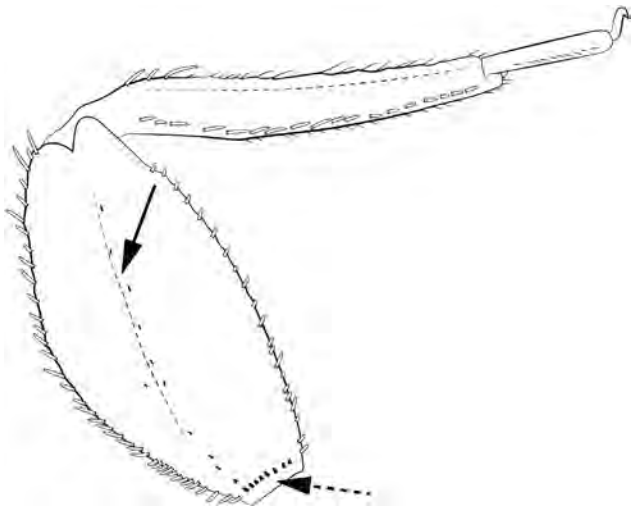

FIGURE 3.56 Hind leg of *Leptohyphes* (Leptohyphidae) nymph. *Solid arrow* showing longitudinal ridge. *Dashed arrow* showing transversal row of spines near base.

11'	Profemora dorsally with medial transverse row of spatulate setae (Fig. 3.58)	*Vacupernius*
12(11)	Body relatively stout (Fig. 3.60); maxillary palpi biarticulate (Figs. 3.61 A, B); operculate gills ovoid and relatively small, not reaching posterior half of abdominal segment VII (Fig. 3.60); gill formula: 3/3/3/3/1–2	13
12'	Body relatively elongated (Fig. 3.62); maxillary palpi bi- or triarticulate (Fig. 3.63); operculate gills ovoid to subquadrate and relatively large, at least reaching posterior half of abdominal segment VII (Fig. 3.62); gill formula: 3/3–4/3–4/3/1–2	14
13(12)	Abdominal gill VI with two lamellae (Fig. 3.64 A); maxillary palpi generally with apical seta (Fig. 3.61 C); fore tarsal claw with a subapical single row of four denticles	*Allenhyphes* (in part)
13'	Abdominal gill VI with one lamella (Fig. 3.64 B); maxillary palpi without apical seta (Fig. 3.61 B); fore tarsal claw with a subapical single row of 6–7 denticles	*Yaurina*
14(12)	Maxillary palpi triarticulate and relatively large (Fig. 3.63 B)	15
14'	Maxillary palpi biarticulate and relatively small (Figs. 3.63 C–E)	*Traverhyphes* (in part)
15(14)	Profemora dorsal spatulate setae not bifid and with smooth apex (Fig. 3.65 C); female mature nymph sterna	16

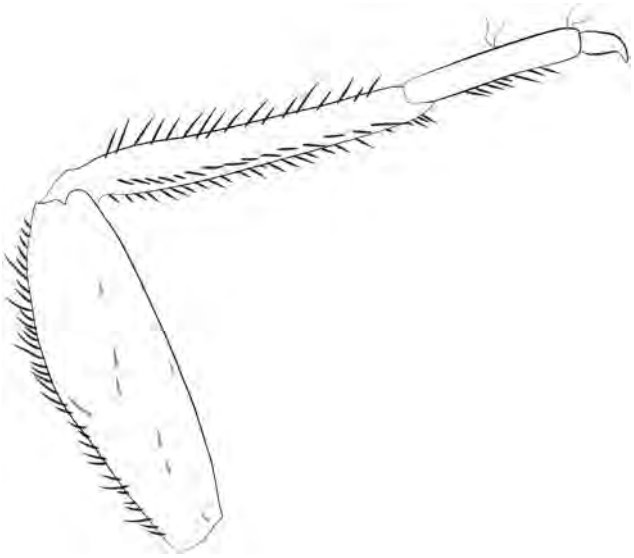

FIGURE 3.57 Hind leg of *Lumahyphes* (Leptohyphidae) nymph.

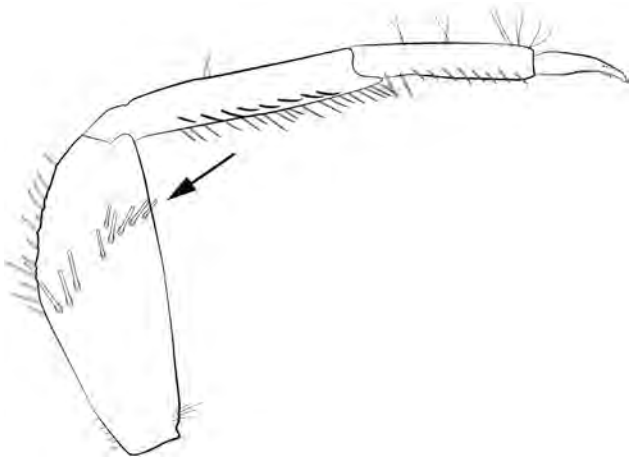

FIGURE 3.59 Fore leg of *Lumahyphes* (Leptohyphidae) nymph. *Solid arrow* showing transverse dorsal row of spatulate setae on femur.

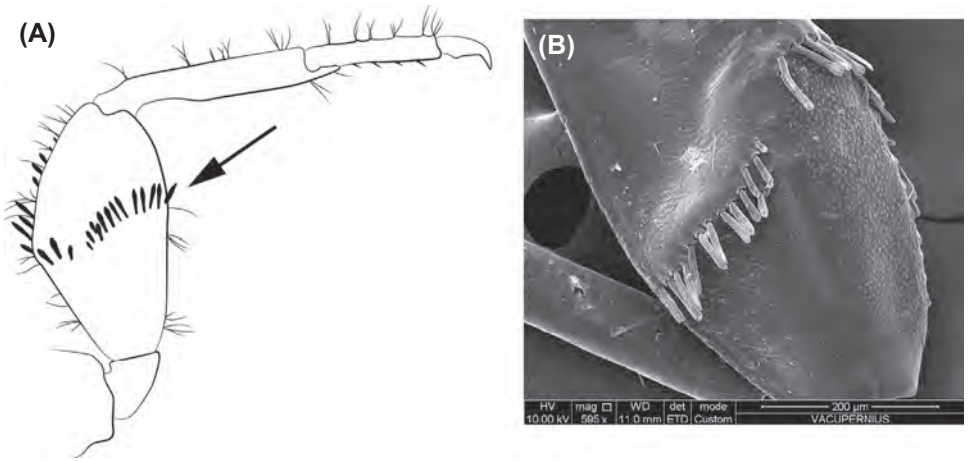

FIGURE 3.58 Fore leg of *Vacupernius* (Leptohyphidae) nymph. *Solid arrow* showing transverse dorsal row of spatulate setae on femur.

15' Profemora dorsal spatulate setae bifid or serrate (Figs. 3.65 A, B); female mature nymph generally with a median black macula between abdominal sterna VII and VIII ..... *Lumahyphes*
16(15) Maxillary palpi with small apical seta (Fig. 3.63 B)..... *Traverhyphes* (in part)
16' Maxillary palpi without apical seta (Figs. 3.61 C)..... *Allenhyphes* (in part)

Ameletopsidae: Genera

This family has only seven species; three species in two genera are known from the Neotropics, exclusively from the Andean-Patagonian region: *Chaquihua penai* Demoulin, *Chaquihua bullocki* (Navás), and *Chiloporter eatoni* Lestage. Nymphs are carnivorous and crawlers, although able to perform fast swimming movements (Domínguez et al., 2006).

1 Gills composed of dorsal lamellar and ventral fringed portions (Fig. 3.14) ..... *Chiloporter eatoni* Lestage
1' Gills composed of only dorsal lamella (Fig. 3.66)..... *Chaquihua*

FIGURE 3.60 Habitus of *Allenhyphes* (Leptohyphidae) nymph.

FIGURE 3.62 Habitus of *Traverhyphes* (Leptohyphidae) nymph.

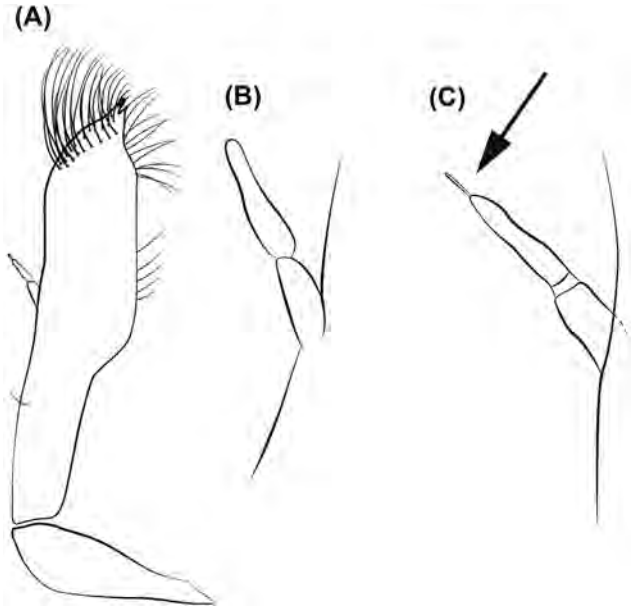

FIGURE 3.61 Maxillae of *Allenhyphes-Yaurina* (Leptohyphidae) nymph: (A) maxilla of *Allenhyphes*; (B) maxillary palp of two articles, without apical seta of *Yaurina*; and (C) maxillary palp of two articles, with apical seta of *Allenhyphes* (*solid arrow*).

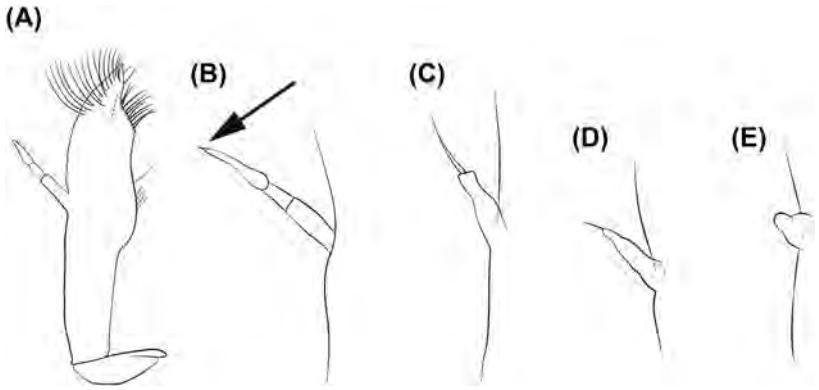

FIGURE 3.63 Maxillae of *Traverhyphes* (Leptohyphidae) nymph: (A) maxilla; (B) maxillary palp of three articles, with apical seta; (C) maxillary palp of two articles, with apical seta (*solid arrow*); (D) maxillary palp of two articles, with apical seta; and (E) maxillary palp of two articles, without apical seta.

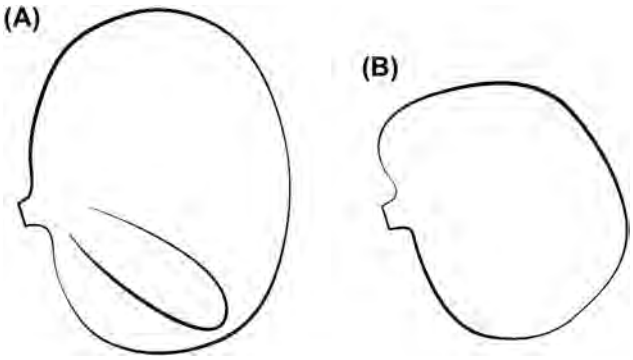

FIGURE 3.64 Abdominal gill VI of Leptohyphidae nymph: (A) *Allenhyphes*; and (B) *Yaurina*.

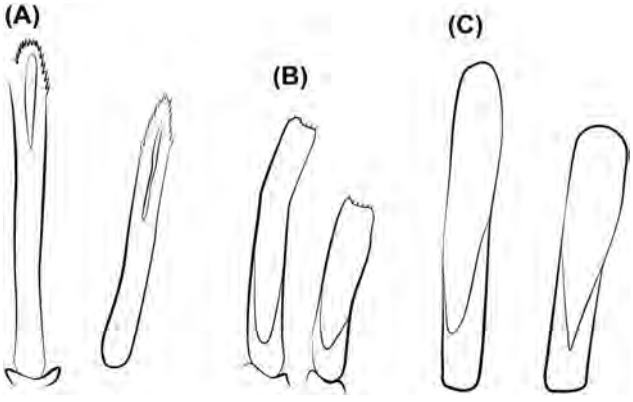

FIGURE 3.65 Detail of spatulate setae on dorsum of fore femora of Leptohyphidae nymph: (A) and (B) *Lumahyphes*; and (C) *Traverhyphes*.

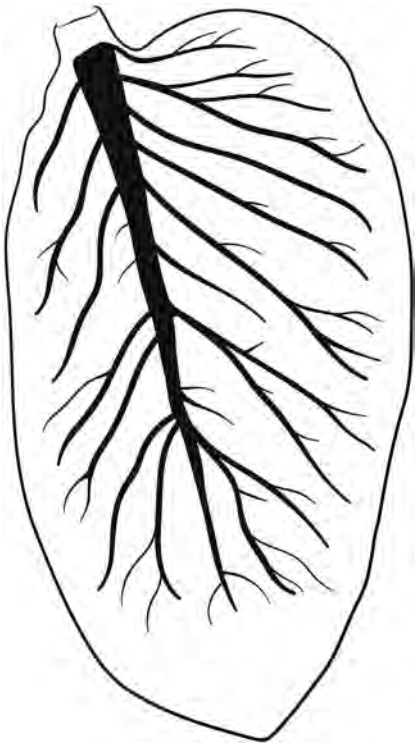

FIGURE 3.66 Abdominal gill of *Chaquihua* (Ameletopsidae) nymph.

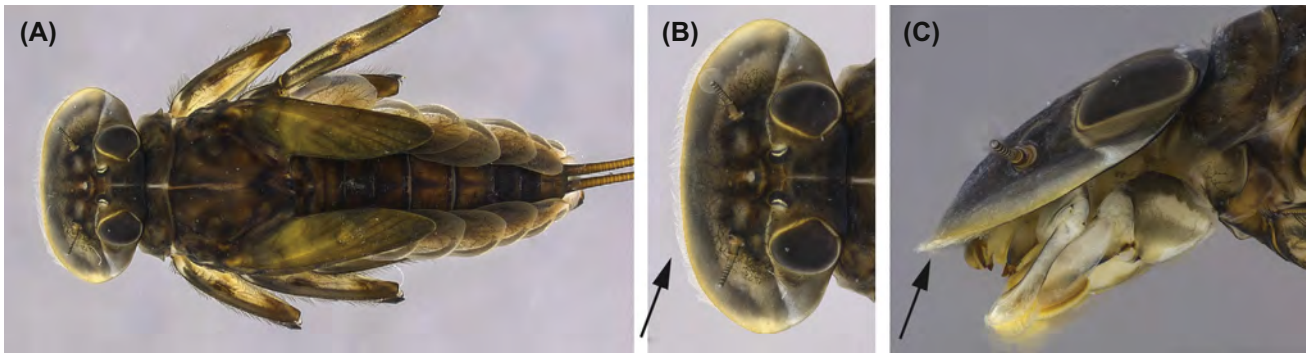

FIGURE 3.67 Nymph of *Epeorus* (Heptageniidae): (A) habitus; (B) detail of head in dorsal view; and (C) detail of head in ventral view. *Solid arrow* showing dense fringe of setae.

FIGURE 3.68 Nymph of *Rithrogena* (Heptageniidae), ventral view.

Heptageniidae: Genera

Modified from Webb & McCafferty (2008). This family has around 600 species: five species in four genera have been reported from Central America. *Stenacron* is also reported from southern Florida (Berner & Pescador, 1988).

1	Median caudal filament well developed (Fig. 3.68); head anterior margin without dense fringe of setae 2
1'	Median caudal filament vestigial (Fig. 3.67 A); head anterior margin with dense fringe of setae (Fig. 3.67 B) (reported from Colombia in error) ..... *Epeorus*
2(1)	First pair of gills do not meet or overlap ventrally; maxillary palp not enlarged (Fig. 3.69 A) 3
2'	First pair of gills meet or overlap ventrally to form friction disk (Fig. 3.68); maxillary palp enlarged (Fig. 3.69 B) ..... *Rhithrogena*

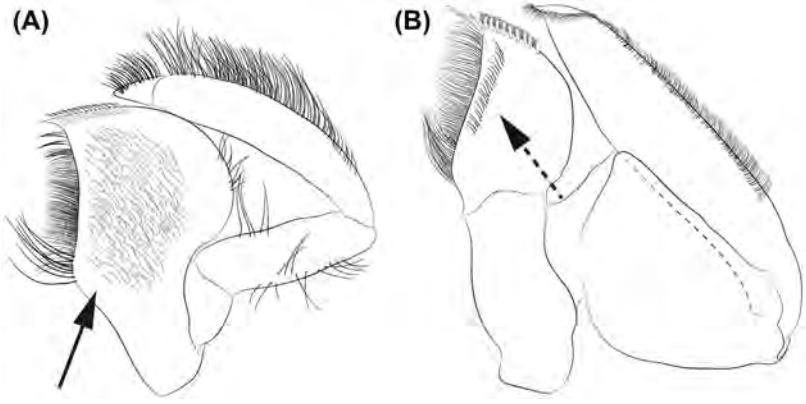

FIGURE 3.69 Maxillae of Heptageniidae nymphs: (A) *Ecdyonurus*; and (B) *Epeorus*.

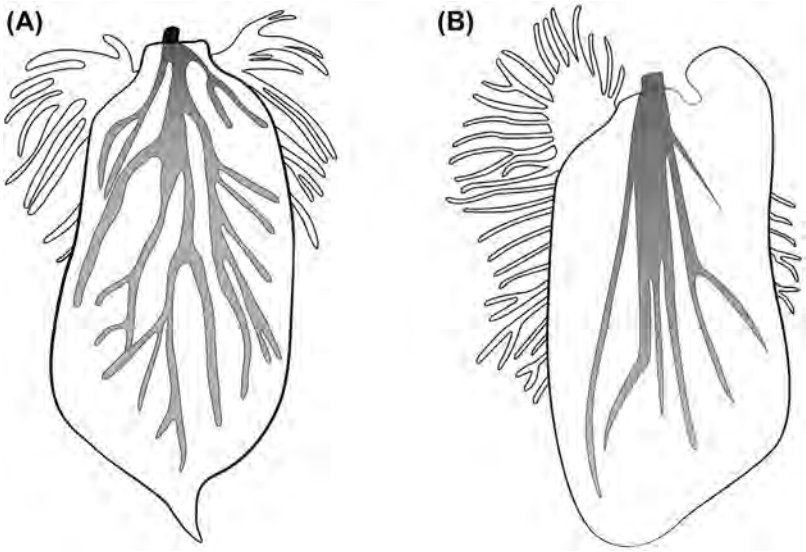

FIGURE 3.70 Gills of Heptageniidae nymphs: (A) *Stenacron*; and (B) *Mccaffertium*.

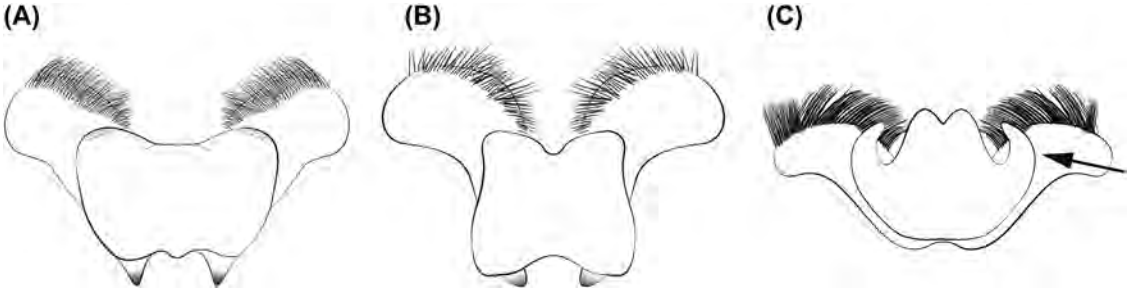

FIGURE 3.71 Hypopharynx of Leptophlebiidae nymphs: (A) *Fittkaulus*; (B) *Terpides*; and (C) *Ecuaphlebia*.

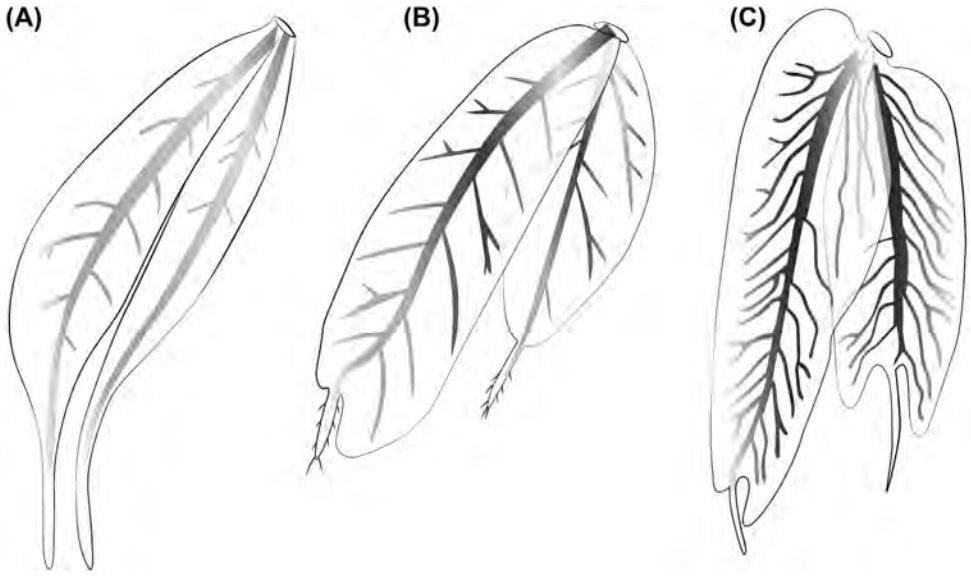

FIGURE 3.72 Gills of Leptophlebiidae nymphs: (A) *Terpides*; (B) *Fittkaulus*; and (C) *Tikuna*.

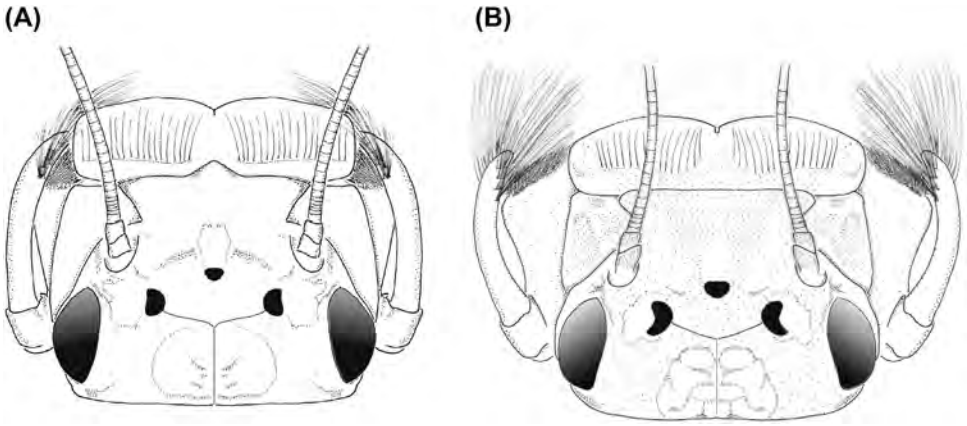

FIGURE 3.73 Head, in dorsal view, of Leptophlebiidae nymphs: (A) *Needhamella*; and (B) *Hylister*.

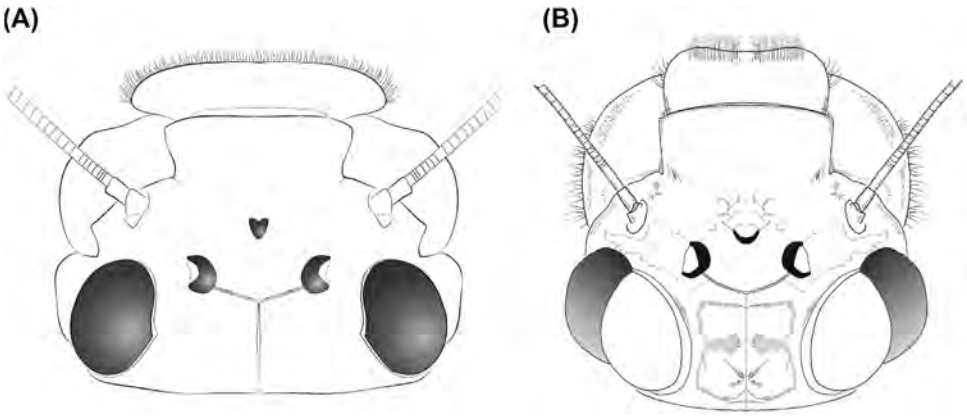

FIGURE 3.74 Head, in dorsal view, of Leptophlebiidae nymphs: (A) *Thraulodes*; and (B) *Massartella*.

3(2)	Maxillae ventrally with setal row (as in Fig. 3.69 B); gill one lamellae of variable, but never reniform	4
3'	Maxillae ventrally with scattered setae (Fig. 3.69 A); gills one lamellae usually reniform	*Ecdyonurus*
4(3)	Gill lamellae I to VI acutely pointed (Fig. 3.70 A); maxillae galea-lacinia crown with comb setae	*Stenacron*
4'	Gill lamellae I to VI truncate (Fig. 3.70 B); maxillae galea-lacinia crown with or without comb setae	*Mccaffertium*

Leptophlebiidae: Genera

Modified from Domínguez et al. (2006). This is one of the most diverse families of Ephemeroptera, with around 270 species and 50 genera recorded for the Neotropics (almost a third of the total number of genera and species). Of these genera, 75% are endemic to this region. Four of them are endemic to the Caribbean and 34 to South America. Most of the nymphs are prognathous, but a few are hypognathous. They have herbivorous mouthparts and are considered collectors-gatherers, collector-filterers, or shredders-detritivores. The nymphs can be found from the sea level, up to 4,500 m. Some genera that live at sea level in Patagonia, but are restricted to higher and higher altitudes toward the Andes in Northern Argentina, Bolivia, and Peru. Most of the genera present in the austral part of South America are more related to taxa from Australia and New Zealand, than to others present in the same continent. Nymphs are predominantly crawlers, with a somewhat flattened body, while a few genera with a streamlined body and abundant caudal filament setae are excellent swimmers (member of the Terpides lineage).

1	Hind wing pads present	2
1'	Hind wing pads absent	48
2(1)	Body hydrodynamic (Fig. 3.17); head hypognathous (Fig. 3.17); caudal filaments with dense row of setae (Fig. 3.17); hypopharynx lingua without lateral projections (Figs. 3.71 A, B)	3
2'	Body flattened (Fig. 3.16); head prognathous (Figs. 3.15, 16); caudal filaments with spines or setae, but not forming swimming setae; hypopharynx lingua with lateral projections (Fig. 3.71 C)	5

FIGURE 3.75 Fore leg, in dorsal view, of *Hagenulus caligatus* (Eaton) nymph. *After Peters (1971).*

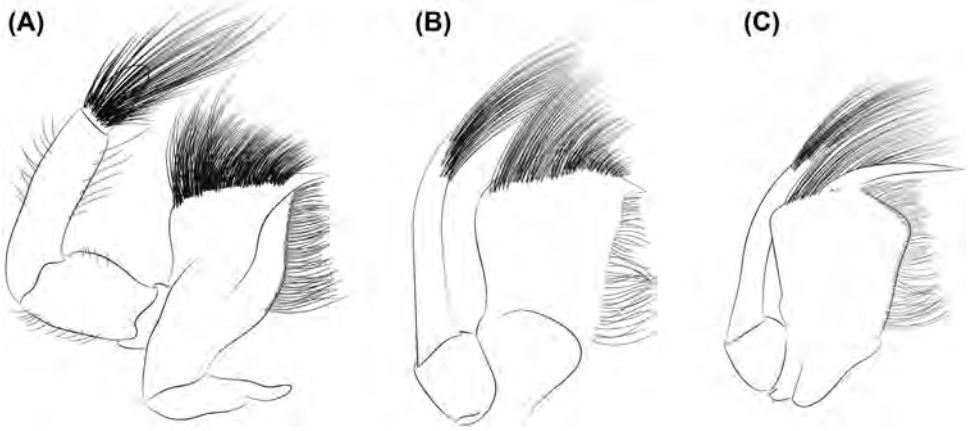

FIGURE 3.76 Maxillae of Leptophlebiidae nymphs: (A) *Hagenulus caligatus* (Eaton); (B) *Hylister*; (C) *Traverella*.

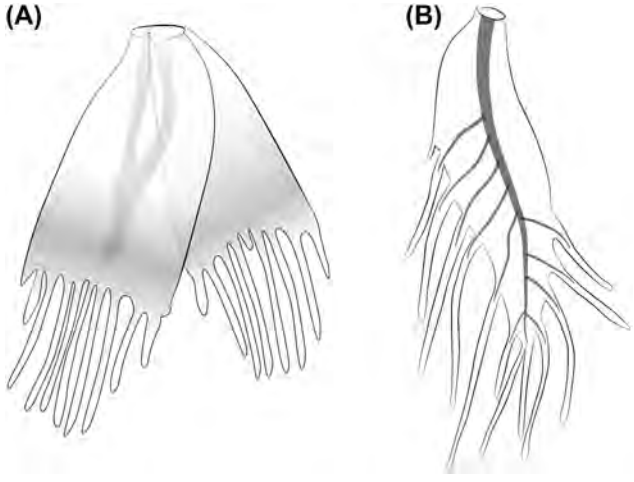

FIGURE 3.77 Gills of Leptophlebiidae nymphs: (A) *Hylister*; (B) *Traverella*. *Figure A adapted from Domínguez & Flowers (1989).*

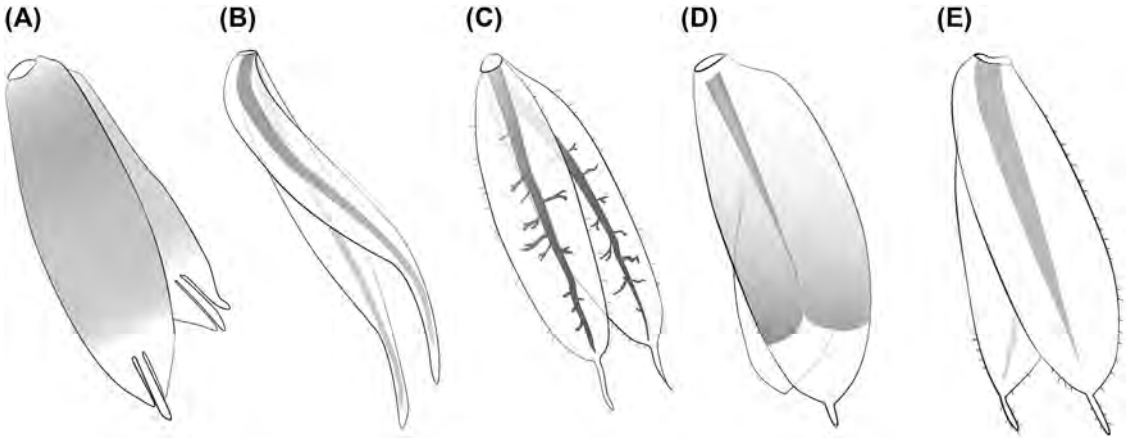

FIGURE 3.78 Gills of Leptophlebiidae nymphs: (A) *Hermanella*; (B) *Leentvaaria*; (C) *Hydrosmilodon*; (D) *Paramaka*; and (E) *Needhamella*. *Figures adapted from: (A) Domínguez & Flowers (1989); (B) Domínguez et al. (2001); (C) Flowers & Domínguez (1992); (D) Blanco-Belmonte et al. (2003); and (E) Flowers & Domínguez (1992).*

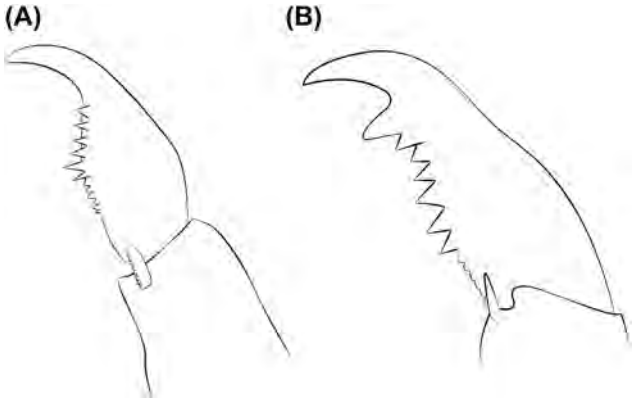

FIGURE 3.79 Tarsal claws of Leptophlebiidae nymphs: (A) *Traverella*; and (B) *Hylister*.

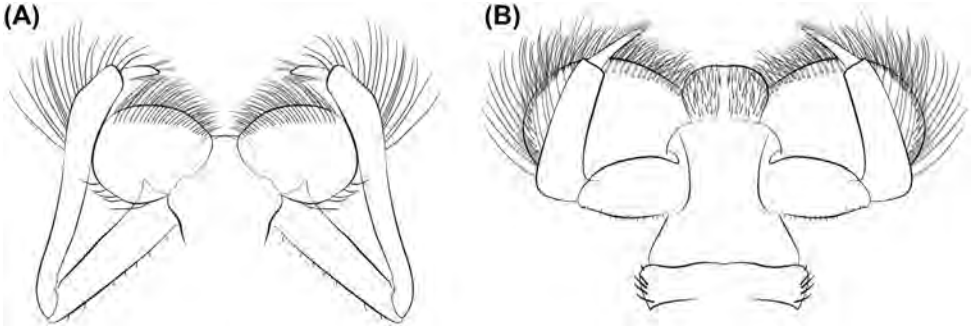

FIGURE 3.80 Labia of Leptophlebiidae nymphs: (A) *Leentvaaria*; and (B) *Paramaka*.

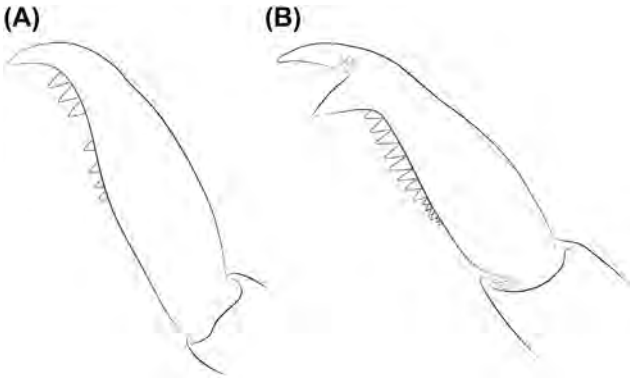

FIGURE 3.81 Tarsal claws of Leptophlebiidae nymphs: (A) *Hydromastodon*; and (B) *Hydrosmilodon*.

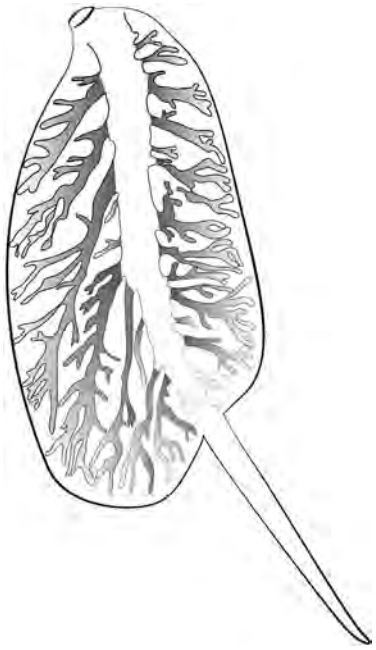

FIGURE 3.82 Gill of *Magallanella* (Leptophlebiidae) nymph. *Adapted from Pescador & Peters (1980).*

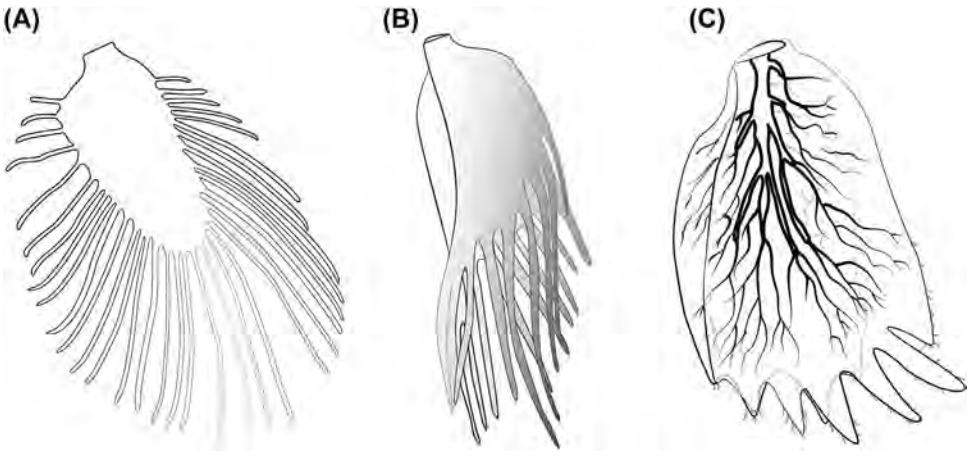

FIGURE 3.83 Gills of Leptophlebiidae nymphs: (A) *Ulmeritoides*; (B) *Atopophlebia*; and (C) *Dactylophlebia*.

3(2)	Gills lamellar, gills II to VI dorsal portions ending in a filament and with 1 or 2 lateral lobes (Figs. 3.72 B, C)	4
3’	Gills lamellar, tapering gradually toward apex and ending in single filament (Fig. 3.72 A)	*Terpides*
4(3)	Gills II–VI ventral portion without developed lobes (Fig. 3.72 B)	*Fittkaulu’*
4’	Gills II–VI ventral portion with apical internal and external lobes (Fig. 3.73 C)	*Tikuna*
5(2’)	Labrum as wide as, or wider than, head (Figs. 3.73 A, B, 75)	6
5’	Labrum narrower than head (Figs. 3.74 A, B)	14
6(5)	Labrum anteromedian emargination absent; maxillary palp article I poculiform, attached to side of maxilla (Figs. 3.76 B, C)	7
6’	Labrum anteromedian emargination present; maxillary palp article I not poculiform nor attached at base of maxilla (Fig. 3.76 A)	*Hagenulus* (in part)

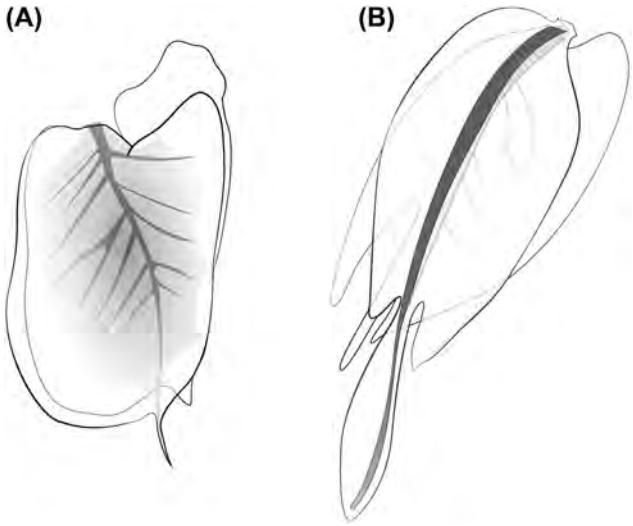

FIGURE 3.84 Gills of Leptophlebiidae nymphs: (A) *Massartella*; and (B) *Choroterps*.

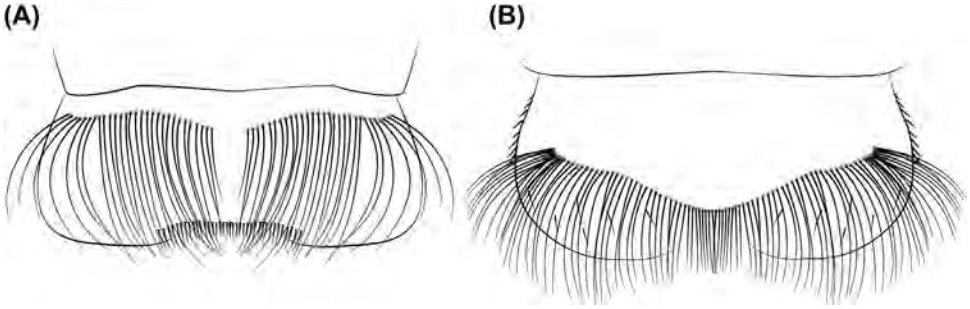

FIGURE 3.85 Labra of Leptophlebiidae nymphs: (A) *Ulmeritus*; and (B) *Ulmeritoides*.

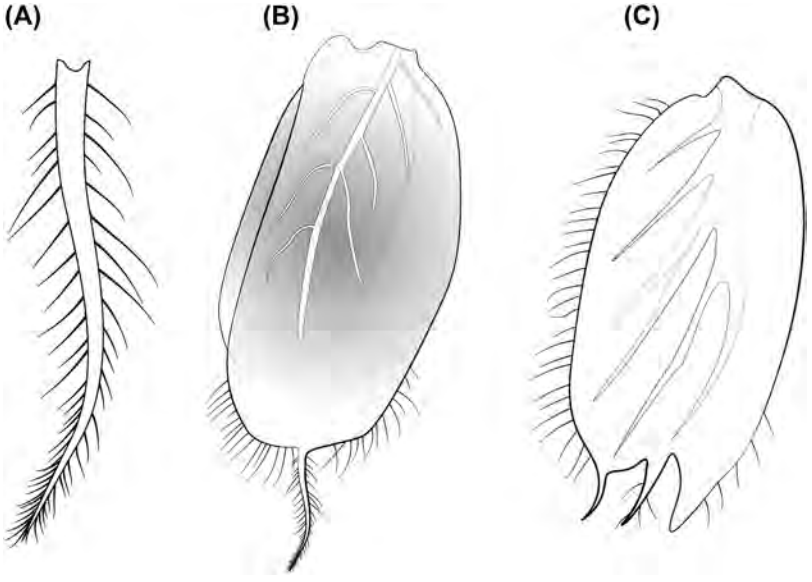

FIGURE 3.86 Gills of Leptophlebiidae nymphs: (A) Gill VII of *Hapsiphlebia*; and (B) Gill IV of *Hapsiphlebia*; (C) Gill IV of *Rhigotopus*. *Figures adapted from: (A-B) Pescador & Edmunds (1972); and (C) Miserendino (1996).*

7(6) Gills with six or more digitiform projections (Fig. 3.77) 8
7' Gills with three or fewer digitiform projections (can be absent) (Fig. 3.78) 9
8(7) Gills oval, fringed with filaments (Fig. 3.77 B); tarsal claws denticle equal size (Fig. 3.79 A) ..... *Traverella*
8' Gills rather quadrangular, truncated apically, with 6−10 digitiform projections (Fig. 3.77 A); tarsal claws with much larger apical denticle (Fig. 3.79 B) ..... *Hylister*
9(7') Labial palpi article II length <3× article III (Fig. 3.80 B) 10
9' Labial palpi article II length ~6× article III (Fig. 3.80 A) ..... *Leentvaaria*
10(9) Some or all gills with single median digitiform projection (Figs. 3.78 B−E) 11
10' Gills ending in lateral lobes and longer median process (Fig. 3.78 A) ..... *Hermanella*
11(10) Maxillary tusk 1/2 or more width of apex of maxilla (Fig. 3.76 C) 12
11' Maxillary tusk approximately 1/4 or less width of apex of maxilla (Fig. 3.76 B) 13
12(11) Tarsal claws with subequal denticles, in two different rows (Fig. 3.81 A) ..... *Hydromastodon*
12' Tarsal claws with subapical denticle much larger than the others, with one row of denticles (Fig. 3.81 B) ..... *Hydrosmilodon*
13(11') Gills of segment VII vestigial; apical process of gills variable (Fig. 3.78 D), small or absent on some gills ..... *Paramaka*
13' Gills similar in form on abdominal segments I−VII, dorsal and ventral portions always with digitiform process (Fig. 3.78 E) ..... *Needhamella*
14(5') Gills on abdominal segments II−VI composed by two narrow-to-broad lamellae (one ventral and one dorsal portion) 15
14' Each abdominal gill composed by single ovoid lamella, ending abruptly in a thick digitiform projection (Fig. 3.82) ..... *Magallanella*
15(14) Gill margins with five or more filaments (Fig. 3.83) 16
15' Gill margins with zero to three filaments (Figs. 3.84, 86) 19
16(15) Entire gill margins fringed with filamentous projections (Fig. 3.83 A) 17
16' Filamentous projections only present on the distal portion of the gill (Figs. 3.83 B, C) 18
17(16) Row of long dorsal setae of labrum divided, without setae medially (Fig. 3.85 A) ..... *Ulmeritus*
17' Row of long dorsal setae of labrum entire, forming a single sinusoidal row (Fig. 3.85 B) ..... *Ulmeritoides*
18(16') Gills I−VI with filamentous projections on apical margin (Fig. 3.83 B), gill VII reduced to pair of filaments; margins of mandibles fringed with long setae, setae denser on apical ½ ..... *Atopophlebia*
18' Gills I−VII similar, with filamentous projections on apical margin (Fig. 3.83 C); margins of mandibles with median tuft of setae, and some setae on basal ½ ..... *Dactylophlebia*
19(15') Gills present on abdominal segments I−VII, gills variable but not as below (Figs. 3.84 B, 86) 20
19' Gills present on abdominal segments I−VI, broad, with (Fig. 3.84 A) or without an apical filament ..... *Massartella*
20(19) Gills on abdominal segment I similarly shaped as other gills 21
20' Gills on abdominal segment I reduced to a single filament, gills on segments II−VII with three projections, dorsal portion with terminal filament long and expanded (Fig. 3.84 B) ..... *Choroterpes*
21(20) Gills on abdominal segments VI−VII or VII vestigial, almost reduced to a single filament (Fig. 3.86 A); ventral portion smaller than dorsal portion (Figs. 3.86 B, C) 22
21' Gills on abdominal segments VI and VII with the same shape as gills on segments II−V (Fig. 3.87) 23
22(21) Gills on abdominal segments I−VI with three distal projections (Fig. 3.86 C), median projection sometimes a little longer; smaller ventral portion with similar projections ..... *Rhigotopus* [Andean-Patagonic Region]
22' Dorsal portion of gills on abdominal segments I−V wide, with narrow distal projection; small ventral portion without terminal projection (Fig. 3.86 B) ..... *Hapsiphlebia* [Andes]
23(21') Gills on abdominal segments I−VII variable, dorsal portion as large as, or larger than, ventral portion (Figs. 3.87 B-E) 24
23' Gills on abdominal segments I−VII oval, dorsal portion 3/4 as long and 1/2 as wide as ventral portion (Fig. 3.87 A) ..... *Microphlebia*
24(23) Gills with long and narrow terminal projection, 4/5 to 1/2 as long as basal part; basal part wider, usually with lateral lobes (Figs. 3.87 B, C) 25
24' Distal projection of gills, if present, ≤1/3 as long as basal part (Figs. 3.87 D, E); basal part not as above 26
25(24) Posterolateral spines present on abdominal segments V or VI to IX; tarsal claw denticles gradually larger from the base to apex (as in Fig. 3.91 B) ..... *Traverina* [Caribbean]
25' Posterolateral spines present on abdominal segments II or III to IX; tarsal claw denticles of progressively larger apically, apical denticle often much larger (as in Fig. 3.81 B) ..... *Miroculis* [South America]
26(24') Posterolateral projections present on abdominal segments II or III−IX 27
26' Posterolateral projections present on abdominal segments V or VI or VII or VIII−IX 32
27(26) Labrum lateral margins divergent, forming lateral angles (Fig. 3.88 A) 28
27' Labrum lateral margins rounded (Fig. 3.88 B) 29
28(27) Labial and maxillary palpi strongly developed (Fig. 3.89 A); maxillary palp article III length 2× II, and labial palp article II length 2× article I ..... *Segesta*
28' Labial and maxillary palpi not strongly developed (Fig. 3.89 B); maxillary palp article III shorter than II, and labial palp article I and II subequal ..... *Thraulodes*
29(27') Mandible lateral margin glabrous, except for submedian tuft (Fig. 3.90 A) 30
29' Mandible lateral margin with setae on at least half of its length (Fig. 3.90 B) 31

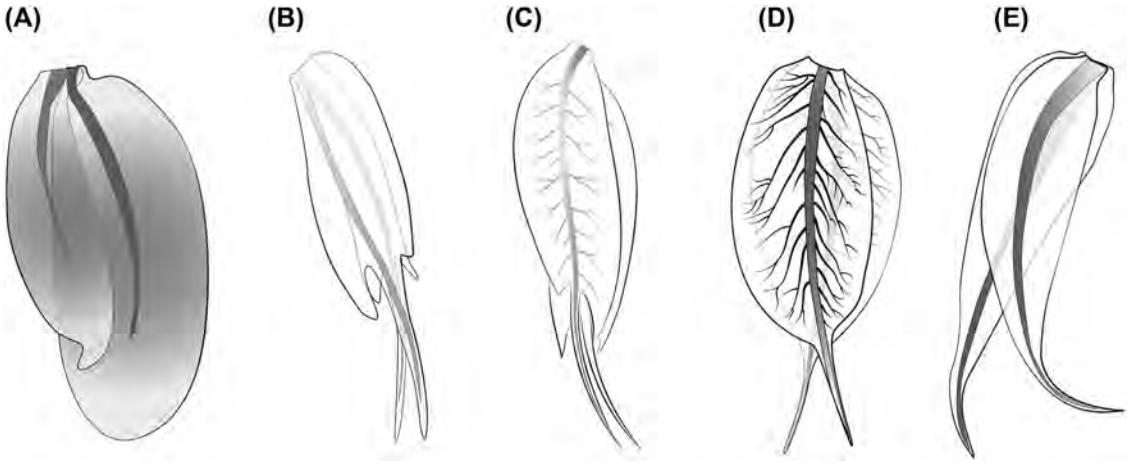

FIGURE 3.87 Gills of Leptophlebiidae nymphs: (A) *Microphlebia*; (B) *Miroculis*; (C) *Traverina*; (D) *Penaphlebia*; and (E) *Thraulodes*.

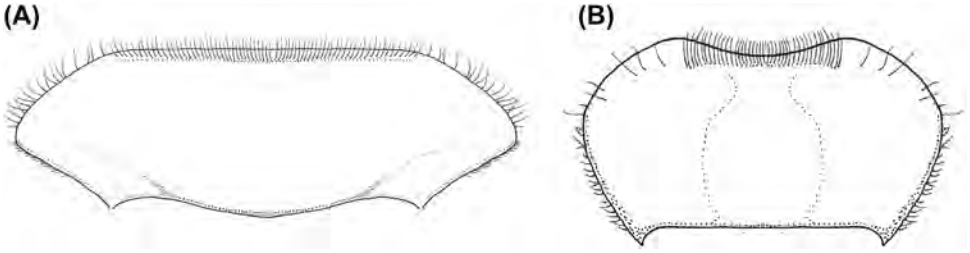

FIGURE 3.88 Labra of Leptophlebiidae nymphs: (A) *Thraulodes*; and (B) *Simothraulopsis*.

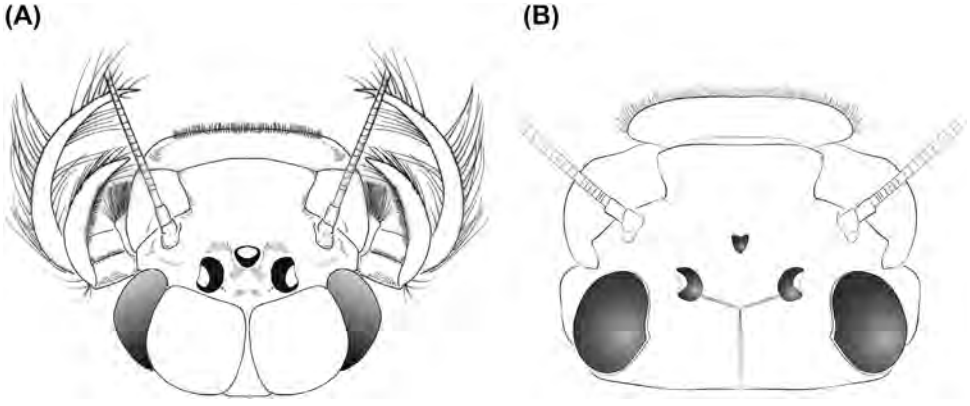

FIGURE 3.89 Head, in dorsal view, of Leptophlebiidae nymphs**:** (A) *Segesta*; and (B) *Thraulodes*.

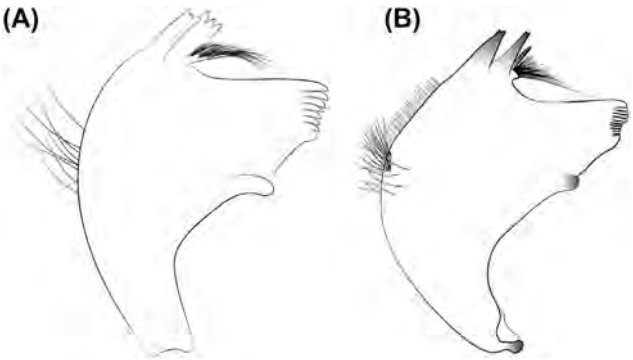

FIGURE 3.90 Left mandibles of Leptophlebiidae nymphs: (A) *Neohagenulus*; and (B) *Massartellopsis*. *Figures adapted from: (A) Peters (1971); and (B) Pescador & Peters (1987).*

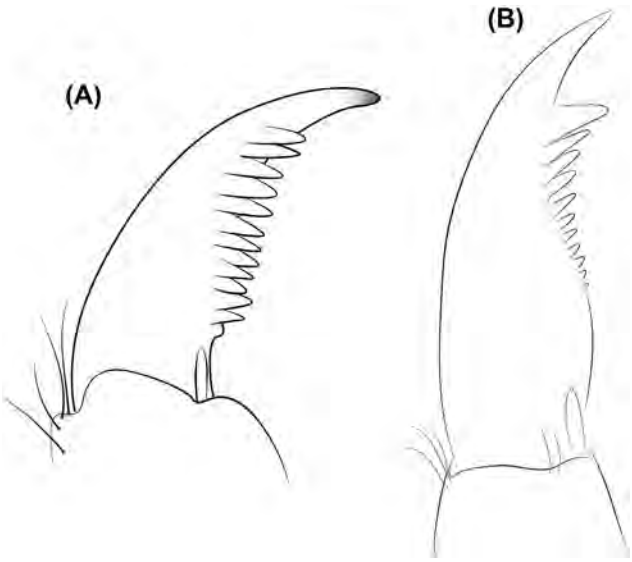

FIGURE 3.91 Tarsal claws of Leptophlebiidae nymphs: (A) *Secochela*; and (B) *Neohagenulus*. *Figures adapted from: (A) Pescador & Gonser (2001); and (B) Peters (1971).*

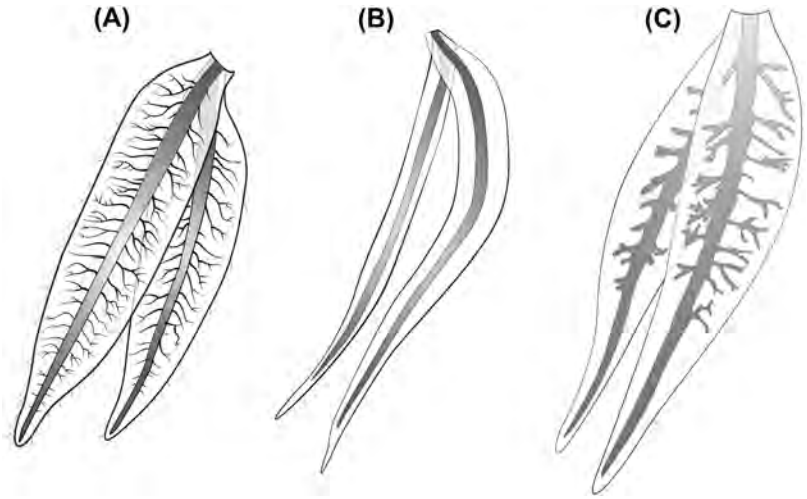

FIGURE 3.92 Gills of Leptophlebiidae nymphs: (A) *Massartellopsis*; (B) *Meridialaris*; and (C) *Meridialaris*. *Adapted from Pescador & Peters (1987).*

30(29) Mandible lateral margin median tuft of setae very short; basal tarsal claw denticles unequal, remaining denticles gradually larger toward the apex (Fig. 3.91 A) ..... *Secochela* [Southern Chile]

30' Mandible lateral margin median tuft of setae long; tarsal claw denticles progressively larger apically (Fig. 3.91 B)..... *Neohagenulus* [Caribbean, Puerto Rico]

31(29') Gills with main tracheal trunk and tracheal branches similarly pigmented (Fig. 3.92 A)..... *Massartellopsis*

31' Gills with tracheal branches less pigmented than main tracheal trunk (Figs. 3.92 B, C)..... *Meridialaris*

32(26') Abdominal gills variable, lanceolate to narrow (Fig. 3.94 A), apical process not as below; labium with glossa on same plane as, or dorsal to, paraglossa (Fig. 3.94 B) 33

32' Abdominal gills wide and oval (width approximately 1/3 total length of gill) with apical process narrowed apically (Fig. 3.93 A); labium with glossa ventral to paraglossa (Fig. 3.93 B) ..... *Penaphlebia*

33(32) Posterolateral projections present on abdominal segments VIII–IX 34

33' Posterolateral projections present on abdominal segments V or VI or VII–IX 38

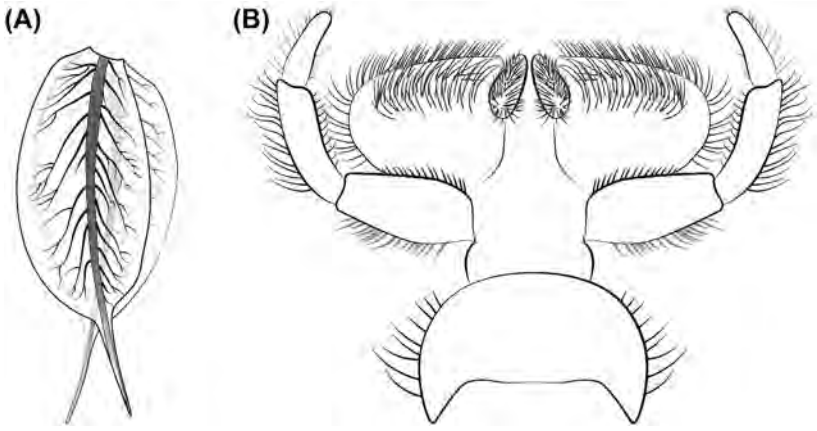

FIGURE 3.93 Nymphal structures of *Penaphlebia* (Leptophlebiidae): (A) gill; and (B) labium. *Adapted from Pescador & Peters (1991).*

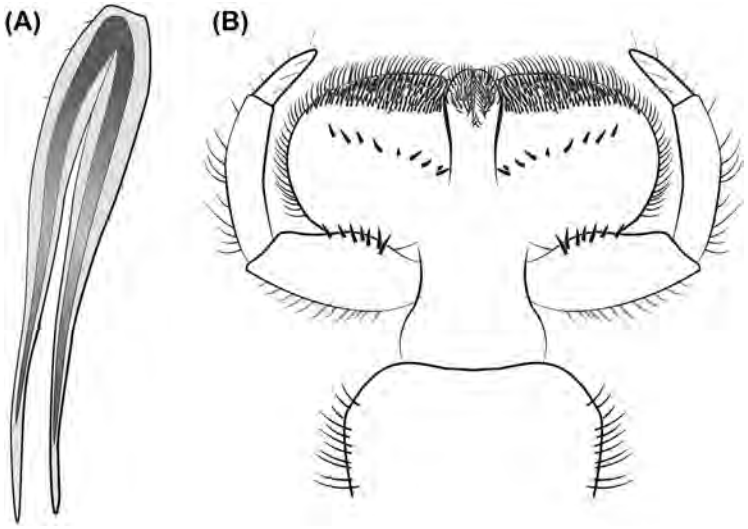

FIGURE 3.94 Nymphal structures of *Farrodes* (Leptophlebiidae): (A) gill; and (B) labium. *Adapted from Domínguez & Savage (1987).*

34(33)	Maxillary palpi not so strongly developed; segments I and II, each approximately twice as long as segment III	35
34'	Maxillary palpi strongly developed, segments I and II, each approximately four times length of segment III (Fig. 3.95)	*Lisetta*
35(34)	Gills very narrow (maximum width approximately 1/10 the length) (Fig. 3.94 A)	36
35'	Gills wider (maximum width 1/5 to 1/3 the length) (Fig. 3.96)	37
36(35)	Labrum anterior emargination shallow, with five equally sized denticles (Figs. 3.97 A, B)	*Farrodes*
36'	Labrum anterior emargination deep, margins rounded, with three weak crenulations (Fig. 3.97 C)	*Poranga*
37(35')	Widest section of gills approximately 1/5 of length (Fig. 3.96 A)	*Simothraulopsis* (in part)
37'	Widest section of gills approximately 1/3 of the length (Fig. 3.96 B)	*Homothraulus*
38(33)	Hind tibia not as below, cylindrical, subcylindrical or slightly flattened, dorsal surface never concave (Fig. 3.98 B)	39
38'	Hind tibia strongly flattened, dorsal surface concave (Fig. 3.98 A) [Caribbean, Cuba]	*Poecilophlebia*
39(38)	Tarsal claw denticles progressively larger toward apex (as in Fig. 3.91 B)	40

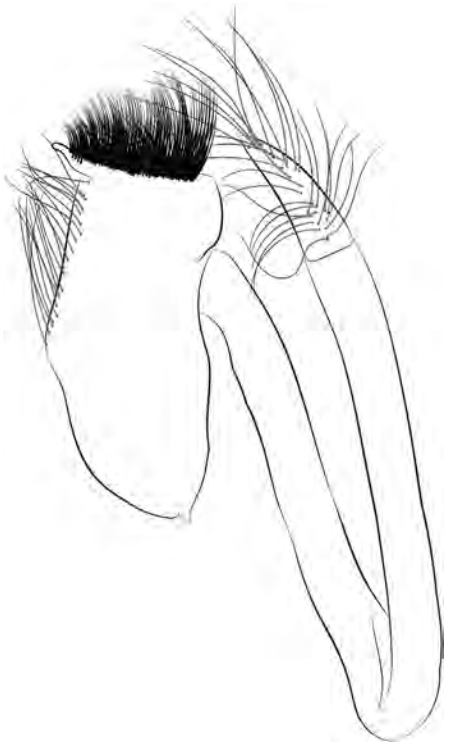

FIGURE 3.95 Maxilla of *Lisetta ernsti* Thomas and Dominique (Leptophlebiidae) nymph. *After Thomas et al. (2005).*

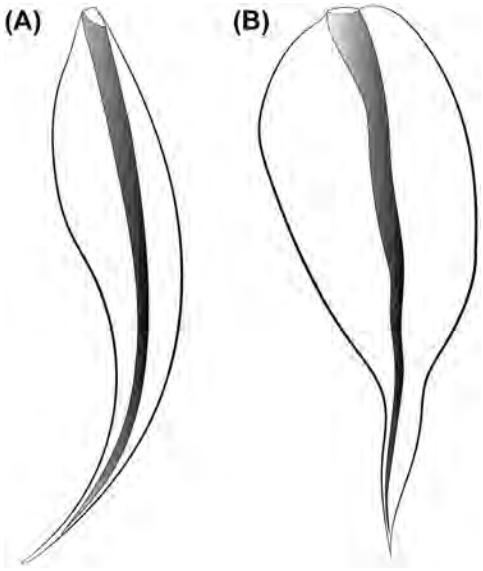

FIGURE 3.96 Gills of Leptophlebiidae nymphs: (A) *Simothraulopsis*; and (B) *Homothraulus*.

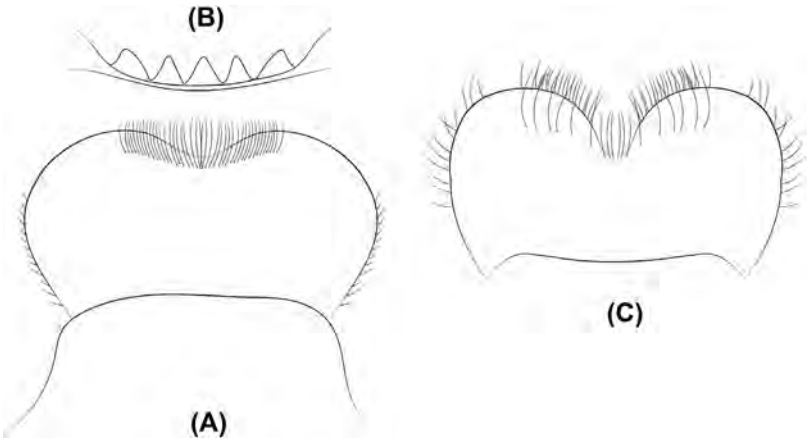

FIGURE 3.97 Labra of Leptophlebiidae nymphs: (A) *Farrodes*; (B) *Farrodes* (detail of anterior margin); and (C) *Poranga nessimiani* Gonçalves and Da-Silva.

39’	Tarsal claw denticles progressively larger toward claw apex, except apical denticle much larger (as in Fig. 3.81 B)	44
40(39)	Maxillary palp longer than maxilla (Fig. 3.99)	41
40’	Maxillary palp distinctly shorter than length of maxilla	42
41(40)	Maxillary tusk absent (Fig. 3.99 B); fore leg without rows of filtering setae.	*Demoulinellus*
41’	Maxillary tusk present (Fig. 3.99 A); fore leg with rows of filtering setae (as in Fig. 3.75)	*Hagenulus* (in part)
42(40’)	Labrum anteromedial emargination broad, with denticles	43
42’	Labrum anteromedial emargination narrow, without denticles	*Turquinophlebia* [Caribbean, Cuba]

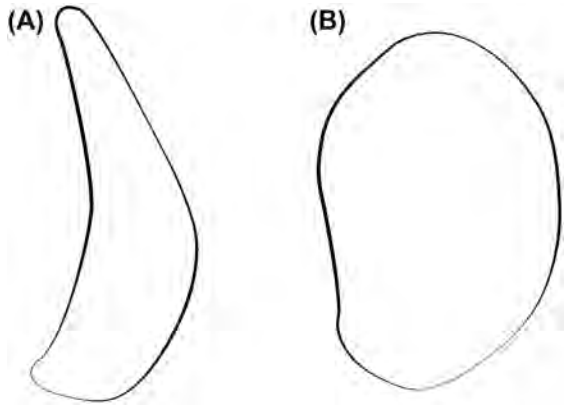

FIGURE 3.98 Cross section of hind tibiae of Leptophlebiidae nymphs: (A) *Poecilophlebia pacoi* Kluge; and (B) *Careospina baconaoi* Kluge. *Adapted from Kluge (1994).*

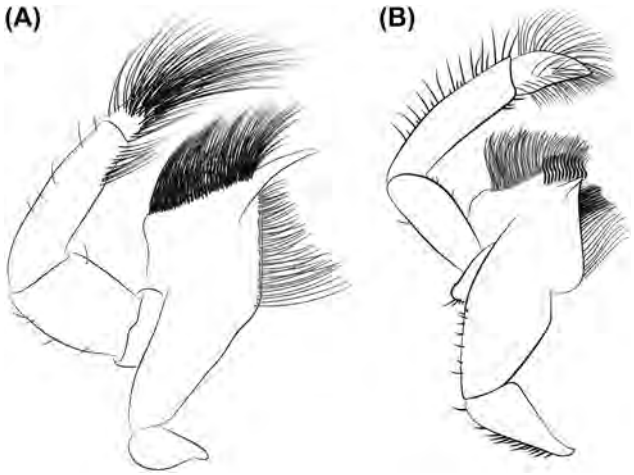

FIGURE 3.99 Maxillae of Leptophlebiidae nymphs: (A) *Hagenulus caligatus* (Eaton); and (B) *Demoulinellus*. *Figures adapted from: (A) Peters (1971); and (B) Pescador & Peters (1982).*

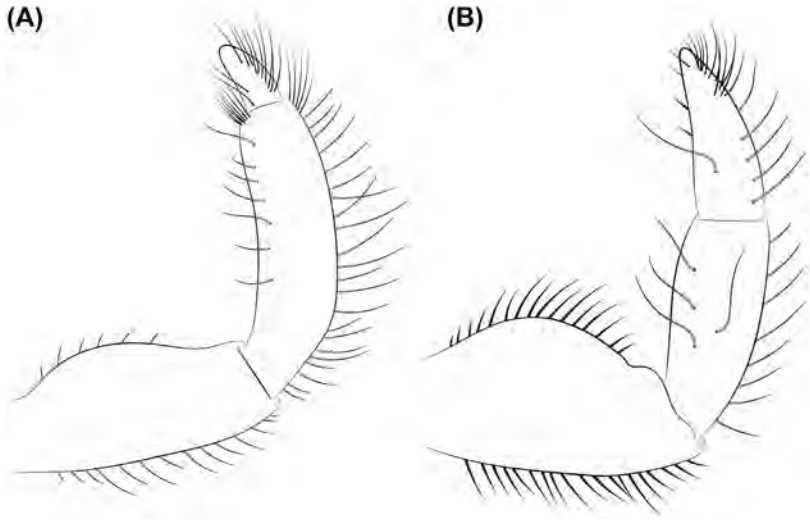

FIGURE 3.100 Labial palpi of Leptophlebiidae nymphs: (A) *Careospina*; and (B) *Nousia*.

ORDER EPHEMEROPTERA

43(42)	Labial palp article III slightly shorter or longer than article II (Fig. 3.100 B)	*Nousia* (in part) [Andean-Patagonic Region]
43'	Labial palp article III distinctly shorter than article II (approximately ¼) (Fig. 3.100 A)	*Careospina* [Caribbean]
44(39')	Maxilla galea-lacinia without tusk on apex	45
44'	Maxilla galea-lacinia with tusk on apex (Fig. 3.101)	*Gonserellus*
45(44)	Labrum anteromedian emargination never with two large denticles	46 [continental South America]

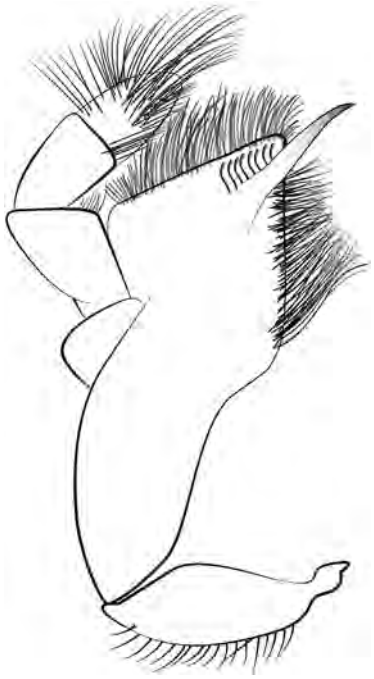

FIGURE 3.101 Maxilla of *Gonserellus* (Leptophlebiidae) nymph. *Adapted from Pescador & Peters (1985).*

FIGURE 3.103 Left mandible of *Ecuaphlebia* (Leptophlebiidae) nymph. *Adapted from Peters (1969).*

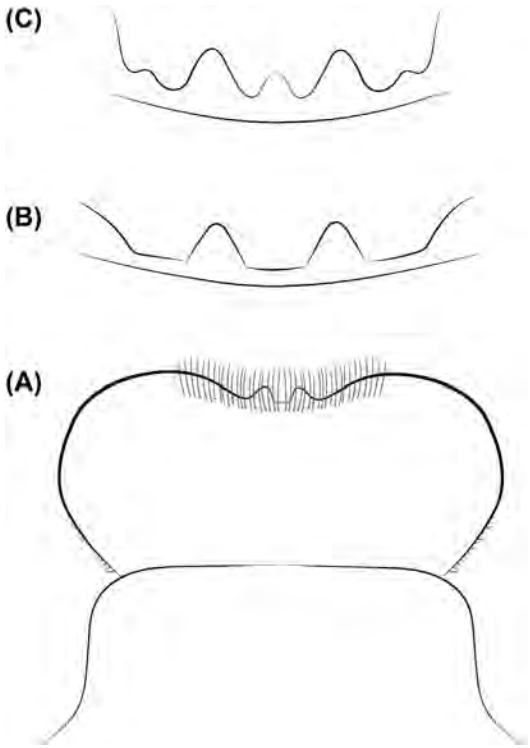

FIGURE 3.102 Labrum of *Borinquena* (Leptophlebiidae) nymph: (A) dorsal view; (B) and (C) detail of anterior margin.

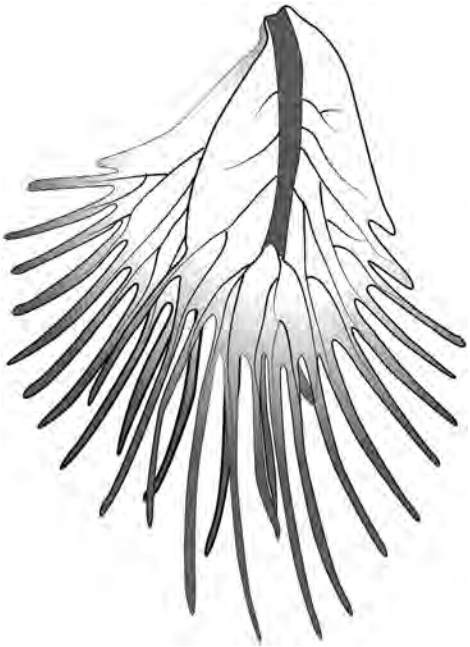

FIGURE 3.104 Gill of *Askola* (Leptophlebiidae) nymph.

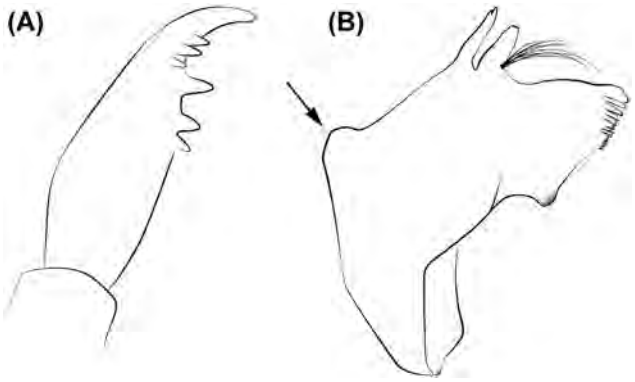

FIGURE 3.105 Nymphal structures of *Perissophlebiodes flinti* (Savage) (Leptophlebiidae): (A) tarsal claw; and (B) left mandible. *Adapted from Savage (1982).*

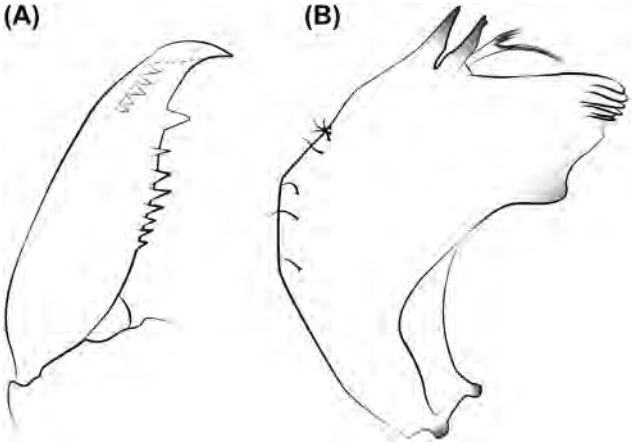

FIGURE 3.106 Nymphal structures of *Bessierus doloris* Thomas and Orth (Leptophlebiidae): (A) tarsal claw; and (B) left mandible. *After Thomas et al. (2001).*

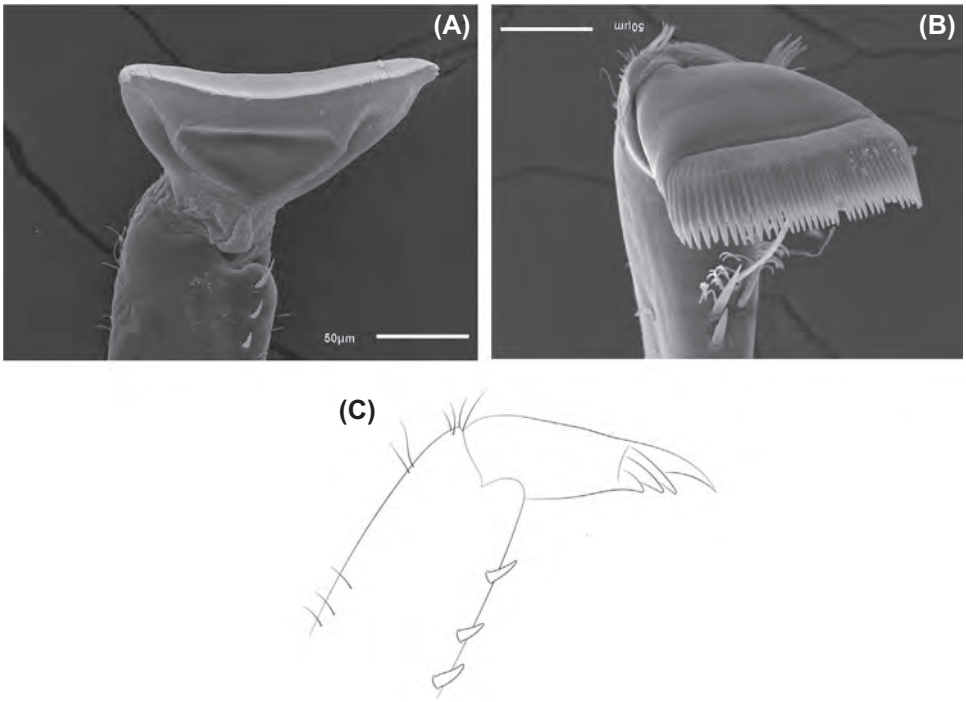

FIGURE 3.107 Tarsal claw of Baetidae nymphs: (A) *Tapajobaetis labiosus* Boldrini and Salles; (B) *Camelobaetidius*; and (C) *Corinella*. *After Boldrini et al. (2017).*

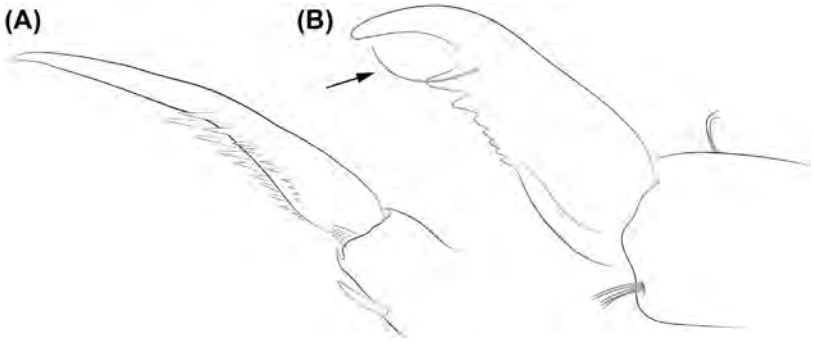

FIGURE 3.108 Tarsal claw of Baetidae nymphs: (A) *Waltzoyphius*; and (B) *Baetodes*.

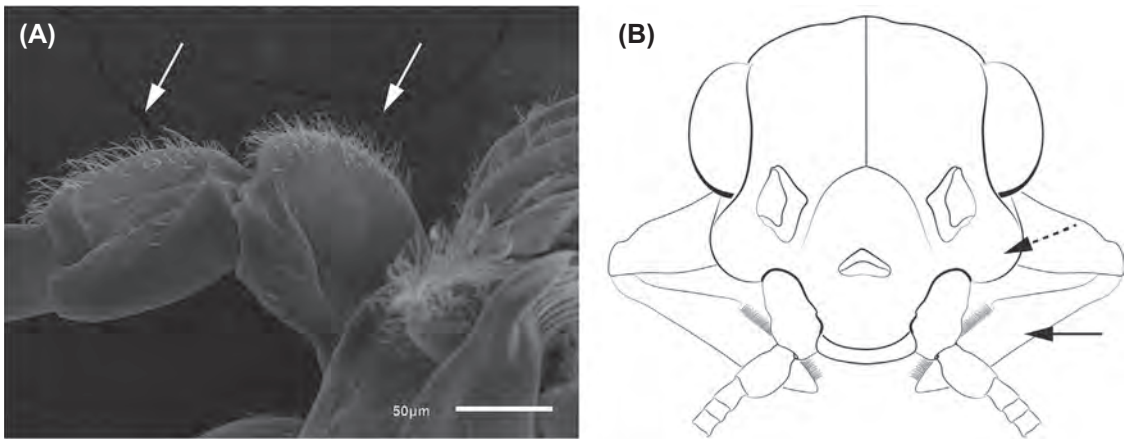

FIGURE 3.109 Head and appendages of *Tapajobaetis labiosus* Boldrini and Salles (Baetidae) nymph: (A) detail of scape and pedicel; and (B) frontal view of head. *White arrows* showing row of setae, *black solid arrow* showing labial palp, *black dashed arrow* showing gena. *After Boldrini et al. (2017).*

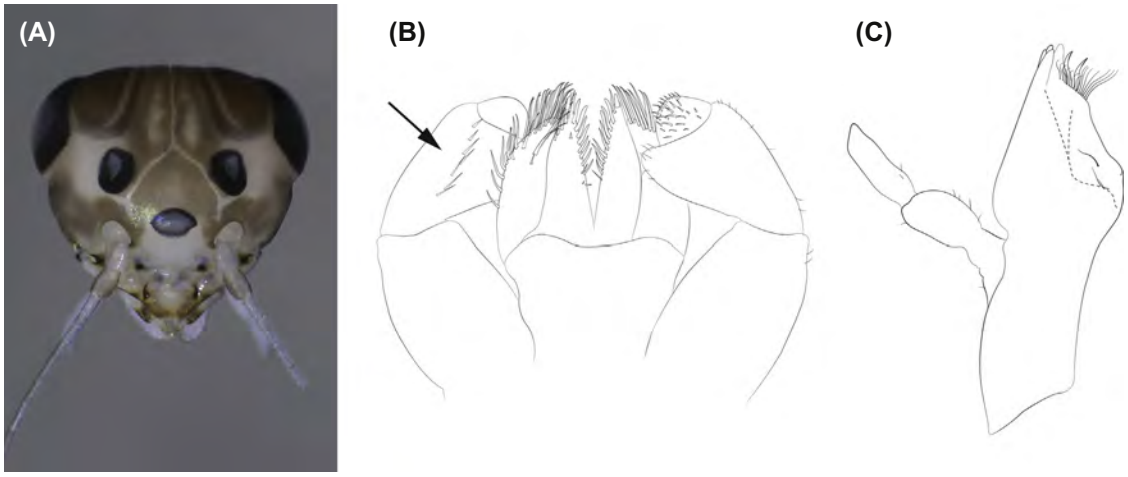

FIGURE 3.110 Head and appendages of *Camelobaetidius* (Baetidae) nymph: (A) frontal view of head; (B) labium; and (C) maxilla. *Black solid arrow* showing row of seta on dorsal surface labial palp segment II.

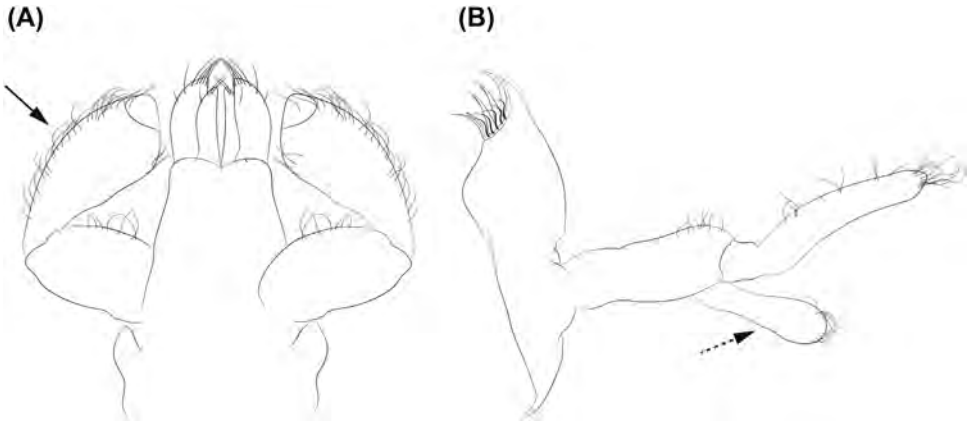

FIGURE 3.111 Selected mouth parts of *Corinella* (Baetidae): (A) labium; and (B) maxilla. *Black solid arrow* showing row of seta on outer margin of labial palp segment II. Black dashed arrow showing long papila.

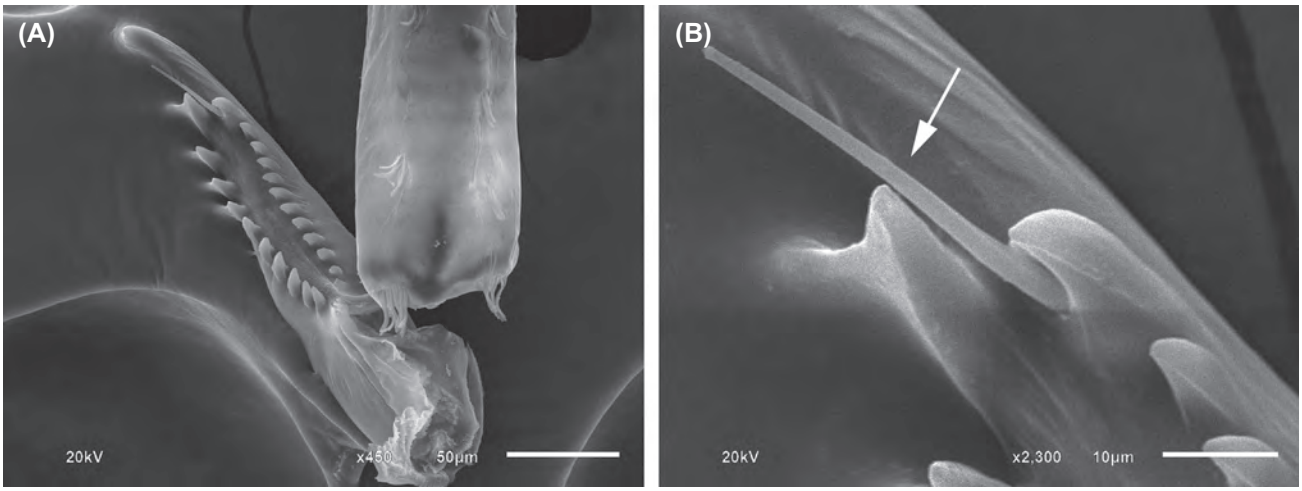

FIGURE 3.112 Tarsal claw of *Spiritiops* (Baetidae), SEM pictures: (A) general view; and (B) detail of apex. *White solid arrow* showing strong subapical seta.

FIGURE 3.113 Right mandible of *Spiritiops* (Baetidae).

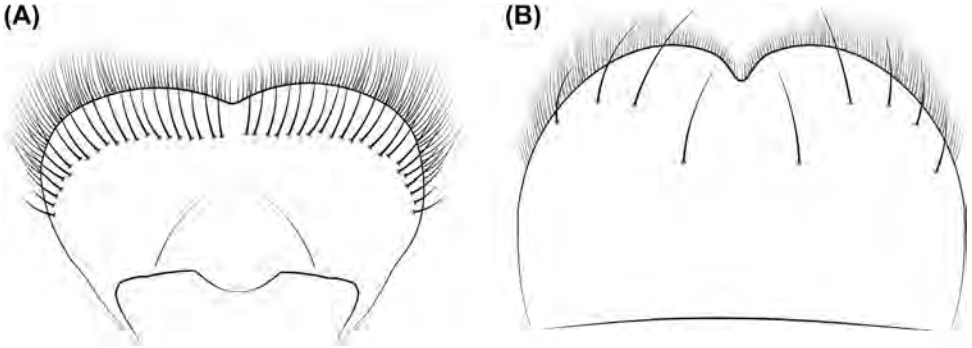

FIGURE 3.114 Labra of Baetidae nymphs: (A) *Moribaetis*; and (B) *Caribaetis*.

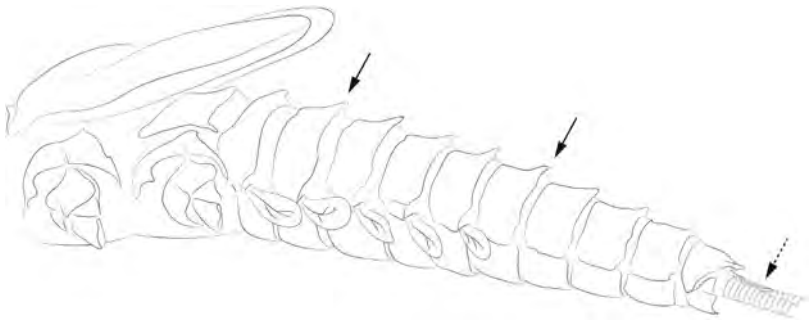

FIGURE 3.115 Lateral view of a nymph of *Baetodes* (Baetidae). *Black arrows* showing dorsal tubercle on abdomen, *black dashed arrow* showing reduced median terminal filament.

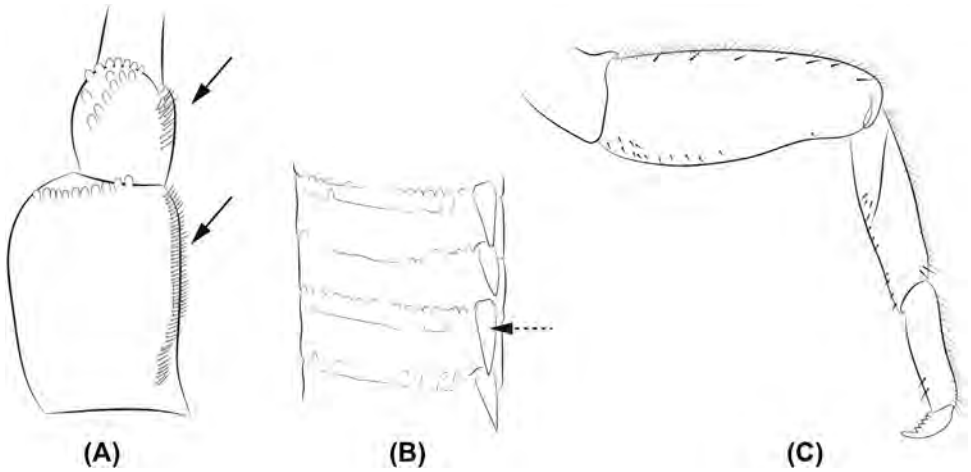

FIGURE 3.116 Nymphal structures of *Mayobaetis* (Baetidae): (A) scape and pedicel; (B) detail of cercus; and (C) fore leg. *Black solid arrows* showing row of setae, *black dashed arrow* showing strong spine.

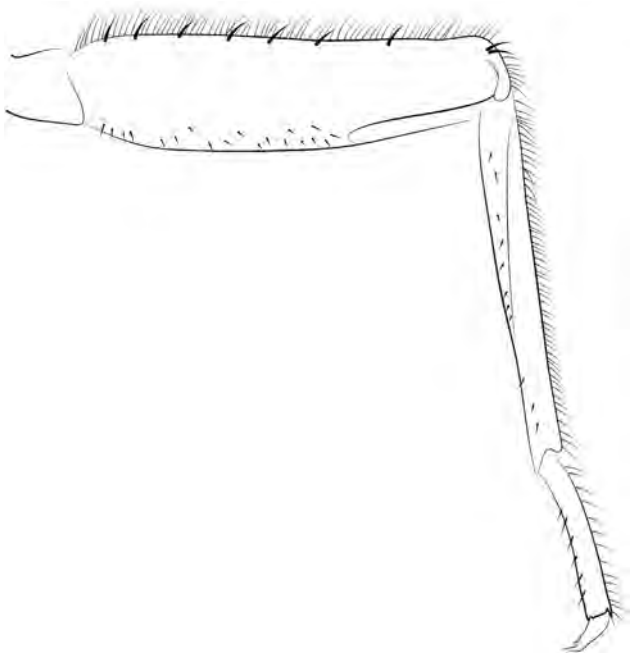

FIGURE 3.117 Fore leg of *Prebatodes* (Baetidae).

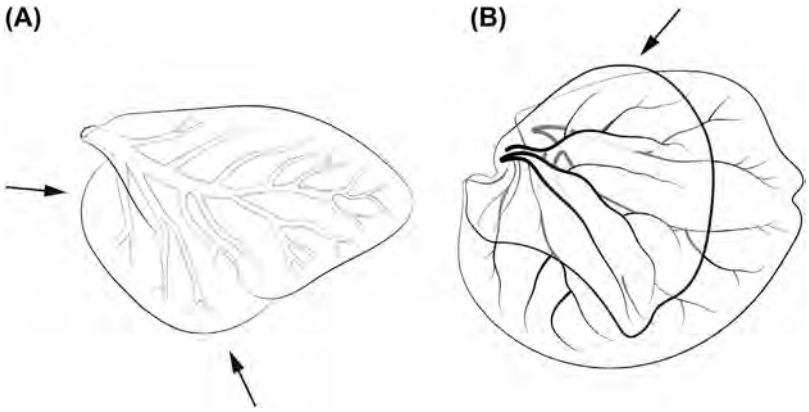

FIGURE 3.118 Gills of Baetidae nymphs: (A) *Callibaetoides caaigua* Cruz, Salles, and Hamada; and (B) *Cloeon smaeleni* Lestage.

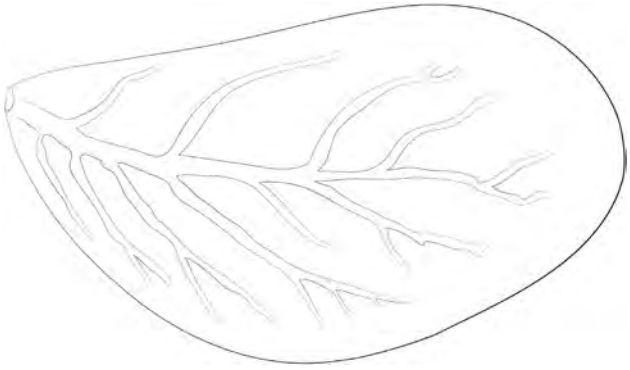

FIGURE 3.119 Gill of *Cloeodes* (Baetidae).

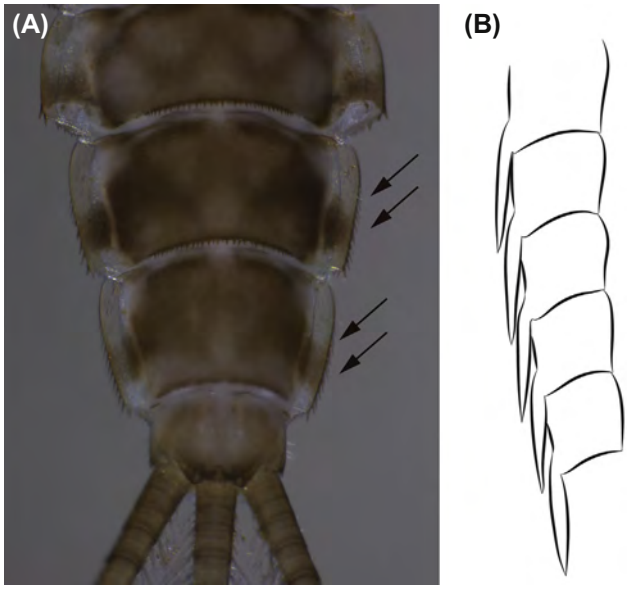

FIGURE 3.120 *Cloeon smaeleni* Lestage (Baetidae), nymphal structures: (A) dorsal view of abdominal segments VII to X; and (B) cercus. *Black solid arrows* showing spines on lateral margin.

45'	Labrum anteromedian emargination with two large denticles (one to three small denticles also present in some species) (Fig. 3.102) ..... *Borinquena* [Caribbean]
46(45)	Labial palp article III distinctly shorter than article II 47
46'	Labial palp article III slightly shorter or longer than article II (Fig. 3.100 B) ..... *Nousia* (in part)
47(46)	Mandible external margin glabrous, except for submedian tuft; gills wide, tapering abruptly on distal $^1/_3$ (Fig. 3.96 A) ..... *Simothraulopsis* (in part) [Widespread]
47'	Mandible external margin with scattered setae on basal half (Fig. 3.103); gills not so wide, gradually tapering toward apex … *Ecuaphlebia* [Northern South America]
48(1')	Gills narrow, tapering gradually toward apex (as in Fig. 3.94 A) 49
48'	Gills wide, apical 1/2 fringed with digitform processes (Fig. 3.104) ..... *Askola*
49(48)	Tarsal claws with two denticle rows (Figs. 3.105 A, 106 A); mandibles strongly curved (Figs. 3.105 B, 106 B) 50

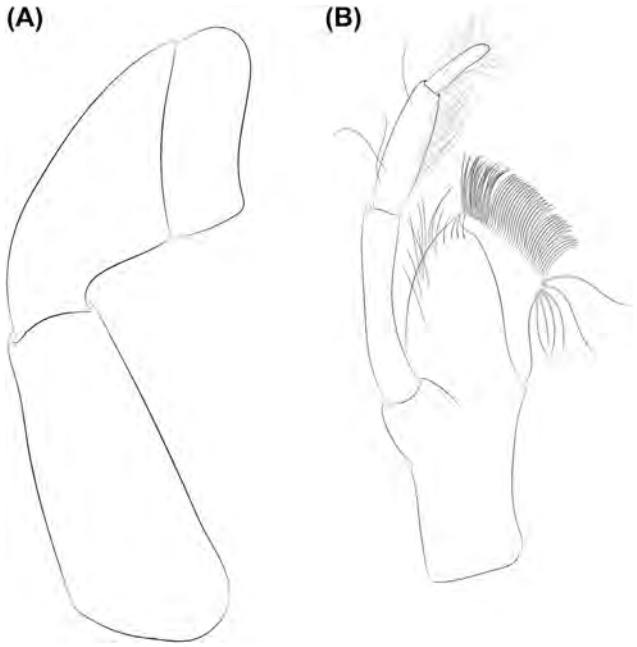

FIGURE 3.121 Mouth parts of *Callibaetoides caaigua* Cruz, Salles, and Hamada nymph (Baetidae): (A) labial palp; and (B) maxilla. *After Cruz et al. (2013).*

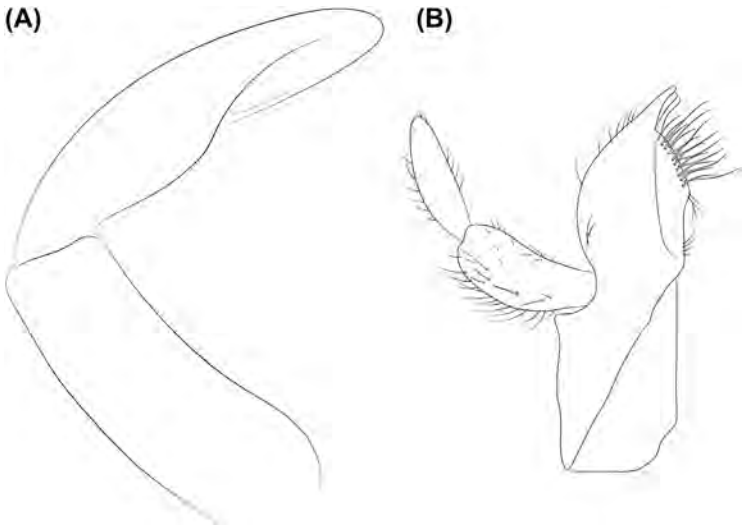

FIGURE 3.122 Mouth parts of *Callibaetis radiatus* Navás nymph (Baetidae): (A) labial palp; and (B) maxilla.

49' Tarsal claws with one denticle row, apical denticle much larger than others (Fig. 3.81B); mandibles smoothly curved as in Fig. 3.90. ..... *Hagenulopsis*

50(49) Tarsal claws with three large medial denticles on median area (Fig. 3.105 A); mandible median area with round protuberance (Fig. 3.105 B) ..... *Perissophlebiodes*

50' Tarsal claws with one submedial denticle (Fig. 3.106 A); mandible median area without protuberances (Fig. 3.106 B) ..... *Bessierus*

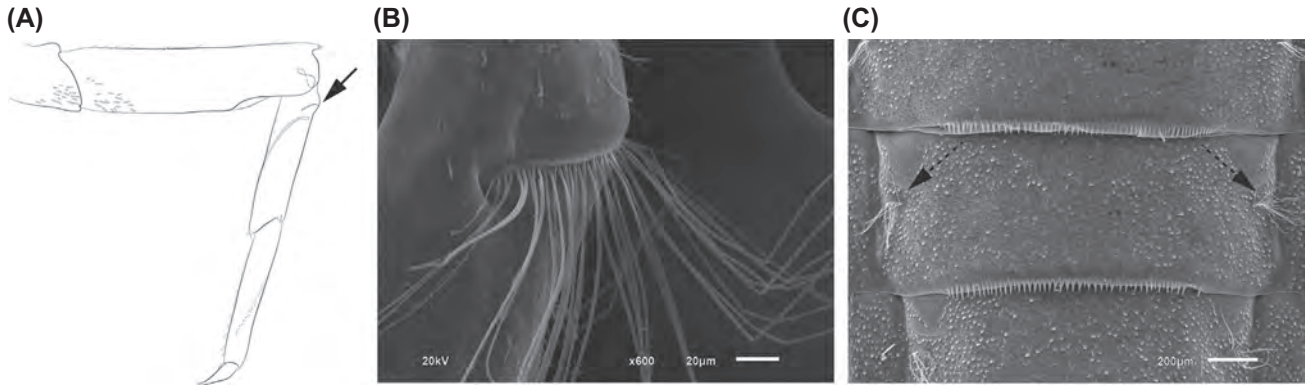

FIGURE 3.123 *Cloeodes* (Baetidae) nymphal structures: (A) fore leg; (B) base of tibia; and (C) abdominal sterna IV to VI. *Black solid arrow* showing subproximal arc of setae, *black dashed arrow* showing row of fine setae.

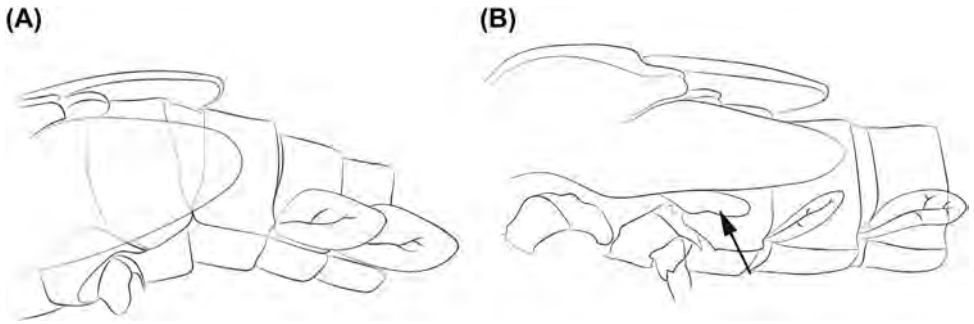

FIGURE 3.124 Partial view of thorax and abdomen of Baetidae nymphs: (A) *Americabaetis*; and (B) *Aturbina*. *Black solid arrow* showing hind wing pad.

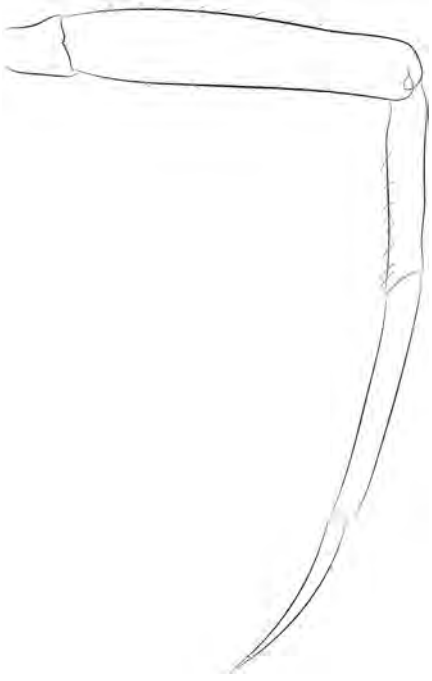

FIGURE 3.125 Fore leg of *Apobaetis fiuzai* Salles and Lugo-Ortiz (Baetidae).

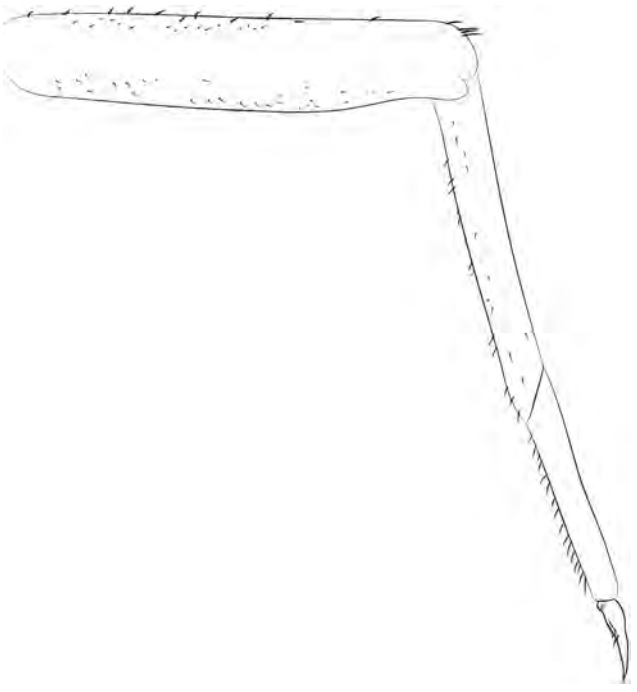

FIGURE 3.126 Fore leg of *Aturbina* (Baetidae).

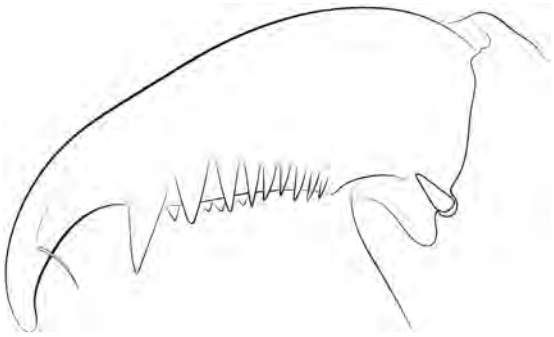

FIGURE 3.127 Tarsal claw of *Andesiops* (Baetidae).

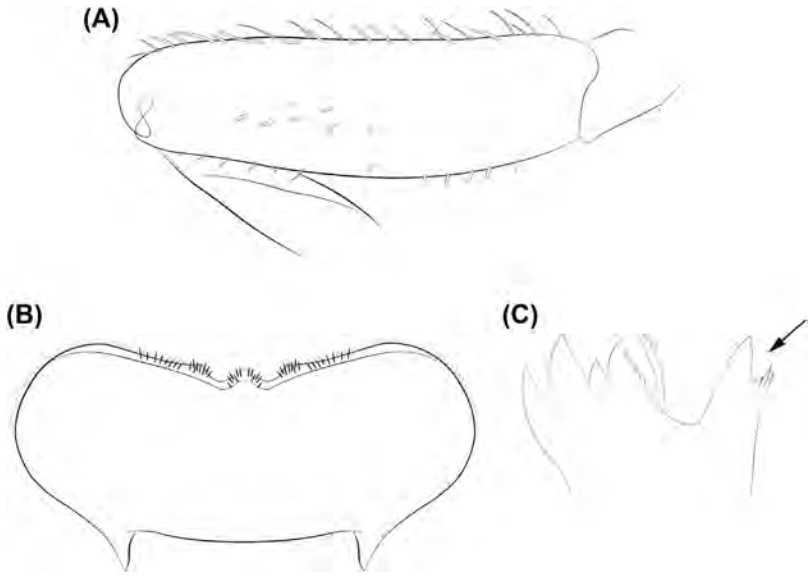

FIGURE 3.128 Nymphal structures of *Harpagobaetis gulosus* Mol (Baetidae): (A) partial view of fore leg; (B) labrum; and (C) distal half of left mandible.

Baetidae: Genera

This family has a thousand species distributed worldwide. The number of genera is also high (over 100), inferior only to Leptophlebiidae. The diversity of Baetidae in the Neotropics is higher than in other realms, with more than 260 species described in 32 genera. Twenty-one genera are endemic to South America, four to Central America and southern North America, while nine have a Panamerican distribution. Except for a few taxa, such as *Baetodes* and some species of *Camelobaetidius*, nymphs have a streamlined body and caudal filaments with well-developed swimming setae. Most genera inhabit lotic environments, but a few live in standing waters (e.g., *Callibaetis* and *Cloeon*).

1	Tarsal claws spatulate (denticles perpendicular to longitudinal axis of legs) (Fig. 3.107)	2
1'	Tarsal claws pointed (denticles on the same axis of legs) (Fig. 3.108)	4
2(1)	Scape and pedicel without row of setae; labial palpi and gena not as below (Fig. 3.110 A); tarsal claws with no more than 60 denticles (Figs. 3.107 B, C)	3
2'	Scape and pedicel with row of setae (Fig. 3.109 A); labial palpi robust and elongated (Fig. 3.109 B); gena protruding (Fig. 3.109 B); tarsal claws with more than 100 denticles (Fig. 3.107 A)	*Tapajobaetis*
3(2)	Labial palpi scattered with short setae (Fig. 3.110 B); labial palpi article II with a dorsal setal row (Fig. 3.110 B); maxillary palp most often without papilla (Fig. 3.110 C) [Widespread]	*Camelobaetidius*

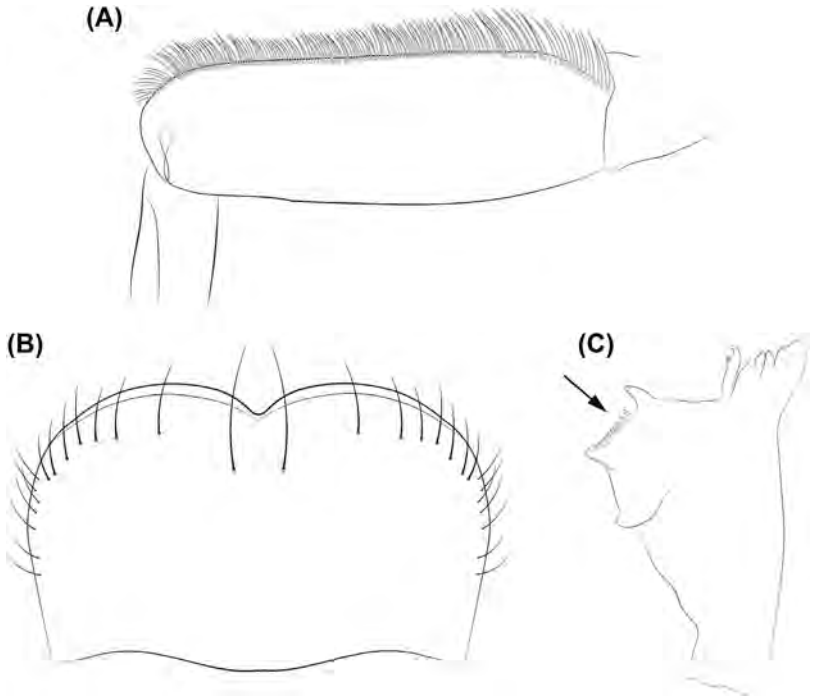

FIGURE 3.129 Nymphal structures of *Andesiops* (Baetidae): (A) partial view of fore leg; (B) labrum; and (C) distal half of left mandible.

FIGURE 3.130 Fore leg of *Varipes helenae* Salles and Batista (Baetidae).

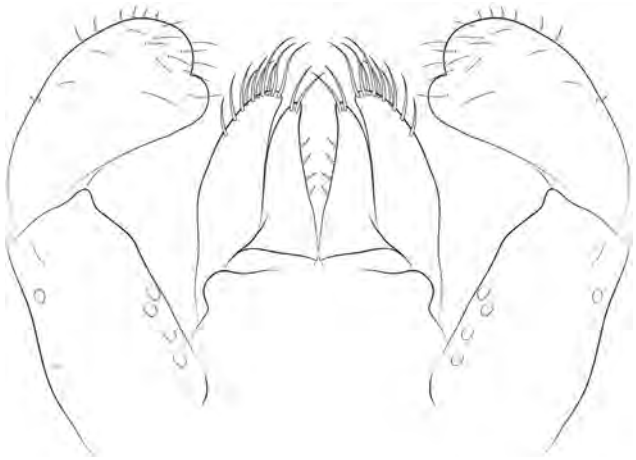

FIGURE 3.131 Labium of *Varipes helenae* Salles and Batista (Baetidae).

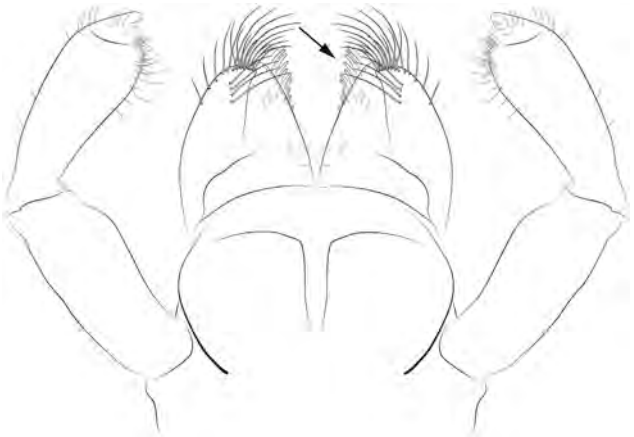

FIGURE 3.132 Labium of *Rivudiva minantenna* Lugo-Ortiz and McCafferty (Baetidae).

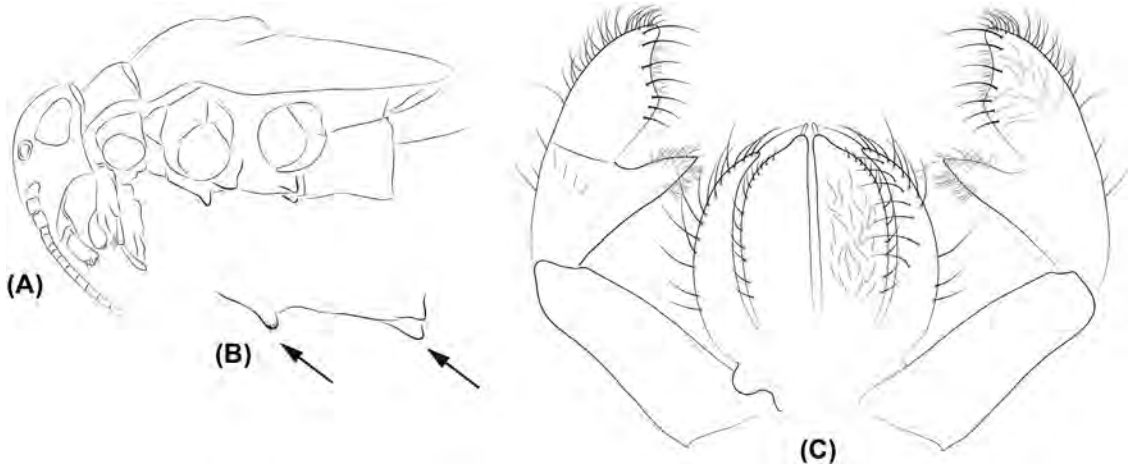

FIGURE 3.133 Nymphal structures of *Waltzoyphius fasciatus* McCafferty and Lugo-Ortiz (Baetidae): (A) head and thorax, lateral view; (B) detail of meso- and meta-sterna; and (C) labium. *Black solid arrow* showing ventral projections.

3’	Labial palpi scattered with fine, long setae (Fig. 3.111 A); labial palpi article II without a dorsal setal row (Fig. 3.111 A); maxillary palp always with a long papilla (Fig. 3.111 B); rare ..... *Corinnella*
4(1’)	Tarsal claws with strong subapical seta (or setae) (Figs. 3.108 B, 112) 5
4’	Tarsal claws without strong subapical seta (fine apical seta may be present) (Fig. 3.108 A) 11
5(4)	Median terminal filament almost as long as cerci; antennal pedicel without row or tuft of setae 6
5’	Median terminal filament reduced (less than ½ length of cerci); antennal pedicel with row or tuft of setae (as in Fig. 3.109 A) 8
6(5)	Tarsal claws with one row of denticles (Fig. 3.108 B); right mandible prostheca without medial process (as in Figs. 3.142, 148 A) 7
6’	Tarsal claws with two rows of denticles (Fig. 3.112); right mandible prostheca of with plumose medial process (Fig. 3.113) .. *Spiritiops*
7(6)	Labrum distally expanded, dorsal surface basomedially raised (Fig. 3.114 A) ..... *Moribaetis*
7’	Labrum not expanded distally, dorsal surface flat (Fig. 3.114 B) ..... *Caribaetis*
8(5’)	Gills dorsal, present on segments I or II to VII; abdominal terga without tubercles 9
8’	Gills ventral, present on segments I to V (Fig. 3.115); abdominal terga usually with tubercles (Fig. 3.115) ..... *Baetodes*
9(8)	Medial terminal filament articulate; gill I present, reduced ..... 10 [Andes]
9’	Medial terminal filament uniarticulate; gill I absent ..... *Lugoiops* [Central America]
10(9)	Scape and pedicel dorsoventrally flattened (Fig. 3.116 A); scape length 3x pedicel (Fig. 3.116 A); cerci lateral margin with strong spines (Fig. 3.116 B); legs robust (Fig. 3.116 C) ..... *Mayobaetis*
10’	Scape and pedicel cylindrical or subcylindrical, scape length subequal to pedicel; cerci without strong lateral spines; legs slender (Fig. 3.117) ..... *Prebaetodes*
11(4’)	Gills with recurved flaps (Fig. 3.118) 12
11’	Gills simple, without recurved flaps (Fig. 3.119) 14

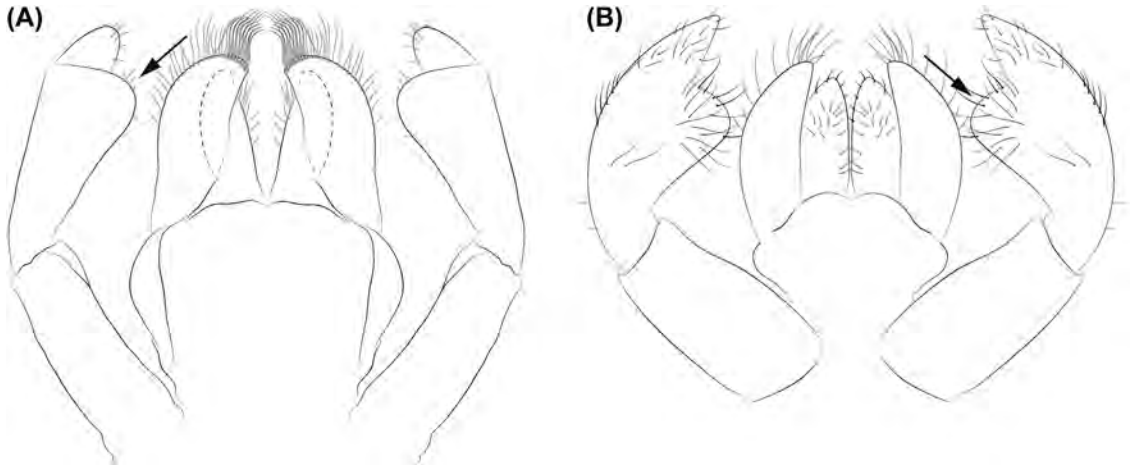

FIGURE 3.134 Labia of Baetidae nymphs: (A) *Tupiara ibirapitanga* Salles, Lugo-Ortiz, Francischetti, and Da-Silva; and (B) *Paracloeodes atroari* Nieto and Salles.

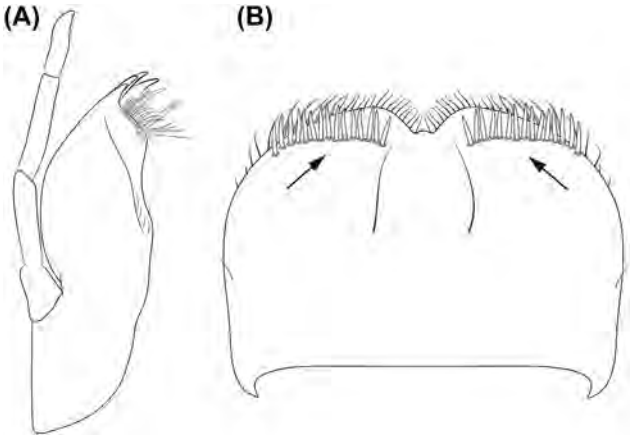

FIGURE 3.135 Mouth parts of *Aturbina* (Baetidae): (A) maxilla; and (B) labrum. *Black solid arrow* showing row of strong setae.

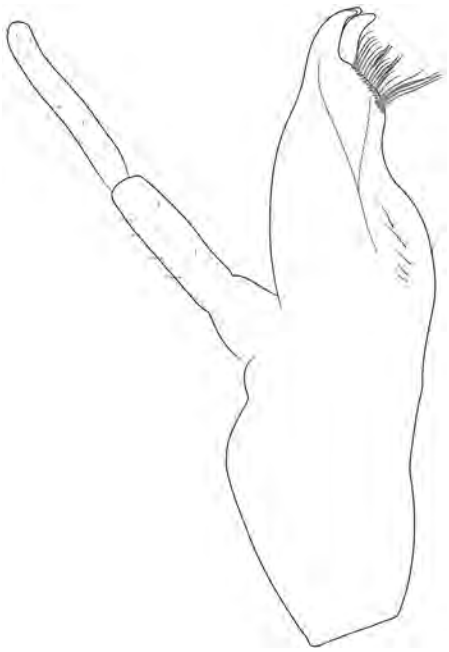

FIGURE 3.136 Maxilla of *Tupiara ibirapitanga* Salles, Lugo-Ortiz, Francischetti and Da-Silva (Baetidae).

12(11)	Abdominal segments lateral margin without spine row; lateral margin of cerci without strong spines on every article 13
12'	Abdominal segments VIII and IX lateral margin with spine row (Fig. 3.120 A); cerci distolateral margin with strong spines on every article (Fig. 3.120 B) ..... *Cloeon*
13(12')	Labial palp article III rectangular, distal margin almost straight (Fig. 3.121 A); maxillary palp tri-articulate (Fig. 3.121 B); body covered with scale and/or scale bases..... *Callibaetoides*
13'	Labial palp article III concave (spoon shaped), distal margin rounded (Fig. 3.122 A); maxillary palp bi-articulate (Fig. 3.122 B); body not covered with scale and/or scale bases..... *Callibaetis*
14(11')	Tibiae without subproximal arc of setae; abdominal sterna II to VI without lateral row of fine setae 15
14'	Tibiae with subproximal arc of setae (Figs. 3.123 A, B); abdominal sterna II to VI with lateral row of fine setae (Fig. 3.123 C) *Cloeodes*
15(14)	Gill I present (Fig. 3.124 B); hind wing pads present or absent (Fig. 3.124 B) 16
15'	Gill I absent (Fig. 3.124 A); hind wing pads always absent (Fig. 3.124 A) 29

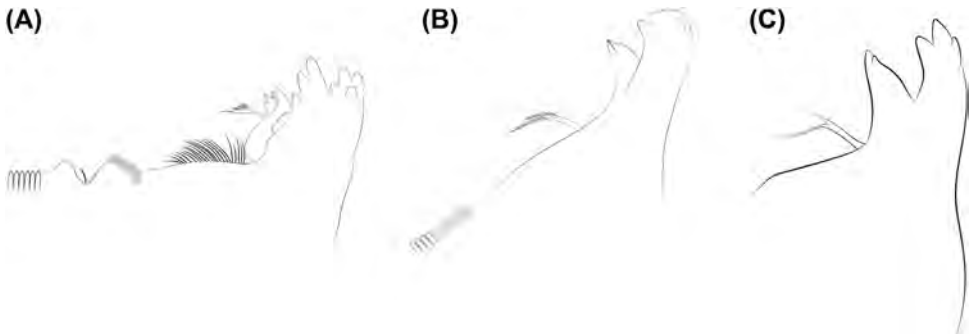

FIGURE 3.137 Distal half of right mandibles of Baetidae nymphs: (A) *Cryptonympha*; (B) *Tupiara ibirapitanga* Salles, Lugo-Ortiz, Francischetti, and Da-Silva; and (C) *Paracloeodes*.

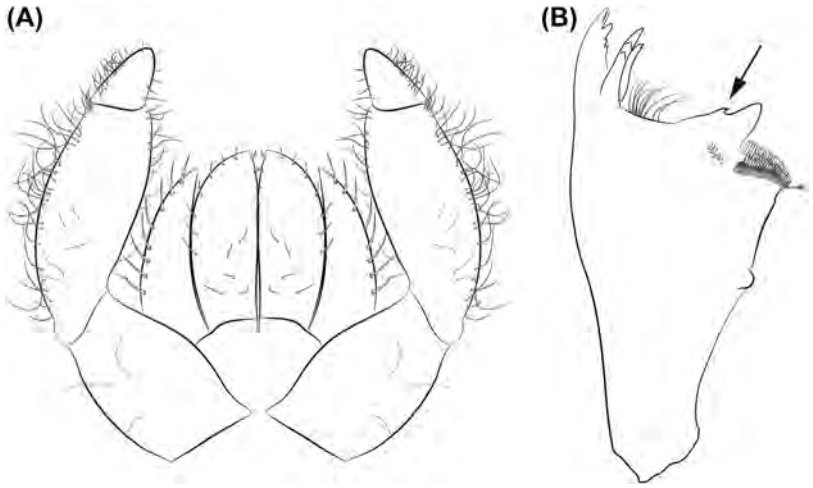

FIGURE 3.138 Mouth parts of *Adebrotus amazonicus* Lugo-Ortiz and McCafferty (Baetidae): (A) labium; and (B) left mandible. *Black solid arrow* showing row of sharp denticle.

16(15)	Tarsal claws short, <0.5× the length of tarsi (Fig. 3.126)	17
16’	Tarsal claws long, at least 0.75× the length of tarsi (Fig. 3.125)	*Apobaetis*
17(16)	Tarsal claws with two rows of denticles (although minute in some cases) (Figs. 3.108 A, 127)	18
17’	Tarsal claws with one row of denticles (Fig. 3.108 B)	27
18(17)	Tarsal claws with two subapical setae (Fig. 3.127)	19
18’	Tarsal claws without subapical setae	20
19(18)	Femora, dorsal margin with a row of robust spiniform setae (Fig. 3.128 A); labrum broad, at least 2× broader than long (Fig. 3.128 B); mandibles with mola adapted for preying (reduced and with pointed denticles) (Fig. 3.128 C)	*Harpagobaetis*
19’	Femora, dorsal margin with a row of long setae (Fig. 3.129 A); labrum 1.5× broader than long (Fig. 3.129 B); mandibles with mola not adapted for preying (with robust denticles) (Fig. 3.129 C)	*Andesiops*
20(18’)	Legs anteriorly with conspicuous setae (strong and usually large) (Fig. 3.130)	21
20’	Legs anteriorly without conspicuous setae (Figs. 3.125, 126)	22
21(20)	Femora II and III proximal third with a transverse row of long spiniform setae (Fig. 3.130); labial palp article III rounded (Fig. 3.131); glossa apically with simple setae (Fig. 3.131)	*Varipes*
21’	Femora II and III without a transverse row of long spiniform setae; labial palp article III conical (Fig. 3.132); glossa apically with robust setae (Fig. 3.132)	*Rivudiva*
22(20’)	Mesosternum, without triangular projection; labial palp article II with or without distomedial projection, but never shaped as below (Fig. 3.134)	23
22’	Mesosternum, at least, with triangular projection (two projections on meta-sternum are also present in one species) (Figs. 3.133 A, B); labial palp article II with curved distomedial projection (Fig. 3.133 C)	*Waltzoyphius*
23(22)	Maxillary palpi biarticulate (Fig. 3.136); labrum without row of strong setae	24
23’	Maxillary palp triarticulate (Fig. 3.135 A); labrum with row of strong setae close to distal margin (Fig. 3.135 B)	*Aturbina*
24(23)	Right prostheca slender, never denticulate (Figs. 3.137 B, C); incisors of both mandibles cleft to partially cleft (Figs. 3.137 B, C); right mandible without setae between incisors and mola (Figs. 3.137 B, C)	25

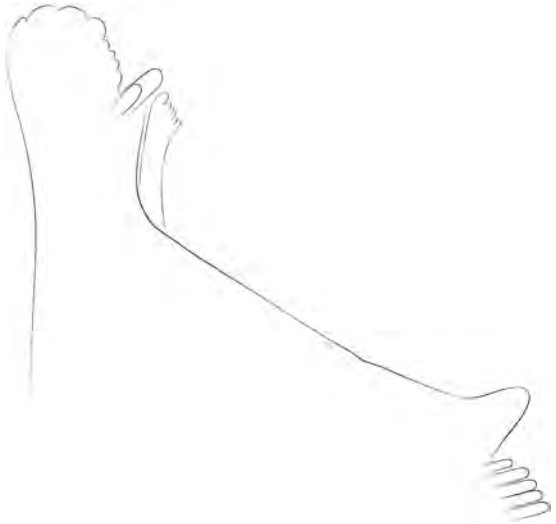

FIGURE 3.139 Distal half of left mandible of *Tupiara ibirapitanga* Salles, Lugo-Ortiz, Francischetti, and Da-Silva (Baetidae).

FIGURE 3.141 Distal half of right mandible of *Nanomis* (Baetidae).

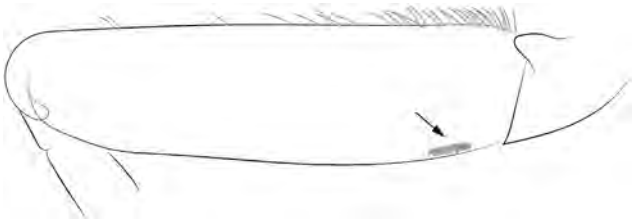

FIGURE 3.140 Partial view of fore leg of *Baetis* (Baetidae). *Black solid arrow* showing villopore.

FIGURE 3.142 Distal half of right mandible of *Fallceon* (Baetidae).

24'	Right prostheca robust, apically denticulate (Fig. 3.137 A); incisors of both mandibles fused (Fig. 3.137 A); right mandible with setae between incisors and mola (Fig. 3.137 A)	*Cryptonympha*
25(24)	Labial palp with distomedial process (Fig. 3.134); left mandible without a sharp denticle at the base of subtriangular process (Fig. 3.139)	26
25'	Labial palp without distomedial process (Fig. 3.138 A); left mandible with a sharp denticle at the base of subtriangular process (Fig. 3.138 B); extremely rare	*Adebrotus*
26(25)	Mandibles with angle between incisors and mola obtuse (Figs. 3.137 B, 139); rare [Atlantic Forest]	*Tupiara*
26'	Mandibles with angle between incisors and mola around 90° (Fig. 3.137 C); common [Widespread]	*Paracloeodes*
27(17')	Villopore absent	28
27'	Villopore (patch of small setae closely pressed together) present at base of femora (Fig. 3.140) [Central America. Nearctic]	*Baetis*

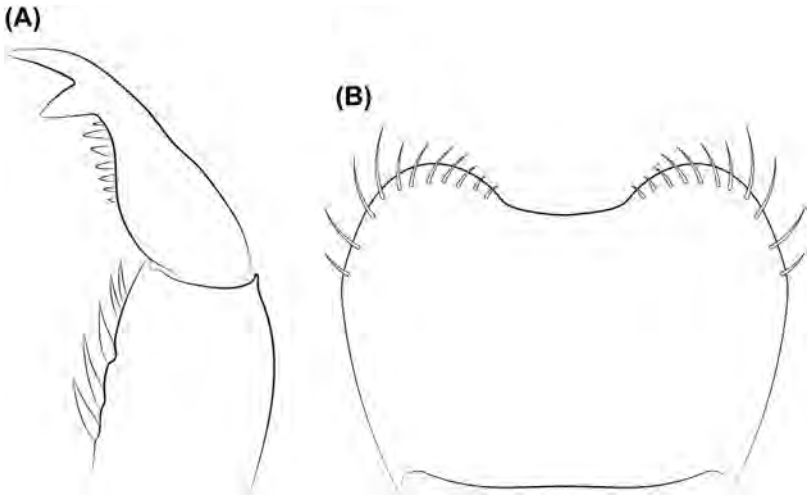

FIGURE 3.143 Nymphal structures of *Guajirolus rondoni* Salles (Baetidae): (A) fore tarsal claw; and (B) labrum.

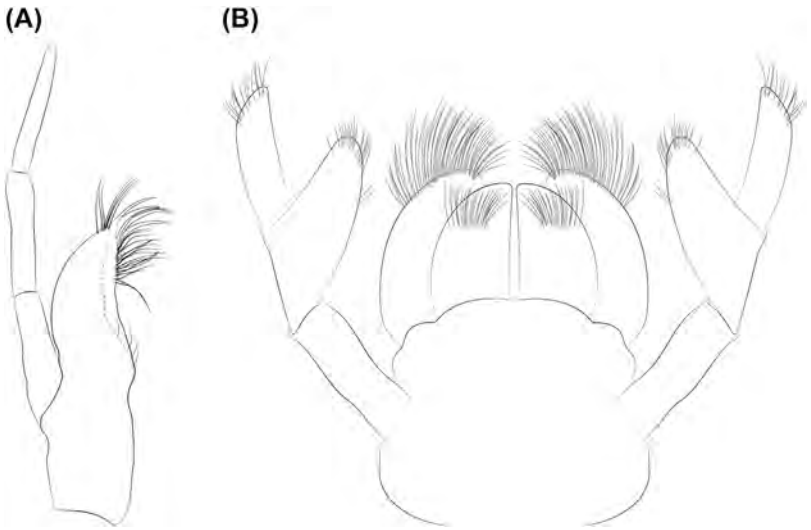

FIGURE 3.144 Mouth parts of *Guajirolus rondoni* Salles (Baetidae): (A) maxilla; and (B) labium.

28(27) Right prostheca slender, apically bifid (Fig. 3.141); right mandible without setae between incisors and mola (Fig. 3.141)..... *Nanomis* [Andes]

28' Right prostheca robust, apically denticulate (Fig. 3.142); right mandible with setae between incisors and mola (Fig. 3.142)..... *Fallceon* [Northern South America, Central America. Nearctic]

29(15') Tarsal claw with distal denticle much larger than others (Fig. 3.143 A); labrum distal margin with broad emargination on distal margin (Fig. 3.143 B); labial palp distal article elongate (at least 3× as long as broad) (Figs. 3.144 B, 145 B)..... 30

29' Tarsal claw with distal denticle slightly larger or subequal to others; labrum distal margin with shallow or narrow emargination; labial pal distal article short (as long as broad)..... 31

30(29) Maxillary palp article III slightly longer than articles I and II (Fig. 3.144 A); labial palp article II with broad medial projection (Fig. 3.144 B) ..... *Guajirolus*

30' Maxillary palp article III more than 3× longer than articles I and II combined (Fig. 3.145 A); labial palp article II with long medial projection (Fig. 3.145 B)..... *Chane*

31(29') Labrum semicircular (Fig. 3.147 A); paraglossa apex as broad as base (Figs. 3.147 B, 148 B, 149 B)..... 32

31' Labrum trapezoidal (Fig. 3.146 A); glossa constricted in mid region (Fig. 3.146 B); paraglossa distally expanded (Fig. 3.146 B) ..... *Tomedontus* [Amazon]

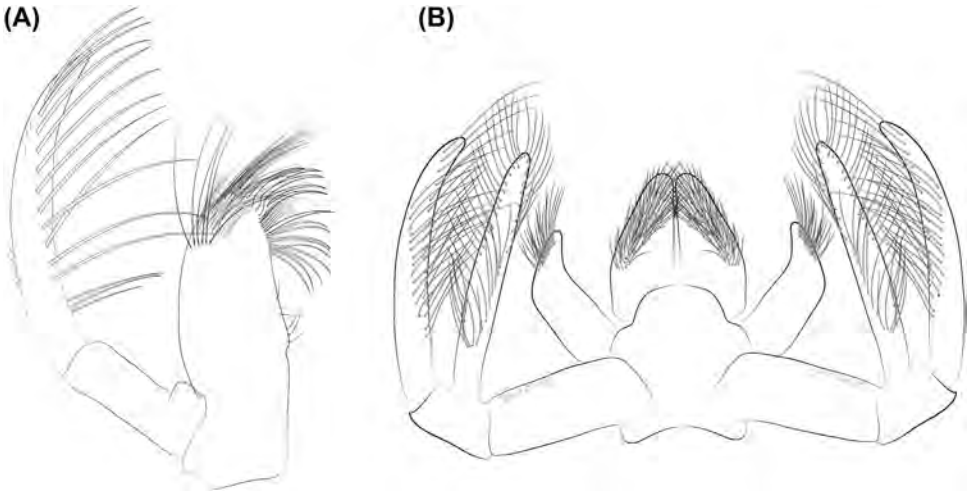

FIGURE 3.145 Mouth parts of *Chane baure* Nieto (Baetidae): (A) maxilla; and (B) labium.

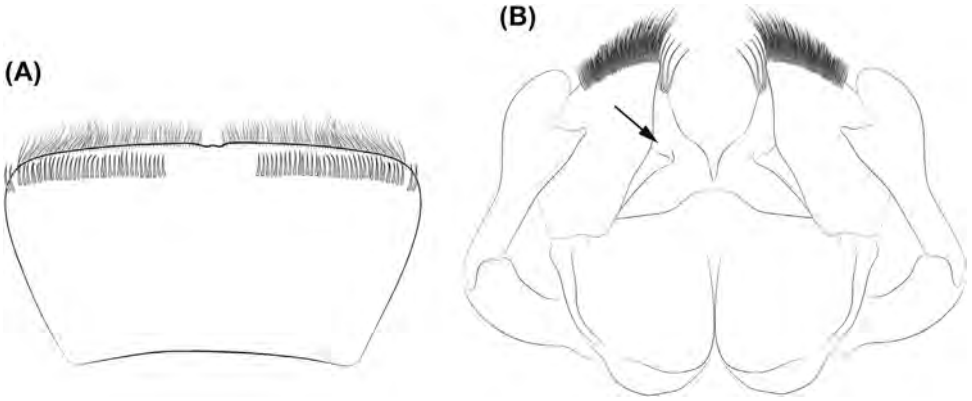

FIGURE 3.146 Mouth parts of *Tomedontus primus* Lugo-Ortiz and McCafferty (Baetidae): (A) labrum; and (B) labium.

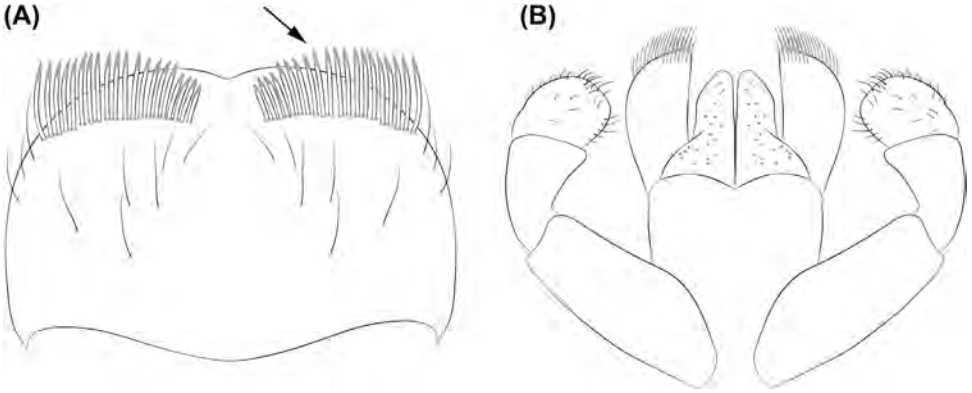

FIGURE 3.147 Mouth parts of *Zelusia principalis* Lugo-Ortiz and McCafferty (Baetidae): (A) labrum; and (B) labium.

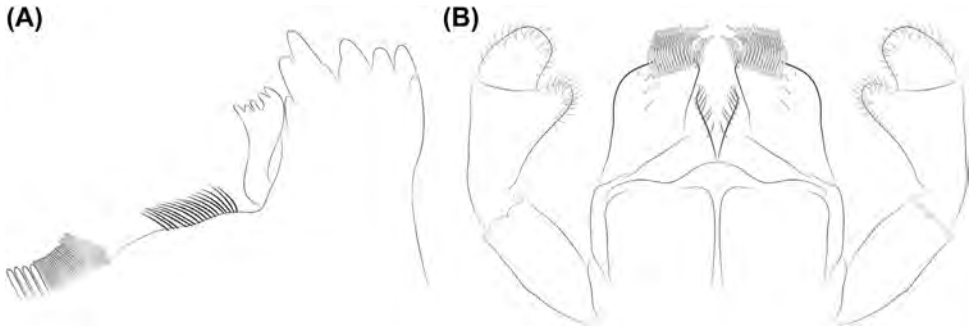

FIGURE 3.148 Mouth parts of *Americabaetis* (Baetidae): (A) distal half of right mandible; and (B) labium.

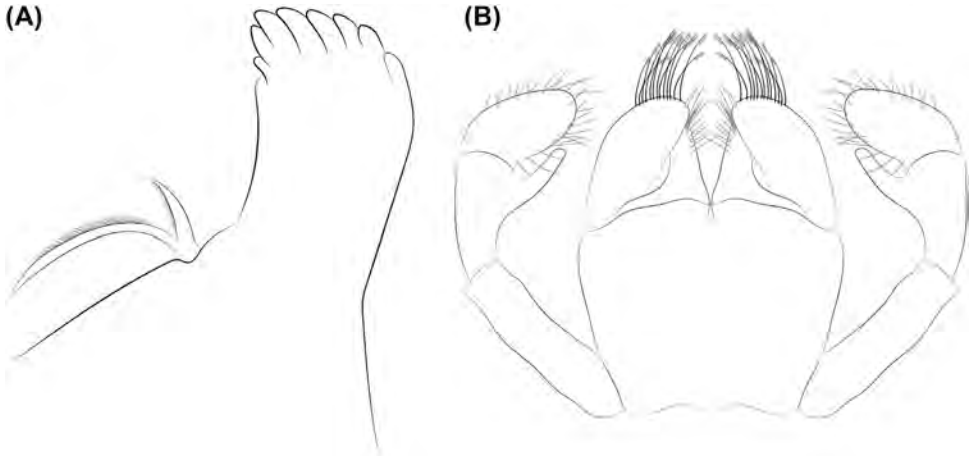

FIGURE 3.149 Mouth parts of *Parakari* (Baetidae): (A) distal half of right mandible; and (B) labium.

32(31) Labrum without distal row of strong setae (subdistal simple setae present); labial palp article II with distomedial projection (Figs. 3.148 B, 149 B) 33

32' Labrum with distal row of strong setae (Fig. 3.147 A); labial palp article II without distomedial projection (Fig. 3.147 B) ..... *Zelusia*

33(32) Right prostheca robust, apically denticulate (Fig. 3.148 A); mandibles with setae between incisors and mola (Fig. 3.148 A); common ..... *Americabetis*
[Widespread]

32' Right prostheca slender, apically bifid (Fig. 3.149 A); mandibles without setae between incisors and mola (Fig. 3.149 A); rare ..... *Parakari*
[northern South America]

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