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Aquatic Insects of Wisconsin

Keys to Wisconsin Genera and Notes on Biology, Habitat, Distribution and Species

William L. Hilsenhoff

AQUATIC INSECTS OF WISCONSIN

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INTRODUCTION AND KEY TO ORDERS

Increased interest in the aquatic environment has produced a need for up-to-date keys to aquatic insects. Previous editions of Aquatic Insects of Wisconsin (Hilsenhoff 1975, 1981) were published to fill this need for Wisconsin and the western Great Lakes region. This revised edition includes recent taxonomic advances, modified keys, and additional information about each order. The regional scope of keys eliminates genera that occur only in other areas of North America, thus simplifying their use. Revised information about biology, ecological requirements, and distribution and abundance of genera in Wisconsin is also included.

Ten orders of insects in Wisconsin contain aquatic species. Five (Ephemeroptera, Odonata, Plecoptera, Megaloptera, and Trichoptera) are aquatic orders in which almost all species have aquatic larvae. The remaining orders (Heteroptera, Coleoptera, Diptera, Lepidoptera, and Neuroptera) are partially aquatic orders in which most species are terrestrial, but in which entire families, genera, or one or more species have a life stage adapted to the aquatic environment. All families with aquatic species that occur or may occur in Wisconsin are discussed; the number of genera and species that have been collected in Wisconsin is listed in parenthesis. Not included are families having larvae that live only on aerial parts of emergent aquatic vegetation, bore into stems or mine leaves of vegetation, or are internal parasites of aquatic animals. Riparian families that are closely associated with water but do not inhabit it are also not included. Terrestrial stages of aquatic orders are discussed briefly, especially as they relate to the bionomics and ecology of the order. A key to genera of aquatic larvae and/or adults in Wisconsin is provided for each order. Appended to each key is a list of species that occur or may occur in Wisconsin; species and genera that have not yet been collected and identified are marked with an asterisk. Names used for families and genera in Hilsenhoff (1981) are noted in parentheses after the present name. References to recent keys to species of aquatic larvae and/or aquatic adults that are not monotypic in Wisconsin are also included. Because of uncertainties in larval identification, no list of species is appended for some families of Diptera. Reliable keys to species do not exist for larvae in many families and genera, and for nymphs of most Heteroptera.

The most recent keys to genera of aquatic insects in North America appear in Merritt and Cummins (1984), a revised edition of which will be published late in 1995. References to recent revisions and descriptions of new species may be found in bibliographies such as those published annually by the North American Benthological Society, and through computer searches of data bases such as Zoological Record and Dissertation Abstracts Online.

Three aquatic orders (Ephemeroptera, Odonata, and Plecoptera) have a hemimetabolous life cycle that includes three developmental stages, egg, larva, and adult. The term "larva" is used in these orders instead of "nymph" or "naiad" because the immature developmental stage is adapted for survival in aquatic environments and does not resemble the terrestrial adult, except in Plecoptera. The other two aquatic orders (Trichoptera and Megaloptera) have a holometabolous life cycle that includes four developmental stages, egg, larva, pupa, and adult.

Four of the five partially aquatic orders (Coleoptera, Diptera, Lepidoptera, and Neuroptera) also have holometabolous life cycles and larvae that do not resemble the adult. The fifth order, Heteroptera (=Hemiptera), has a paurometabolous life cycle that includes three developmental stages, egg, nymph, and adult. Heteroptera nymphs inhabit the same habitat as adults and resemble them in many respects.

IMPORTANCE TO PEOPLE

Aquatic insects are important in many ways. They occur in all aquatic ecosystems, and often dominate the fauna. In streams and lakes they provide a major source of food for fish, and they are widely used to monitor water quality. Larvae of Trichoptera, Ephemeroptera, Diptera, Plecoptera, and adults and larvae of some Coleoptera (riffle beetles) are especially important in biological monitoring of streams. Larvae of mosquitoes, black flies, and many deer flies, horse flies, and biting midges are aquatic, and most adults bite people, frequently becoming a severe nuisance. In Wisconsin some mosquitoes transmit LaCrosse encephalitis virus, heartworm in dogs, and are capable of transmitting malaria, while some black flies transmit a leucocytozoon parasite of poultry. Adults of mayflies (Ephemeridae), caddisflies (Hydropsychidae), and midges (Chironomidae) often emerge in great numbers, and because of attraction to lights may cause severe nuisance problems. Midges and caddisflies also cause allergic reactions in some people. Adults of aquatic Coleoptera and Heteroptera annoy people by entering swimming pools, and individuals of larger species prey on fish in hatcheries. However, adult and immature stages of Coleoptera and Heteroptera, and larvae of Odonata and Megaloptera benefit humans by feeding on mosquito larvae. Adult dragonflies and damselflies are considered highly desirable because they feed on adult mosquitoes and other flying insects.

COLLECTING TECHNIQUES

A D-frame aquatic net, a shallow white pan, a half-inch mesh screen that fits over the pan, a pair of curved forceps, and hip-boots or waders are the equipment needed to collect aquatic insects. Captured insects are killed and preserved by placing them in a jar about half-full of 70% ethanol (or isopropanol). Sampling of lotic and lentic habitats requires somewhat different techniques as follows; special techniques needed for some families are discussed under those families.

Lotic habitats: Riffles and runs are sampled by placing the net firmly against the bottom immediately downstream from where you are standing and disturbing the substrate with your feet to as great a depth as possible. Dislodged insects will be swept into the net by the current. The amount of debris collected should be about equal in volume to a baseball. The contents of the net are then washed by moving the net through clean water before emptying it into a pan containing one-half inch of water. Insects are most easily captured with a curved forceps (curved side down) as they crawl or swim from the

debris; the empty net should always be checked for insects that cling to it. A angled 30 mm loop at the end of a wire, which is covered with nylon from a stocking, is advantageous for capturing species that swim rapidly. Bank vegetation is sampled by moving the net along the bottom toward and against the bank. Leaves and other debris that may collect on sticks and snags should be sampled in the same manner as riffles. Mud banks, silt pools, and sand also harbor insects; these areas are sampled by running the net through the mud, silt, or sand and rinsing it in water until a clean sample is obtained. Rocks and water-logged wood should be removed from the stream, checked for insects, and replaced. Cracks in water-logged wood are the exclusive habitat of many insects; as the wood dries they crawl from the cracks.

Lentic habitats: The net should be moved as rapidly as possible along the bottom and through vegetation without scooping up mud from the bottom. Best results are achieved by working the net toward and against a bank or clumps of vegetation. Repeated sweeps through the same area will disturb the bottom and collect insects that have dived into the bottom. In ponds, most insects will be found among emergent or submerged vegetation, especially in shallow shoreline areas. When the net is about one-third full of debris, its contents should be rinsed by moving the net up and down in clean water. The debris is then spread on a 1/2-inch mesh screen above a pan and left for 5 to 10 minutes, allowing insects to crawl from the debris and drop into the pan. A second sample can be collected while waiting for insects to drop into the pan. A portion of a sample should be placed in another pan with one-half inch of water to collect Diptera and Ephemeroptera larvae, which do not readily crawl from debris on the screen. Different areas of a pond or marsh will harbor different insects. Bottle traps (Hilsenhoff 1987, 1991) will collect adults of species of Coleoptera and Heteroptera that are usually missed by sampling only with a net; they also capture larvae of Odonata, Trichoptera, and other orders. Wave-swept shoreline areas of lakes are sampled by disturbing the substrate and immediately moving the net through the disturbed area, and by examining rocks and decaying wood.

Deep water: Special equipment is needed to sample deep lentic and lotic habitats. Soft sediments are best collected with an Ekman grab, and a Ponar grab is best suited for sampling substrates containing gravel, cobbles, and debris. Substrates are then sieved to obtain insects. This, and other equipment such are artificial substrate samplers, are described in Merritt and Cummins (1984). Artificial substrate samplers provide an effective way to sample deeper substrates in streams, but must be enclosed before retrieval or most insects will escape. Deep, fast streams are difficult and dangerous to sample.

Terrestrial adults: Almost all aquatic species have adults that fly. Adults of many species of Ephemeroptera, Trichoptera, Plecoptera, Diptera, Coleoptera, and Heteroptera can be collected at night with light traps, or from light-colored objects adjacent to lights, especially blacklight. Using nets to sweep vegetation and using an aspirator to collect from rocks, bridges, and trunks of trees adjacent to streams, will often yield many adults of Plecoptera, Ephemeroptera, Trichoptera, Megaloptera, and Diptera. Adult Odonata can be swept from the air or from a perch with an aerial net, as well as flying adults in mating swarms of Ephemeroptera, Trichoptera, and Diptera. Exuviae of Odonata and Plecoptera larvae are often abundant adjacent to aquatic habitats, and can be easily collected to determine the fauna.

KEY TO ORDERS OF AQUATIC INSECTS IN WISCONSIN

1. Thorax without segmented legs 2
Thorax with 3 pairs of segmented legs 3

2(1). Mummy-like, in a case, often silk-cemented and containing vegetable or mineral matter . . . . . .pupae (not keyed)
Not in a case; mobile larvae, mostly with prolegs, pseudopods, or creeping welts on one or more segments; key pp. 58-70 . . . . . **DIPTERA larvae**

3(1). With large, functional wings, which may be shell-like or leather-like at the base 4
Wingless, or with developing wings (wing pads) or brachypterous wings 6

4(3). All wings completely membranous, with numerous veins . . . . . (ovipositing or terrestrial adults)
Mesothoracic wings hardened and shell-like, or leather-like in basal half 5

5(4). Chewing mouthparts; mesothoracic wings hard, shell-like; key pp. 44-49 . . . . . **.COLEOPTERA adults**
Sucking mouthparts, formed into a broad or narrow tube; mesothoracic wings hardened in basal half; key pp. 37-39 . . . . . **HETEROPTERA adults**

6(3). With 2 or 3 long, filamentous terminal appendages. .7
Terminal appendages absent or consisting of only one or two segments 8

7(6). Sides of abdomen with plate-like, feather-like, or leaf-like gills; usually with 3 tail filaments, occasionally only 2; key pp. 6-10. **EPHEMEROPTERA larvae**
Gills absent from middle abdominal segments; 2 tail filaments; key pp. 19-22 . . **PLECOPTERA larvae**

8(6). Labium forming an elbowed, extensile grasping organ; key pp. 13-16 . . . . . **.ODONATA larvae**
With chewing or sucking mouthparts 9

9(8). Mouthparts sucking, formed into a narrow tube . . . **10**
Mouthparts not formed into a narrow tube **11**

10(9). Parasitic on sponges; all tarsi with one claw; key p. 43 . . . . . **NEUROPTERA larvae**
Free-living; mesotarsi with two claws; key pp. 37-39. . . . . **.HETEROPTERA adults and nymphs**

11(9). Ventral abdominal prolegs on abdominal segments 3-6, each with a ring of fine hooks (crochets); key pp. 40-41 . . . . . **.LEPIDOPTERA larvae**
Abdomen without ventral prolegs on abdominal segments 3-6, each with crochets **12**

12(11). Antenna extremely small, inconspicuous, one-segmented; key pp. 25-33. **TRICHOPTERA larvae**
Antenna elongate, with 3 or more segments 13

13(12). Without long lateral filaments; key pp. 49-54 . . . . . **COLEOPTERA larvae**
With long lateral filaments **14**

14(13). A single claw on each tarsus **or** abdomen terminating in 2 slender filaments or a median proleg with 4 hooks; key pp. 49-54 . . . . **COLEOPTERA larvae**

Each tarsus with 2 claws; abdomen terminating in a single slender filament or in 2 prolegs, each with 2 hooks (key p. 35) . . . . . **MEGALOPTERA larvae**

EPHEMEROPTERA - MAYFLIES

Only 115 of about 575 species known from North America have been identified from Wisconsin; others may occur here. This relatively small hemimetabolous order is widespread and abundant in most areas of the state. Larvae of all Ephemeroptera species are aquatic. Most inhabit streams, but several inhabit a variety of permanent and temporary lentic habitats. Larvae occur in streams of all sizes and water temperatures, and even in temporary streams. In lakes they are found among vegetation, or burrowing in littoral areas and sometimes on the bottom in deeper water or along wave-swept shores. Frequently they inhabit vernal or permanent ponds and marshes.

Mayfly larvae are easily distinguished from other aquatic insects by having lateral or ventrolateral gills on most of the seven basal abdominal segments, and usually three, many-segmented, caudal filaments. In a few species the median caudal filament is so reduced only cerci are visible. Ephemeroptera larvae have compound eyes, ocelli, filamentous antennae, and one-segmented tarsi with a single claw. They resemble larvae of Plecoptera, which have only cerci, lack gills on middle abdominal segments, and have two tarsal claws. Subimagos and adults have one or two pairs of wings that they hold vertically above the body when at rest; they have very large compound eyes and two or three long tail filaments. Adults have transparent wings; unpigmented areas in wings of subimagos are opaque.

Mayfly larvae mostly crawl about on aquatic substrates and some burrow in the substrate; many are excellent swimmers. They move their abdomen and caudal filaments up and down to swim, instead of horizontally as in stoneflies. Abdominal gills are important in uptake of oxygen; larvae of most species increase water circulation by moving their gills, which enables some to inhabit lentic habitats or slow-flowing lotic habitats. Almost all larvae are herbivores or detritivores; only a few species are known to prey on other invertebrates. Adults and subimagos do not feed.

Most species are univoltine. In some, eggs hatch shortly after being laid and larvae develop slowly over a one-year period (slow seasonal life cycle). In others, eggs hatch after prolonged diapause and larvae develop rapidly (fast seasonal life cycle). Several species are bivoltine, with rapid larval development and eggs of the second generation diapausing over the winter. A few species are multivoltine or semivoltine. The number of larval instars varies widely, with 12 or more having been recorded for species that have been studied. After completing development, larvae either crawl from the water or swim or float to the surface where sexually mature subimagos emerge. This winged subadult or "dun" stage is unique among insects. Subimagos of most species fly to nearby vegetation or supports where they spend about a day before molting into the adult (imago) stage. A few species molt to adult almost immediately, sometimes while in flight; others never become adults.

Adults usually live only a few days; a few may live two weeks or more, and others only an hour or two. In most species males form aerial swarms to attract females and mate with them when they enter the swarm. Male adults of some species mate with subimago females as they emerge from the water. Females of most species lay eggs on the water's surface by repeatedly touching the water with their abdomen or by landing briefly on the surface. In other species, females crawl beneath the water's surface on a substrate to oviposit. Most females die after oviposition.

A book by Edmunds, Jensen, and Berner (1976) provides generic keys to adults and larvae, as well as information on collecting, rearing, and mayfly biology. Burks (1953) includes keys to species of larvae in many Midwestern genera, but his keys are incomplete and must be used with caution. The biogeography and evolution of Ephemeroptera was reviewed by Edmunds (1972), and in 1982 Brittain reviewed the biology.

Recently many changes in higher classification were proposed by McCafferty (1991). I follow his classification, which includes three suborders and several new families. Acanthametropodidae, Ameletidae, Isonychiidae, and Pseudironidae are new families that occur in Wisconsin, along with Behningiidae, which recently was discovered to also occur here. Although new species and genera are still being discovered, revisions have often synonymized species. Recent studies have made identification of larvae possible in most genera.

RECTRACHAETA

BAETISCIDAE (1 genus, 3 species)

The three species of *Baetisca* have a univoltine life cycle, with larvae overwintering. Larvae of different sizes often occur together, suggesting extended emergence periods for each species during spring and early summer. Larvae are common along shores of sandy streams having a thin layer of silt in which they can partially burrow; larvae of one species occur along margins of impoundments or large lakes. To emerge, they crawl onto a terrestrial substrate.

BEHNINGIIDAE (1 genus, 1 species)

Larvae of *Dolania* inhabit shifting sand bottoms of large rivers; they have been collected only from the St. Croix River in northwest Wisconsin. The life cycle is semivoltine in the southern United States, with a diapausing egg stage. Unlike most mayflies, larvae are predators.

CAENIDAE (3 genera, 10 species)

Caenis larvae occur in a variety of aquatic habitats, and are more tolerant of low dissolved oxygen levels than any other mayfly larvae. They can be found commonly in littoral and sublittoral zones of lakes, in ponds and marshes, and in a wide variety of streams where they inhabit debris and sediments in rapid or slow water. *Brachycercus* larvae are uncommon in

silt-sand stream margins, and have been found many miles from shore in Green Bay. *Cercobrachys* larvae are uncommon in sediments of large rivers. Life cycles are probably mostly univoltine with overlapping cohorts; some may be bivoltine. Subimagos emerge at the water's surface and molt almost immediately to adults, which swarm and mate soon after emerging and die within a few hours.

EPHEMERELLIDAE (6 genera, 21 species)

Ephemerella larvae occur abundantly in clean, rapid streams in autumn and early spring. *Eurylophella* and *Serratella* larvae are found in similar streams, but are less numerous; larvae of *Timpanoga* and *Drunella* are uncommon. While most larvae inhabit rapid water, some are found in slower areas of streams, and some *Eurylophella* larvae occur along windswept margins of lakes. All species are univoltine, with emergence from spring throughout the summer, depending on the species. Larvae of most stream inhabiting species are intolerant of lowered levels of dissolved oxygen and occur only in unpolluted streams. Although most are herbivore-detritivores, some *Drunella* and *Ephemerella* larvae are omnivores, feeding on chironomid larvae as well as plant foods. Subimagos emerge at the water's surface or from a substrate, and molt to adult within a day.

EPHEMERIDAE (4 genera, 7 species)

Species are univoltine or semivoltine, with synchronized emergences of subimagos of *Hexagenia* in July sometimes creating severe nuisance problems in cities along the Mississippi and Wisconsin rivers, and the Great Lakes because of their attraction to lights. Burrowing larvae of *Hexagenia* are common in silt bottoms of larger streams, while those of *Ephemera* burrow commonly in sand and gravel riffles of fast, clean streams, especially in northern Wisconsin. *Pentagenia* and *Litobrancha* larvae are rare in Wisconsin.

LEPTOHYPHIDAE (1 genus, 1 species)

Larvae of *Tricorythodes* are fairly common among gravel in permanent streams of all sizes. There are one or two generations each year, with much overlapping. Most larvae are collected in summer and early autumn; they are generally absent from spring collections.

LEPTOPHLEBIIDAE (4 genera, 7 species)

Larvae of both *Leptophlebia* and *Paraleptophlebia* are common inhabitants of clean streams throughout the state, the former being found in slow currents and the latter mostly in rapid water. Larvae of *Leptophlebia* leave streams in early spring to enter vernal pools from which subimagos emerge. Species of *Paraleptophlebia* and *Choroterpes* emerge from streams in late spring and summer; the latter are uncommon. *Habrophlebiodes* larvae are uncommonly collected from eddies and along stream banks of large streams, mostly in autumn. All Leptophlebiidae are apparently univoltine in Wisconsin.

POLYMITARCYIDAE (1 genus, 2 species)

Larvae of *Ephoron* are relatively uncommon, being found mostly under rocks in medium-sized, rapid steams. The life cycle is univoltine, with emergence during the summer months. *Tortopus* larvae, which live in clay banks of large streams, may occur in southern Wisconsin.

POTAMANTHIDAE (1 genus, 2 species)

Larvae of *Anthopotamus* inhabit shallow gravel and cobble runs of streams where the water is fairly shallow; they are fairly common. The life cycle is univoltine, with emergence throughout the summer months.

SETISURA

HEPTAGENIIDAE (10 genera, 22 species)

Larvae of *Heptagenia*, *Stenacron*, and *Stenonema* are very common year-around in a wide variety of streams throughout Wisconsin. Larvae of some species of *Heptagenia* and *Stenonema* also inhabit wave-swept shorelines of lakes and have been found at depths of 50 feet or more in Lake Superior. *Epeorus* and *Rhithrogena* larvae occur in rapid, clean streams in the northern half of the state, where they are relatively uncommon. *Leucrocuta* larvae are found statewide in small, clean streams, where they may be numerous in late spring. Larvae of *Nixe* are uncommon in mediums-sized streams statewide and *Macdunnoa* larvae are very rare in the lower Wisconsin River. *Arthroplea* larvae are uncommon in vernal pools near large streams in northern Wisconsin, developing rapidly and emerging in late May. The carnivorous larvae of *Anepeorus* are very rare on rocks in deep waters of large rivers, the difficulty of collecting in such habitats probably contributing to their apparent rarity. Heptageniids are predominantly univoltine.

ISONYCHIIDAE (1 genus, 2 species)

Isonychia larvae are fairly common, being found throughout the year among rocks and debris in rapid currents of a variety of streams. They feed mostly on algae and diatoms that they filter from the current with long setae on the inner margin of their prothoracic legs; larvae of some species are at least partly carnivorous. Life cycles are univoltine or bivoltine in Wisconsin.

OLIGONEURIIDAE (1 genus, 1 species)

Larvae of *Homoeoneuria* occur in sand bar drop-offs of large, streams in southern Wisconsin (Lillie 1992). Like *Isonychia*, larvae filter diatoms and other algae from the stream with long setae on their prothoracic legs. Life cycles are probably univoltine.

PSEUDIRONIDAE (1 genus, 1 species)

Larvae of *Pseudiron* are apparently rare in sand bottoms of larger streams, but their rarity is probably due to the difficulty of collecting in this habitat. Unlike most mayfly larvae, they are predators that feed mostly on chironomid larvae. The life cycle is univoltine.

PISCIFORMA

ACANTHAMETROPODIDAE (1 genus, 1 species)

Larvae of *Acanthametropus* occur in the shifting sand bottoms of large rivers in southern Wisconsin, and are difficult to collect because of their habitat (Lillie et al 1987, Lillie 1992). They are carnivores, and apparently have a two-year life cycle with emergence in early summer.

AMELETIDAE (1 genus, 1 species)

Larvae of *Ameletus* occur uncommonly in small, clean streams, which may have an intermittent flow. The life cycle is univoltine, with emergence in spring. *Ameletus lineatus* is known to be parthenogenetic.

AMETROPODIDAE

Larvae of *Ametropus* have been collected from sand eddies of a stream in the Upper Peninsula of Michigan and may occur in large eddies of sand-bottomed streams in northern Wisconsin. The life cycle is univoltine, with larvae being present from late summer until emergence in late May or June.

BAETIDAE (10 genera, 26 species)

Baetid mayflies occur in almost every stream, pond and weedy lake margin in the state. Recently, many changes were made at the generic level; *Pseudocloeon* and *Cloeon* were eliminated from the Wisconsin fauna and five new genera were introduced (Waltz and McCafferty 1987a, 1987b, McCafferty and Waltz 1990, 1995). *Baetis* larvae are very common in riffles and along banks of both clean and organically enriched streams during the warmer months, but are uncommon in winter. *Labiobaetis* is a common summer resident of streams with some organic enrichment. Many species are univoltine, but several have two generations each year. *Callibaetis* is multivoltine; larvae can be found among vegetation of almost every pond, lake margin, or stream backwater. Other genera are uncommon or rare in Wisconsin

METRETOPODIDAE (2 genera, 3 species)

The relatively uncommon larvae of *Siphloplecton* are found among shoreline vegetation in slower currents of large streams. Life cycles are univoltine, with larvae present from late autumn until emergence in late spring. *Metretopus* larvae have been collected only from the Chippewa River.

SIPHLONURIDAE (2 genera, 4 species)

Larvae of *Siphlonurus* are fairly common among shoreline vegetation of larger streams in late autumn and before their emergence in late spring; they also occur in riffles of small streams, in seeps and marshy areas adjacent to streams prior to emergence, and in ponds. *Parameletus* larvae are rare, developing rapidly in woodland pools in spring and emerging in May. Life cycles are univoltine

KEY TO GENERA OF EPHEMEROPTERA LARVAE IN WISCONSIN

1. Mandibles with large forward-projecting tusks; (Fig. 1) gills on abdominal segments 2-7 with fringed margins (Fig. 2) and projecting dorsally or laterally . . . . . **.2**

Mandibles without such tusks; fringed gills absent or projecting ventrolaterally . . . . . **.8**

2(1). Gills dorsal, curving up over abdomen; protibia fossorial (Fig. 3) . . . . . **.3**

Gills lateral, projecting from sides of abdomen; protibia slender, sub-cylindrical (Fig. 4) . . . . . **.POTAMANTHIDAE, *Anthopotamus***

3(2). Apex of metatibia rounded (Fig. 5); mandibular tusks curved inward apically (Figs. 7-8) . . . . . POLYMITARCYIDAE **4**

Apex of metatibia projected into an acute point ventrally (Fig. 6); mandibular tusks curved upward or outward apically (Fig. 9) . . . . . .EPHEMERIDAE **5**

4(3). **POLYMITARCYIDAE** - Mandibular tusks with numerous tubercles on upper surface (Fig. 8); protarsus unmodified, not partially fused with tibia . . . . . ***Ephoron***

Mandibular tusks with one or two prominent teeth on inner margin near apex (Fig. 7); protarsus broad and partially fused to tibia . . . . . ***Tortopus***

5(3). **EPHEMERIDAE** - Frontal process bifid (Figs. 1, 10) . . . . . **.6**

Frontal process rounded, conical, or truncate (Fig. 11) . . . . . **.7**

6(5). Mandibular tusks with teeth or robust spines on dorsolateral margin (Fig. 1) . . . . . ***.Pentagenia***

Mandibular tusks smooth on margins (Fig. 9). . . . . ***.Ephemera***

7(5). Gill on abdominal segment 1 bifid; antenna with whorls of long setae. . . . . ***Hexagenia***

Gill on abdominal segment 1 single; antenna with short, scattered setae . . . . . ***Litobrancha***

8(1). Mesonotum modified into a carapace-like structure that covers gills on abdominal segments 1-6 (Fig. 12). . . . . **.BAETISCIDAE, *Baetisca***

Mesonotum not modified into a carapace; gills exposed **9**

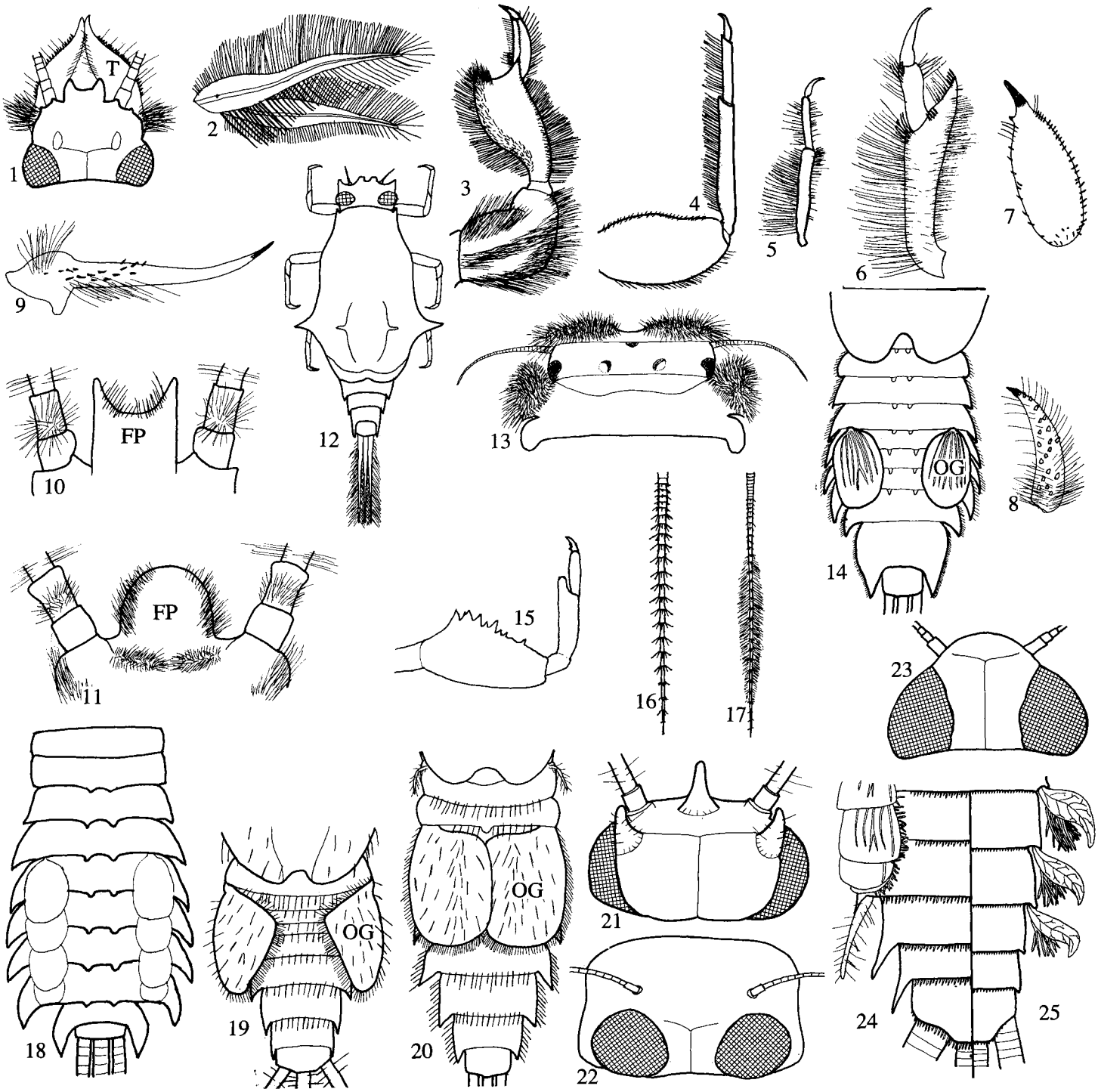
9(8). Head and pronotum with pads of long, dark setae on each side (Fig. 13); fringed gills projecting ventrolaterally . . . . . **.BEHNINGIIDAE, *Dolania***

Head and pronotum without pads of long, dark setae; without ventrolateral fringed gills . . . . . **.10**

10(9). Gill absent from abdominal segment 2, and sometimes from 1 and 3 also; gills on segment 3 or 4 may be operculate (Fig. 14). . . . . .EPHEMERELLIDAE **11**

Gills present on abdominal segment 1 or 2-7 . . . **.16**

11(10). **EPHEMERELLIDAE** - Lamellate gills present on abdominal segments 3-7. . . . . **.12**



Figures 1-26. Ephemeroptera Larvae. 1. Head (dorsal) *Pentagenia* with tusks (T). 2. Gills abdominal segment 3 *Hexagenia.* 3-4. Prothoracic leg: 3. *Hexagenia.* 4. *Anthopotamus.* 5-6. Metatibia and tarsus: 5. *Ephoron.* 6. *Ephemera.* 7-8. Mandibular tusk (dorsal): 7. *Tortopus.* 8. *Ephoron.* 9. Mandibular tusk (lateral) *Ephemera.* 10-11. Frontal process (FP): 10. *Ephemera.* 11. *Hexagenia.* 12. *Baetisca* (dorsal). 13. Head and pronotum *Dolania.* 14. Abdomen (dorsal) *Eurylophella* with operculate gills (OG). 15. Profemur, tibia, tarsus *Drunella.* 16-17. Caudal filament: *16. Serratella.* 17. *Ephemerella.* 18-20. Abdomen (dorsal) with operculate gills (OG): 18. *Attenella.* 19. *Tricorythodes.* 20. *Caenis.* 21-23. Head (dorsal): 21. *Brachycercus.* 22. *Stenonema.* 23. *Siphlonurus.* 24-25. Abdominal segments 6-10 (half): 24. *Stenonema.* 25. *Heptagenia.*

Lamellate gills present on abdominal segments 4-7 14

12(11). Distinct tubercles or spines present on anterior edge of profemur (Fig. 15); tarsal claws with 1-4 denticles . . . . . ***Drunella***

Tubercles and spines absent from anterior edge of profemur; tarsal claws usually with more than 4 denticles 13

13(12). Caudal filaments with whorls of short spines at apex of each segment, and at most with only sparse intersegmental setae (Fig. 16) . . . . . ***Serratella***

Caudal filaments with or without whorls of spines at apex of each segment, and with numerous intersegmental setae (Fig. 17). . . . . ***Ephemerella***

14(11). Abdominal terga with paired submedian tubercles on segments 3-7 (Figs. 14, 18) 15

Abdominal terga without paired submedian tubercles. . . . . ***Timpanoga***

15(14). Mid-dorsal lengths of abdominal terga 2-9 subequal (Fig. 18) . . . . . ***Attenella***

Abdominal segments 5-7 conspicuously shorter than 8 and 9, mid-dorsal length of 5-7 ≤ 1/2 length of segment 9 (Fig. 14) . . . . . ***Eurylophella***

16(10). Gill on abdominal segment 2 operculate or semi-operculate, covering or partially covering gills on succeeding segments (Figs. 19-20) 17

Gill on abdominal segment 2 similar to other gills 20

17(16). Operculate gills sub-triangular, well separated mesally (Fig. 19); succeeding gills without fringed margins. . . . . **LEPTOHYPHIDAE, *Tricorythodes***

Operculate gills quadrate and proximate mesally (Fig. 20); succeeding gills with fringed margins. . . . . CAENIDAE 18

18(17). **CAENIDAE** - Three tubercles on head (Fig. 21), which may be small; palpi 2-segmented 19

No tubercles on head; palpi 3-segmented . . . . ***Caenis***

19(18). Tubercles on head prominent, pointed (Fig. 21); prosternum and anterior of mesosternum without long setae . . . . . ***Brachycercus***

Tubercles on head low, rounded; prosternum and anterior of mesosternum with numerous long setae . . . . . ***Cercobrachys***

20(16). Head flattened dorsoventrally; eyes and antennae dorsal (Fig. 22); gills a single lamella, often with a fibrilliform tuft (Figs. 24-25) 21

Head not flattened; antennae and eyes lateral (Fig. 23); gills not as above 32

21(20). Gills with finger-like projection on lamellae (Fig. 30); tarsal claws very long . . . . . **PSEUDIRONIDAE, *Pseudiron***

Gill lamellae without such a projection; claws normal . . . . . HEPTAGENIIDAE 22

22(21). **HEPTAGENIIDAE** - Larva with 2 tail filaments 23

Larva with 3 tail filaments 24

23(22). Prominent dorsal tubercles on head, thorax, and abdomen . . . . . ***Anepeorus***

No tubercles dorsally . . . . . ***Epeorus***

24(22). Gill on abdominal segment 7 vestigial; gill on segment 6 reduced . . . . . ***Macdunnoa***

Gill on abdominal segment 7 readily visible, although sometimes reduced; gill on segment 6 similar to that on segment 5 25

25(24). Last pair of gills reduced to a single slender filament with tracheation reduced or absent (Fig. 24) 26

Last pair of gills similar to preceding pairs (Figs. 25-26) 27

26(25). Lamellate gills pointed apically (Fig. 27) ***Stenacron***

Lamellate gills rounded or truncated apically (Figs. 28-29) . . . . . ***Stenonema***

27(25). Gill lamellae enlarged on segments 1 and 7; all gills projecting ventrally to form a ventral disc (Fig. 26) . . . . . ***Rhithrogena***

Gill lamellae not as above, with those on segments 1 and 7 smaller than intermediate pairs 28

28(27). Gills ventral, fibrilliform portion large, lamellar portion small, finger-like (Fig. 31) . . . . . ***Raptoheptagenia***

Gills dorsal or lateral, fibrilliform portion smaller than lamellar portion 29

29(28). Distal maxillary palpomere at least 4 times as long as galea-lacinia (Fig. 32) . . . . . ***Arthroplea***

Distal maxillary palpomere much shorter 30

30(29). Gill on abdominal segment 7 with fibrilliform portion (Fig. 25); claws without denticles . . . ***Heptagenia***

Gill on abdominal segment 7 without fibrilliform portion; claws with denticles 31

31(30). Caudal filaments with only short spine-like setae arranged in whorls; many dark spots near anterior margin of unpatterned head . . . . . ***Leucrocuta***

Caudal filaments with long, intersegmental setae in distal half; head without dark spots, or with spots anterior to dark pattern . . . . . ***Nixe***

32(20). Claw on protarsus (Fig. 33) much shorter than long, slender claws of meso- and metatarsi (Fig. 35). 33

Claws on all tarsi similar in length and structure. . 35

33(32). Protarsal claw simple, with long, slender denticles (Fig. 34); spinose pad present on procoxa . . . . . **AMETROPODIDAE, *Ametropus***

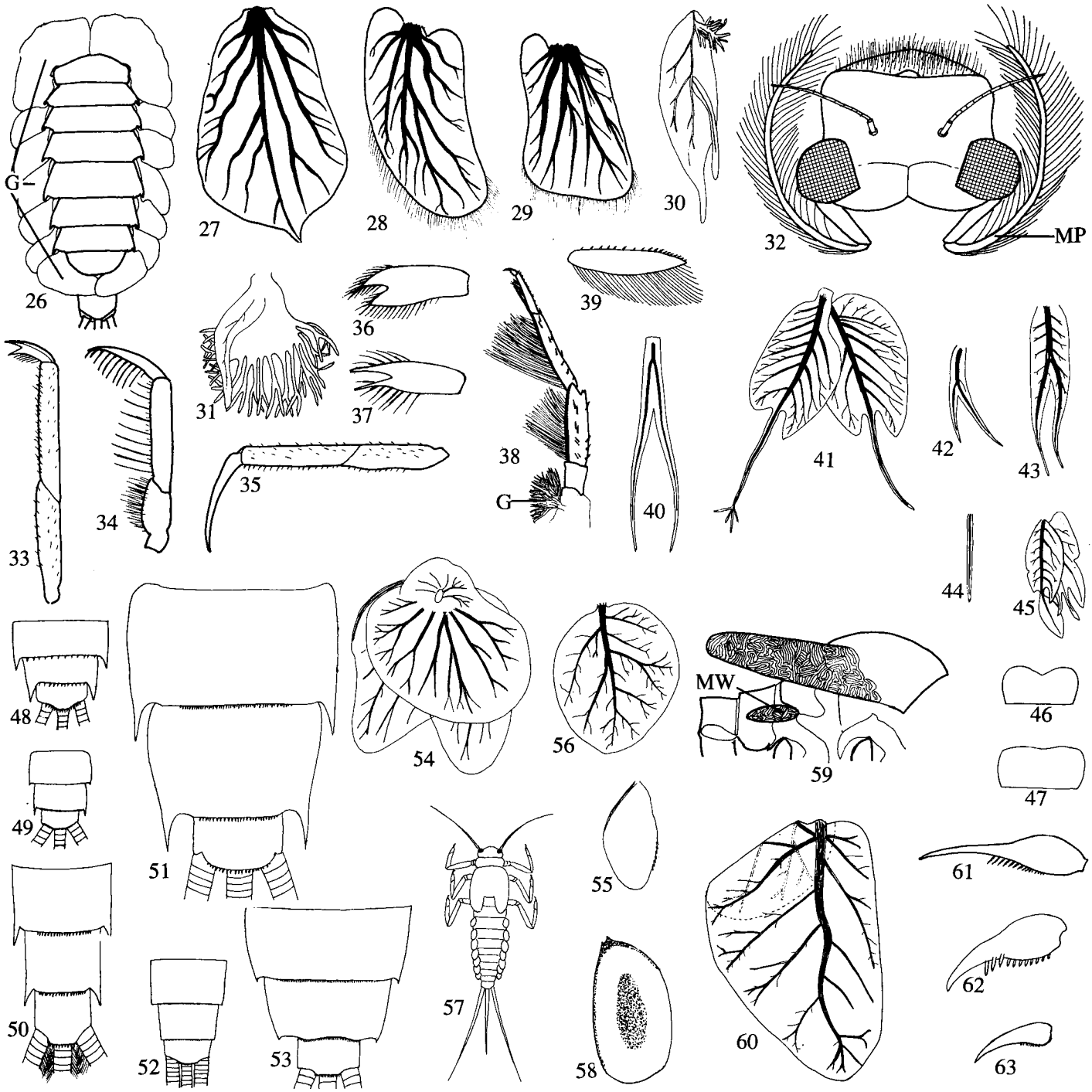
Protarsal claw bifid (Fig. 33); no spinose pad on procoxa . . . . . METRETOPODIDAE 34

34(33). **METRETOPODIDAE** - Margin of protarsal claw densely covered with spines that are only slightly smaller than the short terminal spines (Fig. 36); gills 3-7 with 2-7 stout spines on outer edge in addition to small setae . . . . . ***Metretopus***

Margin of protarsal claw sparsely covered with spines that are much weaker than the long terminal spines (Fig. 37); gills 3-7 with only small setae on outer margins . . . . . ***Siphloplecton***

35(32). Prothoracic leg with dense row of setae along inner surface (Fig. 38) 36

Prothoracic leg without dense row of setae along inner surface 37



Figures 26-63. Ephemeroptera Larvae. 26. Abdominal sterna and gills (G) *Rhithrogena.* 27-31. Gill lamella (ventral): 27. *Stenacron.* 28-29. *Stenonema.* 30. *Pseudiron.* 31. *Raptoheptagenia.* 32. Head with maxillary palp (MP) *Arthroplea.* 33-34. Protibia and tarsus: 33. *Siphloplecton.* 34. *Ametropus.* 35. Metatibia and tarsus *Siphloplecton.* 36-37. Protarsal claw: 36. *Metretopus.* 37. *Siphloplecton.* 38. Prothoracic leg with basal gill tuft (G) *Isonychia.* 39. Gill *Homoeoneuria.* 40-45. Gills on abdominal segment 1 and 3 respectively: 40-41. *Leptophlebia.* 42-43. *Paraleptophlebia.* 44-45. *Choroterpes.* 46-47. Labrum: 46. *Habrophlebiodes.* 47. *Paraleptophlebia.* 48-53. Abdominal terga 8-10: 48. *Habrophlebiodes.* 49. *Paraleptophlebia.* 50. *Ameletus.* 51. *Siphlonurus.* 52. *Baetis.* 53. *Callibaetis.* 54-56. Gills (dorsal): 54. *Siphlonurus.* 55. *Ameletus.* 56. *Parameletus.* 57. *Baetis* (dorsal). 58. Gill *Heterocloeon.* 59. Meso- and metathoracic (MW) wing pads *Baetis.* 60. Gill (dorsal) *Callibaetis.* 61-63. Tarsal claw: 61. *Callibaetis.* 62. *Baetis.* 63. *Paracloeodes.*

36(35). Gills single lamellae with fibrilliform tuft; gill tuft at base of procoxa (Fig. 38) . . . . . **ISONYCHIIDAE, *Isonychia***

Gills on abdominal segments 2-7 small, lateral, lanceolate, with posterior fringe (Fig. 39); gill on segment 1 large, fibrilliform, projecting between metacoxae. . .OLIGONEURIIDAE, ***Homoeoneuria***

37(35). Gills forked (Figs. 40, 42-43), or bilamellate and terminating in a filament or point (Figs. 41, 45). . . . . .LEPTOPHLEBIIDAE **38**

Gills single or double lamellae (Figs. 54-56, 58, 60), sometimes with ventral fibrilliform tuft **41**

38(37). LEPTOPHLEBIIDAE - Gill on abdominal segment 1 different in structure from succeeding pairs (Figs. 40-41, 44-45) **39**

Gills on segments 1 to 7 narrowly lanceolate and bifid (Figs. 42-43) **40**

39(38). Gill on segment 1 forked (Fig. 40), remaining gills bilamellate (Fig. 41) . . . . . ***Leptophlebia***

Gill on segment 1 a single, linear lamella (Fig. 44), remaining gills bilamellate (Fig. 45). . .***Choroterpes***

40(38). Front of labrum rather deeply emarginate (Fig. 46); posterolateral spines on abdominal segment 9 one-half as long as that segment (Fig. 48). . . . . ***Habrophlebiodes***

Front of labrum shallowly emarginate (Fig. 47); posterolateral spines on segment 9 not more than one-fourth as long as that segment (Fig. 49). . . . . ***Paraleptophlebia***

41(37). Abdominal segments 8 and 9 produced posterolaterally into distinct, flattened spines (Figs. 50-51); if spines are weak, antenna < twice width of head **42**

Abdominal segments 8 and 9 without such spines (Fig. 52); if weak spines are present (Fig. 53), antenna > twice width of head . . . BAETIDAE **45**

42(41). Head, pronotum, and mesonotum with conspicuous lateral spines; a row of median spines on abdominal terga . . . . . **ACANTHAMETROPODIDAE,** . . . . . ***Acanthametropus***

Without such spines **43**

43(42). Gills single, with sclerotized band on ventral margin and little or no tracheation (Fig. 55); maxilla with crown of pectinate spines. . . . . **AMELETIDAE, *Ameletus***

Gills with well-developed tracheation (Figs. 54, 56); maxilla without pectinate spines. . . . . SIPHLONURIDAE **44**

44(43). SIPHLONURIDAE - Gill lamellae double on segments 1 and 2, sometimes on other segments (Fig. 54). . . . . ***Siphlonurus***

Gill lamellae single on all segments (Fig. 56) . . . . . ***Parameletus***

45(41). BAETIDAE - With 2 well-developed tail filaments, median filament absent or no longer than tenth tergum **46**

With 3 well-developed tail filaments, median filament much longer than tenth tergum (Fig. 57) **49**

46(45). Center region of gills with large pigmented area (Fig. 58); procoxa with a single filamentous gill on inner margin . . . . . ***Heterocloeon***

Center region of gills without large pigmented area; procoxa lacking a gill **47**

47(46). Metathoracic wingpads present (Fig. 59) . . . . ***Baetis***

Metathoracic wingpads absent, or reduced to a minute thread **48**

48(47). Cerci unbanded; larva short, dorsoventally flattened, with broad thorax and legs spread outward; abdominal terga tan, lighter posteriorly, especially on segments 9 and 10. . . . . ***Acentrella***

Cerci banded; if cerci unbanded, larva elongate, with abdominal terga 4 and 8-10 paler than other terga . . . . . ***Baetis***

49(45). Tail filaments with narrow dark band at apex of every third to fifth segment in basal two-thirds **50**

Banding of tail filaments, if present, not as above **51**

50(49). Metathoracic wing pad absent and all gills simple lamellae . . . . . ***Centroptilum***

Metathoracic wing pad present **or** some gills with a small, recurved dorsal flap . . . . . ***Procloeon***

51(49). Gills on abdominal segments 1 and 2 with ventral recurved flap (Fig. 60); tarsal claws with elongate, slender tip (Fig. 61) . . . . . ***Callibaetis***

All gills single lamellae; tarsal claws without elongate, slender tip (Fig. 62) **52**

52(51). Tarsal claws elongate, > half as long as tarsus, with indistinct denticles (Fig. 63); metathoracic wing pad absent; mature larva 3 mm long . . . ***Paracloeodes***

Tarsal claws stout, much < half length of tarsus, with large denticles (Fig. 62); metathoracic wing pad present (Fig. 59) **53**

53(52). Gill on abdominal segment 7 lanceolate . ***Acerpenna***

Gill on abdominal segment 7 rounded **54**

54(53). Cerci with a dark brown apical band . . . . ***Diphetor***

Cerci unbanded or with dark bands before apex. . .**55**

55(54). Antennal scape with apicolateral lobe; maxillary palp with mesal subapical emargination . . . ***Labiobaetis***

Antennal scape without apicolateral lobe; maxillary palp not emarginate before apex . . . . . ***Baetis***

WISCONSIN SPECIES AND REFERENCES TO LARVAL KEYS

RECTRACHAETA

BAETISCIDAE (Hilsenhoff 1984b, Pescador and Berner 1981)

Baetisca - lacustris, laurentina, obesa

BEHNINGIIDAE

Dolania - americana

CAENIDAE

Brachycercus (Soldan 1986) - *lacustris, nasutus, prudens*

Caenis (Provonsha 1990) - *amica, anceps*, diminuta, hilaris, latipennis, punctata, tardata*, youngi*

Cercobrachys (Soldan 1986) - new species

EPHEMERELLIDAE
Attenella (Allen and Edmunds 1961) - *attenuata*
Drunella (Allen and Edmunds 1962b) - *cornuta, cornutella, lata*, walkeri**
Ephemerella (Allen and Edmunds 1965) - *aurivillii, catawba, dorothea, excrucians, inermis, invaria, needhami, rotunda, septentrionalis*, subvaria*
Eurylophella (Allen and Edmunds 1963b, Funk and Sweeney 1994) - *aestiva, bicolor, funeralis, lutulenta, minimella*, temporalis*
Serratella (Allen and Edmunds 1963a) - *deficiens, frisoni*, sordida*
Timpanoga (=*Dannella*) (Allen and Edmunds 1962a, McCafferty 1977) - *lita, simplex*
EPHEMERIDAE (McCafferty 1975)
Ephemera - *simulans, varia**
Hexagenia - *atrocaudata, bilineata, limbata, rigida*
Litobrancha - *recurvata*
Pentagenia - *vittigera*
LEPTOHYPHIDAE (=TRICORYTHIDAE)
Tricorythodes - *atratus, peridius*, stygiatus**
LEPTOPHLEBIIDAE
Choroterpes - *basalis*
Habrophlebiodes - *americana*
Leptophlebia - *cupida, nebulosa*
Paraleptophlebia - *adoptiva*, debilis, guttata*, moerens*, mollis, ontario*, praepedita*
POLYMITARCYIDAE (McCafferty 1975)
Ephoron - *album, leukon*
*Tortopus** - *primus**
POTAMANTHIDAE (Bae and McCafferty 1991)
Anthopotamus (=*Potamanthus*) - *myops, verticis*
SETISURA
HEPTAGENIIDAE (Flowers and Hilsenhoff 1975)
Anepeorus (=*Spinadis*) - *simplex*
Arthroplea - *bipunctata*
Epeorus - *vitreus*
Heptagenia - *diabasia, flavescens, pulla*
Leucrocuta (=*Heptagenia*, part) - *hebe*
Macdunnoa - *persimplex*
Nixe (=*Heptagenia*, part) - *inconspicua, lucidipennis*
*Raptoheptagenia** (=*Anepeorus*, part) - *cruentata**
Rhithrogena - *impersonata, jejuna, pellucida, undulata*
Stenacron - *interpunctatum*
Stenonema (Bednarik and McCafferty 1979) - *exiguum, femoratum, integrum, mediopunctatum, modestum, pulchellum, terminatum, vicarium*
ISONYCHIIDAE (=OLIGONEURIIDAE, part) (Kondratieff and Voshell 1984)
Isonychia - *bicolor, rufa*, sayi, sicca**
OLIGONEURIIDAE
Homoeoneuria - *ammophila*
PSEUDIRONIDAE (=HEPTAGENIIDAE, part)
Pseudiron - *centralis*
PISCIFORMA
ACANTHAMETROPODIDAE (=SIPHLONURIDAE, part)
Acanthametropus - *pecatonica*
AMELETIDAE (=SIPHLONURIDAE, part)
Ameletus - *lineatus, subnotatus**
AMETROPODIDAE
*Ametropus** - *neavei**
BAETIDAE
Acentrella (=*Pseudocloeon*, part) - *ampla, carolina*
Acerpenna (=*Baetis*, part) - *macdunnoughi, pygmaea*
Baetis (+*Pseudocloeon*, part) (Bergman and Hilsenhoff 1978, Morihara and McCafferty 1979) - *armillatus, brunneicolor, cinctutus, dubius, elliotti*, flavistriga, intercalaris, punctiventris, tricaudatus*
Callibaetis (Check 1982) - *ferrugineus, fluctuans, skokianus**
Centroptilum (=*Cloeon*, part) - *alamance*
Diphetor (=*Baetis*, part) - *hageni*
Heterocloeon - *curiosum*
Labiobaetis (=*Baetis*, part) (Bergman and Hilsenhoff 1978, Morihara and McCafferty 1979) - *frondalis, longipalpus, propinquus*
Paracloeodes - *minutus*
Procloeon (=*Centroptilum, Cloeon*, part) - *album*, bellum, convexum, insignificans*, mendax*, minor*, rubropictum, rufostrigatum, walshi*
METRETOPODIDAE
Metretopus - *borealis*
Siphloplecton - *basale, interlineatum*
SIPHLONURIDAE
Parameletus - *chelifer*
Siphlonurus - *alternatus, quebecensis, phyllis*, rapidus, typicus**

ODONATA - DRAGONFLIES

This relatively small hemimetabolous order has two distinctive suborders, Anisoptera (dragonflies) and Zygoptera (damselflies). Only 154 species have been found in Wisconsin (Smith et al. 1993 + unpublished notes); about 420 are known from North America. Larvae of all species are aquatic; about two-thirds are lentic and one-third lotic. Lotic larvae occur in all types of permanent stream habitats, including gravel and rock riffles, debris along banks, bank vegetation, soft sediments, and sand; occasionally they are found along wind-swept shores of lakes. Lentic larvae inhabit permanent and temporary ponds, marshes, swamps, and littoral zones and shoreline areas of lakes.

Odonata larvae are readily distinguished from other aquatic insects by their elongate, hinged labium that is modified for seizing and grasping prey. They have conspicuous compound eyes and relatively short filamentous antennae. The abdomen is elongate and thin in Zygoptera, terminating in three long, vertically-oriented, caudal lamellae. The abdomen is relatively broad in Anisoptera, and terminates in 3 triangular-shaped, pointed appendages, the upper one being the "epiproct" and the lower ones "paraprocts". Between them are triangular-shaped cerci, which usually are distinctly shorter than the epiproct and paraprocts. Adults do not resemble larvae, being much more elongate, having conspicuous genitalia, two pairs of elongate net-veined wings, and much larger compound eyes. Like

Ephemeroptera, the primitive wings of Odonata cannot be folded. Wings of Anisoptera are held horizontally to the side when at rest; those of Zygoptera are held just above or slightly to the side of the abdomen.

Odonata larvae move about on the substrate by crawling; some actively stalk prey. Zygoptera larvae swim by moving their abdomen and caudal lamellae from side to side. Anisoptera larvae can move rapidly when disturbed by expelling water from a rectal chamber. Tracheal gills within the rectal chamber, and movement of water in and out of the chamber, aid in respiration of Anisoptera larvae. In Zygoptera, respiration is greatly enhanced by the caudal lamellae, enabling most species to live in water with relatively low levels of dissolved oxygen.

Life cycles are relatively long, mostly one year in Zygoptera, and one to four years in Anisoptera. Slow seasonal developmental cycles predominate, but fast seasonal cycles occur in both suborders. Normally there are 11 to 12 larval instars, the number varying somewhat between species and within a species. Upon completing development, larvae crawl onto a shore, bank, rock, or emergent vegetation, where ecdysis occurs. Larvae of some species may crawl several meters from the water to emerge. Newly emerged (teneral) adults are feeble fliers for a day or two and vulnerable to predation. Adults often disperse widely and feed for a week or more on flying insects before returning to breeding sites where males patrol selected areas, chasing away rival males and other species. Before mating, the male transfers sperm from primary genitalia at the tip of the abdomen to a secondary genital organ on abdominal sternum 2. Using claspers on the terminal segment, a male will seize a female that flies into his territory, grasping her either by the pronotum (Zygoptera) or by the head (Anisoptera). The female then loops the tip of her abdomen forward and upward to receive sperm from the penis on the second abdominal sternum of the male. Adults may live several weeks.

Eggs are laid singly in plant tissues (endophytic oviposition) above, at, or below the water's surface, or singly or in masses on plants, debris, or other substrates, or randomly on the water's surface (exophytic oviposition). Oviposition is endophytic in all Zygoptera and Aeshnidae; it is exophytic in other families found in Wisconsin. In many species, especially those of Zygoptera and Libellulidae, the male continues to grasp the female to protect her from other males while she is ovipositing. Larvae hatch from eggs after a week or more, or after a long diapause. The first instar is a prolarval stage that lasts a few minutes to several hours. Prolarvae lack well-developed appendages.

Most Odonata larvae and all adults in Wisconsin can be identified to species by using keys and descriptions provided by Walker (1953, 1958), Walker and Corbet (1975), Needham and Westfall (1955), and Garman (1917, 1927). However, problems often arise when using the keys. Although larvae of most species have been described, revised larval keys are restricted to limited geographical areas or to a few genera. Because Odonata are relatively homogeneous, differences between families and genera are not as obvious as in other aquatic orders. Larvae of Corduliidae cannot be readily separated from those of Libellulidae without identifying them to genus. Disagreement also exists among systematists about the status of various genera and even families. However, species of North American Odonata are better known as larvae and adults than aquatic insects in any other order. This may be due to significant contributions by many amateur odonatologists. Books by Corbet (1962) and Miller (1987), and a review article by Corbet (1980) summarize our knowledge of Odonata biology and ecology.

ZYGOPTERA - Damselflies

CALOPTERYGIDAE (2 genera, 4 species)

Larvae of *Calopteryx* and *Hetaerina* are common statewide in permanent streams, especially among bank vegetation and snags of debris where the current is moderate. One or two years are required for larval development, depending on the species. Adults emerge in early summer.

COENAGRIONIDAE (7 genera, 31 species)

In this, the most abundant family of damselflies, larvae of all genera, except *Argia*, occur year-around in almost every type of permanent lentic habitat with vegetation. *Enallagma* and *Ischnura* larvae are abundant; *Nehalennia* and *Coenagrion* larvae are fairly common, and larvae of *Amphiagrion* and *Chromagrion* are uncommon. Larvae of *Argia* are fairly common inhabitants of streams where they cling to rocks and debris in the current. Larvae of some species of *Enallagma* are also lotic. Most, if not all species are univoltine; adults can be seen from April through October.

LESTIDAE (2 genera, 10 species)

Larvae of *Lestes* commonly inhabit vegetation of marshy, or bog-margined ponds, or small sheltered lakes. Several species develop in temporary ponds. All species are univoltine, with adults emerging at various times throughout the summer. Larvae of *Archilestes* are rare in southern Wisconsin, occurring along margins of streams.

ANISOPTERA - Dragonflies

AESHNIDAE (7 genera, 16 species)

Larvae of *Boyeria*, are common in clean, permanent streams. Those of *Basiaeschna, Nasiaeschna,* and two species of *Aeshna* are also found in streams, usually where the current is slow, as well as in lentic habitats. Larvae of other genera inhabit ponds and margins of lakes where they climb about on vegetation. Larvae of *Aeshna* and *Anax* are very common statewide, those of *Epiaeschna and Nasiaeschna* are uncommon, and *Gomphaeschna* larvae are rare, occurring only in some northern swamps. Most species have life cycles of one to three years, with emergence during the summer. An exception is *Anax junius,* adults of which migrate into Wisconsin from the south in April. In warm summers a partial second generation may be completed before remaining larvae are killed by freezing water; some larvae may survive unusually warm winters.

CORDULEGASTRIDAE (1 genus, 3 species)

Larvae of *Cordulegaster* burrow into the substrate of small, clear, woodland streams, where they are fairly common. They have a 3 to 4 year life cycle, with adults emerging in May and June, and flying until early August.

CORDULIIDAE (6 genera, 21 species)

Larvae of *Williamsonia* are rare in northern bogs, and those of *Cordulia, Dorocordulia, Neurocordulia* and most species of *Somatochlora* are uncommon. Larvae of *Neurocordulia* are primarily lotic; those of *Epitheca* and *Somatochlora* are found in both lotic and lentic habitats. *Epitheca* larvae may become abundant in lakes, ponds, marshes, and swamps, with adults often forming huge swarms in spring and early summer. This family is closely related to Libellulidae, and larvae have similar habits. Univoltine life cycles probably predominate; some species may be semivoltine.

GOMPHIDAE (10 genera, 32 species)

Larvae of *Gomphus, Ophiogomphus, Stylogomphus,* and *Stylurus* are lotic, while those of *Dromogomphus, Gomphurus,* and *Hagenius* inhabit streams and larger lakes. *Arigomphus* larvae occur in ponds and slow streams, and larvae of *Phanogomphus* are both lotic and lentic, depending on the species. *Progomphus* larvae are fairly common in sandy lakes and streams in central and northwest Wisconsin. *Gomphus, Hagenius,* and *Stylogomphus* are found only in the northern two-thirds of Wisconsin, where larvae are fairly common. Two-year life cycles are probably the rule for most species, but some may have much longer life cycles; *Hagenius* apparently has a 4-year life cycle. Various species emerge throughout the spring and summer months. Larvae lie partially buried in sand or silt substrate to ambush their prey; those of *Gomphurus, Ophiogomphus, Stylurus,* and *Phanogomphus* are frequently encountered.

LIBELLULIDAE (12 genera, 33 species)

Larvae of this widespread and abundant family occur in permanent lentic habitats of all types, with *Leucorrhinia, Libellula,* and *Sympetrum* being abundant. They crawl about on the bottom among debris or weeds, waiting to ambush prey. Larvae in other genera are all fairly common and widespread, except those of *Nannothemis,* which are rare in northern bogs. Most genera have slow seasonal univoltine life cycles with emergence from May to October; *Sympetrum* has a fast seasonal life cycle with emergence in summer and early autumn.

MACROMIIDAE (2 genera, 4 species)

Larvae of *Macromia* and *Didymops* occur uncommonly in shallow muck, marl, and debris in slow areas of streams, or in lakes, where they lie near the substrate's surface to ambush prey. Emergence takes place in late spring or early summer, with most species probably being univoltine or semivoltine.

KEY TO GENERA OF ODONATA LARVAE IN WISCONSIN

1. Abdomen terminating in 3 caudal lamellae (Figs. 10-14), longest > 1/3 length of abdomen . . . . . ZYGOPTERA **2**

Abdomen terminating in 3 stiff, pointed valves, separated by pointed cerci, the longest < 1/3 length of abdomen (Figs. 22-25) . . . . . ANISOPTERA **4**

2(1). Length of antennomere 1 ≥ 2-5 combined; mentum with deep, median cleft (Figs. 1-2); lotic. . . . . CALOPTERYGIDAE **8**

Length of antennomere 1 < 2-5 combined; mentum with at most a very small median cleft (Figs. 3-4); mostly lentic **3**

3(2). Basal half of labium greatly narrowed and elongate (Fig. 3); labium in repose extends back to or past mesocoxae . . . . . LESTIDAE **9**

Basal half of labium not greatly narrowed (Fig. 4);labium in repose extends only to procoxae. . . . . COENAGRIONIDAE **10**

4(1). Mentum flat, or nearly so, without stout setae. . . . **5**

Mentum spoon-shaped, covering face to base of antennae and armed with stout setae. **6**

5(4). Antenna 4-segmented; mesotarsus 2-segmented . . . . . GOMPHIDAE **16**

Antenna 6- or 7-segmented; mesotarsus 3-segmented . . . . . AESHNIDAE **25**

6(4). Labium with large irregular teeth on distal edge of lateral lobes (Fig. 5); wing-pads divergent; lotic. . . . . **CORDULEGASTRIDAE, *Cordulegaster***

Labium with distal edge of lateral lobes entire or with small, even crenulations or teeth (Fig. 6); wing-pads parallel; lentic or lotic. **7**

7(6). Head with prominent, almost erect, thick frontal horn between bases of antennae; legs very long, apex of metafemur reaching to or beyond apex of abdominal segment 8; metasternum with broad, median tubercle. . . . . MACROMIIDAE **32**

Head without prominent frontal horn, except in *Neurocordulia molesta;* legs shorter, apex of metafemur usually not reaching apex of abdominal segment 8; metasternum without median tubercle. . . . . LIBELLULIDAE and CORDULIIDAE **33**

8(2). **CALOPTERYGIDAE** - Mentum cleft almost halfway to base (Fig. 1). . . . . ***Calopteryx***

Mentum cleft only to base of lateral lobes (Fig. 2). . . . . ***Hetaerina***

9(3). **LESTIDAE** - Lateral lobe with movable hook and 3 sharply pointed processes (Fig. 7); each caudal lamella with 2 dark cross-bands; lotic . ***Archilestes***

Lateral lobe with movable hook, a pointed process, and a median truncated process with sharp points (Fig. 8); caudal lamellae never with 2 distinct dark cross-bands; lentic. . . . . ***Lestes***

10(3). **COENAGRIONIDAE** - Distal margin of lateral lobe produced into 3 pointed hooks, middle one shorter than end hook and usually about 1/2 as long as movable hook (Fig. 9); median caudal lamella usually 1/3 to 1/2 as broad as long and often quite thick or triquetral (Fig. 10); lotic ..... ***Argia***

Distal margin of lateral lobe with a comparatively small end hook and a more or less truncate and denticulate middle lobe < 1/3 as long as movable hook (Fig. 4); caudal lamella at mid-length < 1/3 as broad as long (Figs. 12-14), except *Amphiagrion* (Fig. 11); mostly lentic..... **11**

11(10). Posterolateral margins of head angulate, with angles projecting and forming blunt tubercles (Fig. 15).**12**

Posterolateral margins of head broadly rounded, without blunt tubercles (Fig. 16)..... **13**

12(11). Antenna 5- or 6-segmented; caudal lamellae each about 1/3 as broad as long (Fig. 11) ***Amphiagrion***

Antenna 7-segmented; caudal lamellae each not > 1/6 as broad as long, (Fig. 12)..... ***Chromagrion***

13(11). Mentum with 1 or 2 dorsal setae on each side of median line, the second, when present, very small. ..... ***Nehalennia***

Mentum with 3 to 7 dorsal setae on each side (Fig. 4) **14**

14(13). Antenna 6-segmented ..... ***Enallagma***

Antenna 7-segmented (6-segmented in young larvae) **15**

15(14). Caudal lamellae terminating in a blunt point (Fig. 13) ..... ***Coenagrion***

Caudal lamellae terminating in a sharp, tapered point (Fig. 14) ..... ***Ischnura***

16(5). **GOMPHIDAE** - Naked antennomere 4 generally about 1/4 as long as setose 3 (Fig. 17); mesocoxae closer together at base than pro- and metacoxae. . ..... ***Progomphus***

Antennomere 4 vestigial or nearly so (Fig. 18); mesocoxae not closer together than other coxae .**17**

17(16). Wing-pads strongly divergent; lotic . ***Ophiogomphus***

Wing-pads parallel along back; lentic or lotic.... **18**

18(17). Body very flat, abdomen nearly circular in dorsal view; paired tubercles on top of head. . ***Hagenius***

Abdomen more nearly cylindrical; no tubercles on head **19**

19(18). Flattened antennomere 3 nearly as wide as long (Fig. 19); lotic ..... ***Stylogomphus***

Cylindrical antennomere 3 > 4 times as long as wide (Fig. 18)..... **20**

20(19). Dorsal spines on abdominal segments 2-9; distinct, short, mid-dorsal carinae on segments 7 and 8, a longer one on 9, each terminating in a spine-like dorsal hook (Fig. 22) ..... ***Dromogomphus***

If dorsal spines are present on abdominal segments 2-9, those on segments 7-9 are not terminations of raised dorsal carinae **21**

21(20). Pro- and mesotibiae with burrowing hooks at outer apical angle about as long as width of tarsus (Fig. 20)..... **22**

Pro- and mesotibiae with burrowing hooks absent or obsolete (Fig. 21); lotic ..... ***Stylurus***

22(21). Abdominal segment 10 shorter than wide **23**

Abdominal segment 10 longer than wide; mostly lentic ..... ***Arigomphus***

23(22). Mid-dorsal length of abdominal segment 9 ≥ 1/2 basal width; length of abdominal segment 10 2/3 to 3/4 width (Fig. 23); lotic or lentic ... ***Phanogomphus***

Mid-dorsal length of abdominal segment 9 < 1/2 basal width; length of abdominal segment 10 < 1/2 width (Figs. 24-25); lotic **24**

24(23). Lateral spines on segment 9 apart from segment 10 and not much longer than those on 8 (Fig. 24); lotic ..... ***Gomphus***

Lateral spines on segment 9 close to segment 10 and much longer than those on 8 (Fig. 25)..... ..... ***Gomphurus***

25(5). **AESHNIDAE** - Hind angles of head angulate; lateral spines present on abdominal segments 5-9 .... **26**

Hind angles of head rounded; lateral spines present on abdominal segments 6 or 7-9 (In *Aeshna eremita* hind angles of head slightly angulate, and minute lateral spines present on abdominal segment 5) .**29**

26(25). Blade of lateral lobe truncate on outer end (Fig. 26) **27**

Blade of lateral lobe narrowed toward tip (Fig. 27) **28**

27(26). Tips of paraprocts incurved; mound-like protuberance on each side of mesothorax at mid-height; lotic . . .. ***Boyeria***

Tips of paraprocts straight; no mound-like protuberance on each side of mesothorax .... ***Epiaeschna***

28(26). Dorsum of abdomen broadly rounded; epiproct about 2/3 length of paraprocts ..... ***Basiaeschna***

Blunt dorsal hooks on median ridge of abdominal segments 7-9; epiproct about same length as paraprocts ..... ***Nasiaeschna***

29(25). Lateral spines on abdominal segments 7-9 only (rarely an extremely small one on segment 6..... **30**

Lateral spines on abdominal segments 6-9 . . ***Aeshna***

30(29). Antenna longer than distance from its base to rear of head; lentic ..... ***Gomphaeschna***

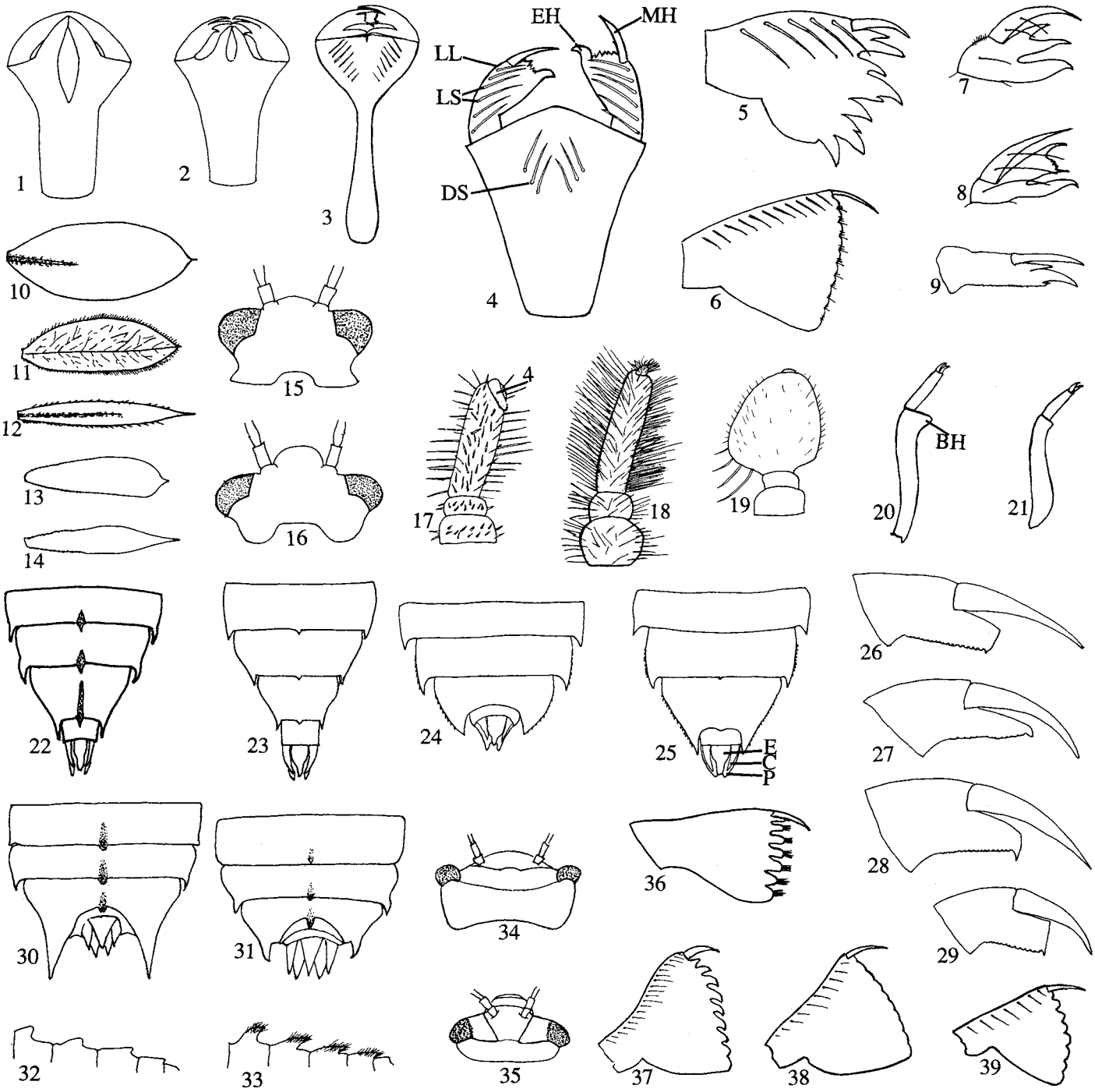
Antenna about 1/2 as long as distance from its base to rear of head **31**

31(30). Truncated blade of lateral lobe with prominent end hook (Fig. 28); mentum 2 or more times as long as width at base; lentic ..... ***Anax***

End hook not prominent (Fig. 29); mentum < 1 1/2 times as long as width at base ..... ***Aeshna***

32(7). **MACROMIIDAE** - Lateral spines on abdominal segment 9 project at most to mid-length of epiproct; lateral setae 6, dorsal setae 5-6 + 3-4 . . ***Macromia***

Lateral spines on abdominal segment 9 project to apex of epiproct or beyond; lateral setae 5, dorsal setae 5 + 1-2 ..... ***Didymops***



Figures 1-39. Odonata Larvae. 1-2. Mentum (ventral): 1. *Calopteryx*. 2. *Hetaerina*. 3-4. Mentum (dorsal): 3. *Lestes*. 4. *Enallagma* with dorsal setae (DS), lateral lobes (LL), lateral setae (LS), movable hook (MH), and end hook (EH). 5-9. Lateral lobe (dorsal): 5. *Cordulegaster*. 6. *Libellula*. 7. *Archilestes*. 8. *Lestes*. 9. *Argia*. 10-14. Caudal lamella (lateral): 10. *Argia*. 11. *Amphiagrion*. 12. *Chromagrion*. 13. *Coenagrion*. 14. *Ischnura*. 15-16. Head (dorsal): 15. *Amphiagrion*. 16. *Enallagma*. 17-19. Antenna: 17. *Progomphus* with segment (4). 18. *Phanogomphus*. 19. *Stylogomphus*. 20-21: Left protibia and tarsus (ventral): 20. *Arigomphus* with burrowing hook (BH). 21. *Stylurus*. 22-25. Abdominal segments 7-10 (dorsal): 22. *Dromogomphus*. 23. *Phanogomphus*. 24. *Gomphus*. 25. *Gomphurus* with epiproct (E), cerci (C), and paraprocts (P). 26-29. Lateral lobe: 26. *Boyeria*. 27. *Basiaeschna*. 28. *Anax*. 29. *Aeshna*. 30-31. Abdominal segments 7-10 (dorsal): 30. *Epitheca*. 31. *Somatochlora*. 32-33. Mid-dorsal hooks (lateral): 32. *Neurocordulia*. 33. *Epitheca*. 34-35. Head (dorsal): 34. *Libellula*. 35. *Leucorrhinia*. 36-39. Lateral lobe (dorsal): 36. *Neurocordulia*. 37. *Pantala*. 38. *Tramea*. 39. *Cordulia*.

33(7). **LIBELLULIDAE** and **CORDULIIDAE** - Abdomen with a mid-dorsal hook, spine or knob on segment 9 34

Abdomen without a mid-dorsal hook, spine, or knob on segment 9 38

34(33). No lateral spines on abdominal segment 8; lentic. . . . . .**CORDULIIDAE,** ***Williamsonia***

Lateral spines present on abdominal segment 8. . . 35

35(34). Lateral spines on abdominal segment 9 reaching almost to tip of epiproct or beyond (Fig. 30). . . . . .CORDULIIDAE **36**

Lateral spines on abdominal segment 9 not reaching much beyond mid-length of epiproct, usually only to its base (Fig. 31). 37

36(35). **CORDULIIDAE (part)** - Mid-dorsal hooks knob-like, with apices blunt and rounded (Fig. 32); crenations on distal margin of lateral lobe very deep, each crenation 2 or more times as long as wide (Fig. 36); mostly lotic . . . . . ***Neurocordulia***

Mid-dorsal hooks spine-like, with apices acuminate (Fig. 33); crenations on distal margin of lateral lobe shallow, each crenation not longer than width; mostly lentic . . . . . ***Epitheca***

37(35). Each cercus about as long as epiproct; lateral setae 6-8; mostly lotic . .**CORDULIIDAE,** ***Somatochlora***

Each cercus about 1/2 as long as epiproct; lateral setae 5; lentic . . . . . **LIBELLULIDAE,** ***Perithemis***

38(33). Abdomen with mid-dorsal hook, spine, or knob on segments 5, 6 or 7 39

Abdomen without mid-dorsal hook, spine or knob on segments 5, 6 or 7. 45

39(38). Minute knobs dorsally on abdominal segments 5-8; sides of thorax with a broad, dark, longitudinal stripe; lentic or lotic . . . . . .**CORDULIIDAE,** ***Dorocordulia***

Abdominal segments with spines or hooks dorsally; sides of thorax usually without a longitudinal stripe; lentic . . . . . .LIBELLULIDAE **40**

40(39). **LIBELLULIDAE (part)** - Lateral spines of abdominal segment 9 long and straight, reaching to or beyond tips of paraprocts and about twice mid-dorsal length of segment 9; no mid-dorsal hook on segment 8 . . . . . ***Celithemis***

Lateral spines of abdominal segment 9 not twice mid-dorsal length of that segment; dorsal hook present or absent on segment 8. 41

41(40). 0-3 dorsal setae on mentum, inconspicuous . ***Ladona***

7-21 dorsal setae on mentum, prominent 42

42(41). When viewing head from above so that frontal shelf obscures labrum, eyes are small and project forward from anterolateral margins of head (Fig. 34); body with numerous long setae 43

Eyes larger, more lateral, occupying 1/2 length of head (Fig. 35); body with scattered long setae . 44

43(42). Abdominal segments 7-9 with brown or black, shining, mid-dorsal ridges; distal margin of mentum with shallow crenations . . . . . ***Plathemis***

Abdominal segments 7-9 without dark mid-dorsal ridges, and with a dorsal spine on 7 and often on 8; distal margin of mentum not crenate. . . ***Libellula***

44(42). Dorsal hook on abdominal segment 3; epiproct and paraprocts about equal in length; dark markings usually present on abdominal sterna. ***Leucorrhinia***

No dorsal hook on abdominal segment 3; epiproct distinctly shorter than paraprocts; abdominal sterna with at most dark spots. . . . . ***Sympetrum***

45(38). Lateral spines on abdominal segment 8 distinctly longer than mid-dorsal length of segment 9; lentic . . . . . LIBELLULIDAE **46**

Lateral spines on abdominal segment 8 shorter than mid-dorsal length of segment 9 47

46(45). **LIBELLULIDAE (part)** - Crenations of lateral lobe deep (Fig. 37). . . . . ***Pantala***

Crenations of lateral lobe shallow (Fig. 38). ***Tramea***

47(45). Crenations of distal margin of lateral lobe distinct, about 3 times as wide as deep (Fig. 39) . . . . . .CORDULIIDAE **48**

Crenations on distal margin of lateral lobe obsolete, > 6 times as wide as deep (Fig. 6); lentic . . . . . LIBELLULIDAE **49**

48(47). **CORDULIIDAE (part)** - Sides of thorax with a broad, dark longitudinal stripe; lentic. . . ***Cordulia***

Sides of thorax uniformly colored; mostly lotic . . . . . ***Somatochlora***

49(47). **LIBELLULIDAE (part)** - Apical third of cerci and paraprocts curved strongly downward; lateral spines absent on abdominal segment 9 . . . . . ***Erythemis***

Cerci and paraprocts straight, or nearly so; lateral spines present on abdominal segment 9 50

50(49). Lateral spines on abdominal segment 8 absent or so small they are difficult to see. . . . . ***Sympetrum***

Lateral spines on abdominal segment 8 prominent, at least 1/4 mid-dorsal length of that segment. . . . 51

51(50). Tips of lateral spines of abdominal segment 9 extending farther caudad than tip of epiproct; dark ridge running mesad from mesoposterior part of eye. . . . . ***Pachydiplax***

Tips of lateral spines of abdominal segment 9 not extending beyond tip of epiproct; no dark ridge running mesad from mesoposterior part of eye. .52

52(51). Each cercus > 2/3 length of paraprocts and turned outward . . . . . ***Nannothemis***

Each cercus < 1/2 length of paraprocts and straight 53

53(52). When viewing head from above so that frontal shelf obscures labrum, eyes are small and project forward from anterolateral margins of head (Fig. 34); lateral spines on abdominal segments 8 and 9 subequal . . . . . ***Libellula***

Eyes larger, more lateral, occupying 1/2 length of head (Fig. 35); lateral spines on abdominal segment 9 about twice length of those on 8 . . . ***Leucorrhinia***

WISCONSIN SPECIES AND REFERENCES TO LARVAL KEYS

ZYGOPTERA - Damselflies
CALOPTERYGIDAE
Calopteryx (Walker 1953) - *aequabilis, maculata*
Hetaerina - *americana, titia*
COENAGRIONIDAE (Walker 1953)
Amphiagrion - *saucium*
Argia - *apicalis, bipunctulata*, fumipennis, moesta, plana, sedula*, tibialis, translata**
Chromagrion - *conditum*
Coenagrion - *angulatum*, interrogatum, resolutum*
Enallagma - *anna, antennatum, aspersum, basidens, boreale, carunculatum, civile, clausum*, cyathigerum, divagans*, ebrium, exsulans, geminatum, hageni, signatum, traviatum, vernale, vesperum*
Ischnura - *hastata, kellicotti, posita, verticalis*
Nehalennia - *gracilis, irene*
LESTIDAE (Walker 1953)
Archilestes - *grandis*
Lestes - *congener, disjunctus, dryas, eurinus, forcipatus, inaequalis, rectangularis, unguiculatus, vigilax*
ANISOPTERA - Dragonflies
AESHNIDAE (Needham and Westfall 1955, Walker 1958)
Aeshna - *canadensis, clepsydra, constricta, eremita, interrupta, juncea*, mutata, sitchensis*, subarctica*, tuberculifera, umbrosa, verticalis*
Anax - *junius, longipes*
Basiaeschna - *janata*
Boyeria - *grafiana*, vinosa*
Epiaeschna - *heros*
Gomphaeschna - *furcillata*
Nasiaeschna - *pentacantha*
CORDULEGASTRIDAE (Needham and Westfall 1955, Walker 1958)
Cordulegaster - *diastatops, erronea*, maculata, obliqua*
CORDULIIDAE (Needham and Westfall 1955, Walker and Corbet 1975)
Cordulia - *shurtleffi*
Dorocordulia - *libera*
Epitheca - *canis, cynosura, princeps, spinigera*
Neurocordulia - *molesta, obsoleta*, yamaskanensis*
Somatochlora (Daigle 1991) - *cingulata, elongata, ensigera, forcipata, franklini, hineana, incurvata, kennedyi, minor, tenebrosa, walshii, williamsoni*
Williamsonia - *fletcheri*
GOMPHIDAE (Needham and Westfall 1955, Walker 1958)
Arigomphus - *cornutus, furcifer, submedianus, villosipes,*
Dromogomphus - *spinosus*
Gomphurus - *externus, fraternus, lineatifrons, vastus, ventricosus*
Gomphus (=*Hylogomphus*) - *adelphus, viridifrons*
Hagenius - *brevistylus*
Ophiogomphus - *anomalus, aspersus*, carolus, colubrinus, howei, rupinsulensis, susbehcha,* undescribed species
Phanogomphus (=*Gomphus*) - *exilis, graslinellus, lividus, quadricolor, spicatus*
Progomphus - *obscurus*
Stylogomphus - *albistylus*
Stylurus - *amnicola, laurae*, notatus, plagiatus, scudderi, spiniceps*
LIBELLULIDAE (Needham and Westfall 1955, Walker and Corbet 1975)
Celithemis - *elisa, eponina, monomelaena**
Erythemis - *simplicicollis*
Ladona - *julia*
Leucorrhinia - *frigida, glacialis, hudsonica, intacta, proxima*
Libellula - *cyanea, incesta, luctuosa, pulchella, quadrimaculata, semifasciata, vibrans*
Nannothemis - *bella*
Pachydiplax - *longipennis*
Pantala - *flavescens, hymenaea*
Perithemis - *tenera*
Plathemis - *lydia*
Sympetrum (Tai 1967) - *ambiguum*, corruptum, costiferum, danae, internum, obtrusum, rubicundulum, semicinctum, vicinum*
Tramea - *carolina, lacerata, onusta*
MACROMIIDAE (Needham and Westfall 1955, Walker and Corbet 1975)
Didymops - *transversa*
Macromia - *illinoiensis, pacifica, taeniolata*

PLECOPTERA - STONEFLIES

Plecoptera is a relatively small hemimetabolous order, with most species occurring in mountainous regions of North America where fast, cold streams abound. Only 58 of about 550 North American species have been found in Wisconsin. All larvae are aquatic, almost all being found in streams; larvae of a few species may live in cold, oligotrophic lakes.

Stonefly larvae differ from most other aquatic insects by having two long filamentous cerci and an elongate or flattened appearance. They have rather long antennae, compound eyes, two or three ocelli, chewing mouthparts, three-segmented tarsi with two claws, and usually two pairs of thoracic wing-pads. Larvae of Ephemeroptera are similar because of their long cerci, but they have lateral gills on middle abdominal segments, usually have three caudal filaments instead of two, and have a single claw on each tarsus. Some stonefly larvae have gills ventrally on the head, thorax, and/or basal or apical segments of the abdomen, but never on the middle abdominal segments. Adults are similar to larvae, except most have two pairs of net-veined wings that fold flat over the abdomen; one species is apterous. In adults, genitalia are well developed and gills are absent or vestigial.

Stonefly larvae mostly crawl on aquatic substrates; when necessary, they swim weakly by moving their abdomen from side to side. Larvae obtain oxygen for respiration from the water through their cuticle; various gills aid oxygen uptake, especially in larger species. Most Plecoptera larvae lack extensive gills and occur only in oxygen-rich water. Feeding habits vary among families and sometimes among species within a family or genus. The stage of development and

availability of food may influence feeding habits within a species.

Most species are univoltine, but several larger species need two or three years to complete development. Many univoltine species have fast seasonal life cycles, with eggs or small larvae diapausing during the summer and larvae developing rapidly in autumn, winter, or spring; others have a slow seasonal life cycle with eggs hatching within a few weeks and larvae developing throughout the year.

Studies indicate larvae have 12 to 23 instars. After development is completed, larvae crawl from the water onto a convenient substrate and adults emerge. Newly emerged adults crawl or fly to nearby trees, shrubs, rocks, or other substrates to find a mate. In most species males initiate a drumming signal by tapping their abdomen and females respond. After repeated drumming and crawling, they find each other and mate. After maturation, eggs are extruded by the female into a mass on the tip of her abdomen. Depending on the species, females either land briefly on the water's surface to oviposit, jettison their egg mass over water while in flight, or crawl into the water on a protruding substrate to oviposit beneath the surface. Females often lay more than one egg mass. Adult stoneflies normally live a few days to two weeks. Adults of some species feed on algae, lichens, and/or riparian leaves or flowers.

There are two suborders, Euholognatha and Systellognatha. Euholognatha larvae (Capniidae, Leuctridae, Nemouridae, and Taeniopterygidae) are primarily herbivore-detritivores. Larvae in two families of Systellognatha (Perlidae and Chloroperlidae) are predators, while those of Pteronarcyidae are herbivore-detritivores. Larval Perlodidae have variable feeding habits depending on the species and larval instar.

Hynes (1976) reviewed Plecoptera biology. More recently, a book by Stewart and Stark (1988) discussed classification, phylogeny, biogeography, ecology, and behavior. It also included generic keys and illustrations for larvae in all North American genera, notes on their biology, and the published distribution of North American species. Most larvae in Wisconsin can be identified to species as well as all adults; an exception is in *Alloperla* (Chloroperlidae), for which larval keys do not exist.

EUHOLOGNATHA

CAPNIIDAE (2 genera, 11 species)

Adults of these "winter stoneflies" emerge from late January (*Allocapnia)* through April (*Paracapnia),* and frequently can be found crawling on ice and snow near streams. *Paracapnia* and *Allocapnia* larvae occur abundantly in streams of all sizes, the latter even in temporary streams; *Capnura* and *Capnia* may occur in northern Wisconsin. All species are univoltine, with *Allocapnia* spending spring and summer months in the substrate as tiny diapausing larvae. *Paracapnia* larvae remain active and can be found throughout autumn and winter. Larvae feed on algae and detritus, occurring most abundantly in allochthonous debris.

LEUCTRIDAE (2 genera, 5 species)

Leuctra larvae can be collected uncommonly throughout the year; in autumn most are very small. All species are univoltine, with emergence from May through September, depending on the species. Adults feed on algae and hide in the vicinity of streams from which they emerged. Larvae are detritivores, and occur among gravel and debris in fast, permanent streams. Larvae of *Zealeuctra* are very rare.

NEMOURIDAE (5 genera, 8 species)

Larvae of *Amphinemura, Nemoura, Prostoia,* and *Shipsa* are generally common in Wisconsin. Most occur in smaller streams, especially in those that are spring-fed; *Shipsa* larvae also occur in larger streams. They often are the only stoneflies inhabiting springs and spring-runs. Larvae of *Soyedina* are rare in very small, cold streams. The life cycle is univoltine, with adults emerging mostly in spring and early summer, depending on the species; *Amphinemura linda* adults emerge in early autumn. Larvae may be encountered throughout the year among debris where they feed on diatoms and detritus; most are very small in autumn.

TAENIOPTERYGIDAE (3 genera, 5 species)

Adults are also "winter stoneflies" with a univoltine life cycle, emerging in March and early April. Larvae hatch from eggs almost immediately, feed briefly, and then burrow into the substrate where they spend the late spring and summer in diapause. Mummy-like diapausing larvae resume a normal appearance in September and commence feeding on allochthonous detritus and some diatoms. *Taeniopteryx* larvae are common statewide along the banks and among debris in a wide variety of permanent streams that are not organically enriched. Larvae of *Oemopteryx* and *Strophopteryx* are uncommon in gravel riffles of larger clean streams.

SYSTELLOGNATHA

CHLOROPERLIDAE (2 genera, 3 species)

All species apparently are univoltine in Wisconsin, although semivoltine cycles are known to occur elsewhere. *Alloperla* larvae are uncommon during summer in rapid, northern streams, while *Haploperla* larvae are fairly common throughout the northern half of Wisconsin in a variety of permanent streams. The carnivorous larvae prey mostly on larvae of Chironomidae. Adults of *Haploperla* have been collected from May to July, but larvae were found only from November through May, suggesting an egg diapause.

PERLIDAE (7 genera, 10 species)

Larvae of *Neoperla* and *Perlinella* occur uncommonly in larger streams and those of *Attaneuria* are very rare in large rivers; larvae in other genera are common in a wide variety of streams, especially in strong currents where they cling to rocks or debris. Larvae of *Acroneuria, Agnetina, Attaneuria,* and *Paragnetina* require two or three years to complete development, with adults emerging from May to July. *Neoperla, Perlinella,* and *Perlesta* are univoltine. *Perlesta* has a long egg diapause with emergence in July or August; most

larvae occur from May to August, often in organically enriched streams. Large *Neoperla* and *Perlinella* larvae occur from October into June, when emergence commences; smaller larvae have not been collected and may be hyporheic. Larvae of all species are carnivorous, feeding on Chironomidae, Ephemeroptera, and other arthropods.

PERLODIDAE (3 genera, 14 species)

Isoperla larvae occur commonly statewide in all types of unpolluted streams, where they cling to rocks and debris. *Isogenoides* larvae have been found only in cold streams in the northern fourth of the state, while those of *Clioperla* occur in similar streams, mostly farther south. Larvae of *Arcynopteryx* and *Isogenoides* may occur in Lake Superior, and *Hydroperla* larvae apparently occurred many years ago in southern Wisconsin, but are probably no longer present. Larvae of *Isogenoides* and *Clioperla* are carnivores, and have a slow seasonal univoltine life cycle, with adults emerging mostly in June. Larvae of most species of *Isoperla* are also carnivores, but at least two are herbivore-detritivores and others are omnivores. *Isoperla* species have a fast seasonal univoltine life cycle with adults emerging from April to July, depending on the species, and eggs hatching after a diapause of two months or more.

PTERONARCYIDAE (1 genus, 2 species)

Both species of *Pteronarcys* are widely distributed throughout the state, the larvae occurring most commonly among debris in fast water of medium to large streams. The life cycle in Wisconsin is 3 years, with emergence in late April and May. Larvae are detritivores.

KEY TO GENERA OF PLECOPTERA LARVAE IN WISCONSIN

1. Finely branched gills present ventrolaterally on all thoracic segments . . . . . **.2**

Thoracic gills absent, confined to prosternum, or not branched . . . . . **.3**

2(1). Finely branched gills on abdominal sterna 1 and 2 . . . . . **.PTERONARCYIDAE, *Pteronarcys***

Gills absent from abdominal sterna. . PERLIDAE **18**

3(1). Robust, pronotum distinctly wider than abdomen; inner and outer margins of metathoracic wing pads strongly diverging from axis of body (Figs. 1-2); if wing pads are not developed, outer margins of metanotum are divergent (Fig. 5) . . . . . **.4**

Elongate, pronotum barely wider than abdomen; metathoracic wing pads nearly parallel along outer margins (Figs. 3-4, 36), if slightly divergent, inner margins are parallel (Fig. 13); if wing pads are not developed, outer margins of metanotum are rounded (Fig. 6). **6**

4(3). Tips of glossae produced as far forward as tips of paraglossae (Fig. 7) . . . . . **.5**

Tips of glossae much posterior to tips of paraglossae (Figs. 8, 29-30) . . . . . .PERLODIDAE **24**

5(4). Length of tarsomere 2 (side view) subequal to 1 (Fig. 9) . . . . . .TAENIOPTERYGIDAE **12**

Tarsomere 2 much shorter than 1 (Fig. 10) . . . . . NEMOURIDAE **14**

6(3). Cerci about as long or longer than abdomen (Figs. 3-4); tips of glossae produced nearly as far forward as tips of paraglossae (Fig. 7) . . . . . **.7**

Cerci much shorter than abdomen (Fig. 36); tips of glossae much posterior to tips of paraglossae (Fig.8) . . . . . CHLOROPERLIDAE **28**

7(6). Meso- and metathoracic wing pads similar in shape, mesothoracic wing pads 2 to 3 times as far apart as metathoracic wing pads (Fig. 4); abdominal segments 7 to 9 a complete sclerotized ring, not divided by a ventrolateral fold (Fig. 12) . . . . . LEUCTRIDAE **8**

Meso- and metathoracic wing pads subequally separated (Figs. 3, 14) or absent, or metathoracic wing pad truncated (Fig. 13); terga and sterna of abdominal segments 1 to 9 divided by a membranous fold ventrolaterally (Fig. 11) . . . . . CAPNIIDAE **9**

8(7). **LEUCTRIDAE** - Setae on pronotum in tufts at corners; only first 4 abdominal segments divided by ventrolateral fold (Fig. 12). . . . . ***.Leuctra***

Setae evenly distributed around margins of pronotum; first 6 abdominal segments divided by ventrolateral fold . . . . . ***Zealeuctra***

9(7). **CAPNIIDAE** - Head with dorsal, purplish, reticulate pattern; meso- and metathoracic wing pads similar in shape (Fig. 3); numerous conspicuous bristles almost half mid-dorsal length of an abdominal tergum, mostly along posterior margins of abdominal terga, margins of pronotum and wing pads . . . . . ***Paracapnia***

Head without purplish reticulate pattern; metathoracic wing pad frequently truncated (Fig. 13); abdominal bristles, if conspicuous, less than 1/3 mid-dorsal length of an abdominal tergum **10**

10(9). Metathoracic wing pad not notched on inner margin, or truncate and notched near tip (Fig. 13), or absent . . . . . ***.Allocapnia***

Metathoracic wing pad notched on inner margin halfway to tip (Fig. 14) **11**

11(10). Galea elongate, extending past lacinia, and truncate apically, with long setae . . . . . ***Capnia***

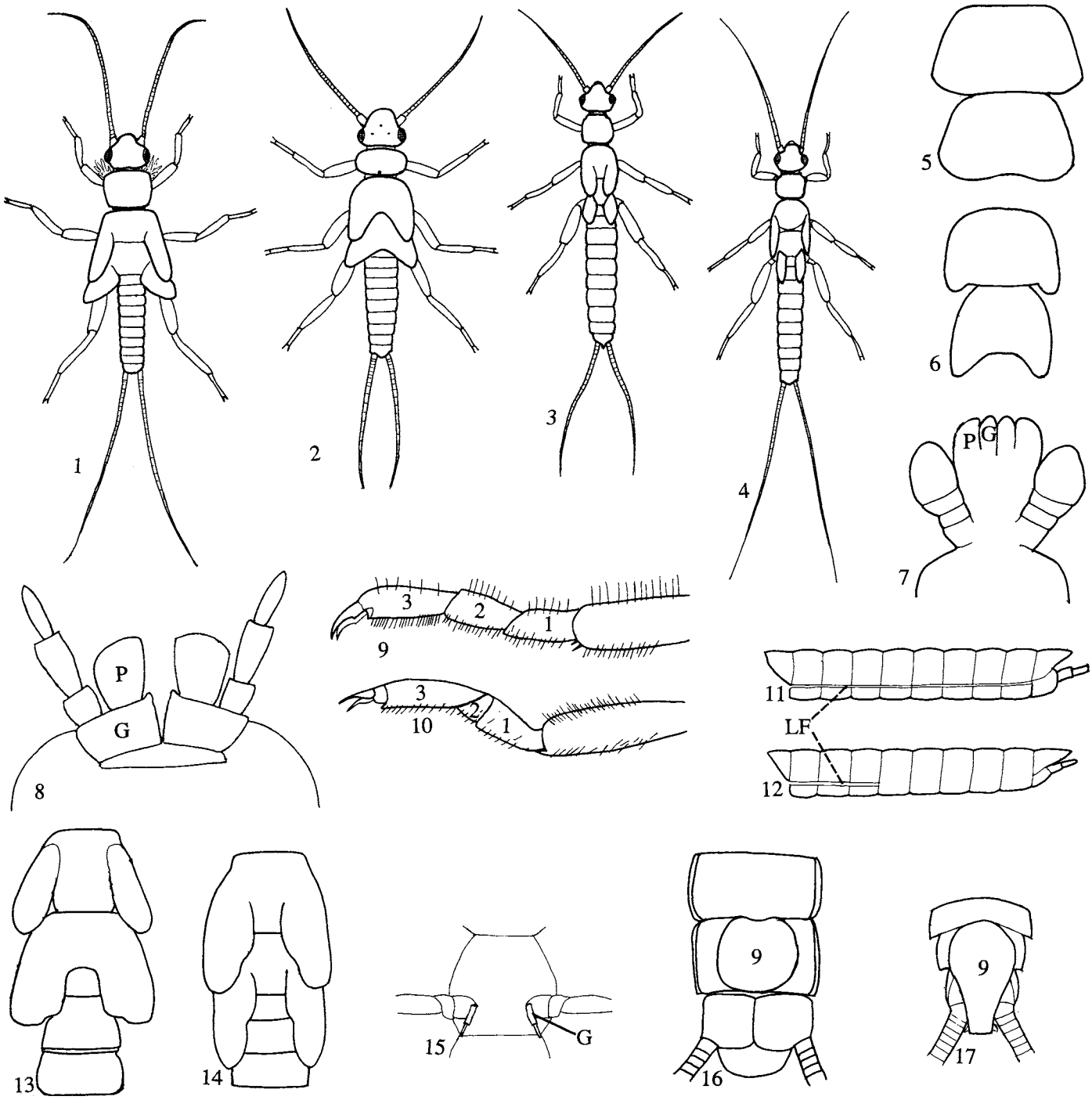
Galea not extending past lacinia, tapered to a point, and with short apical setae . . . . . ***.Capnura***

12(5). **TAENIOPTERYGIDAE** - Single gill present on inner side of each coxa (Fig. 15); ninth sternum not elongate (Fig. 16) . . . . . ***.Taeniopteryx***

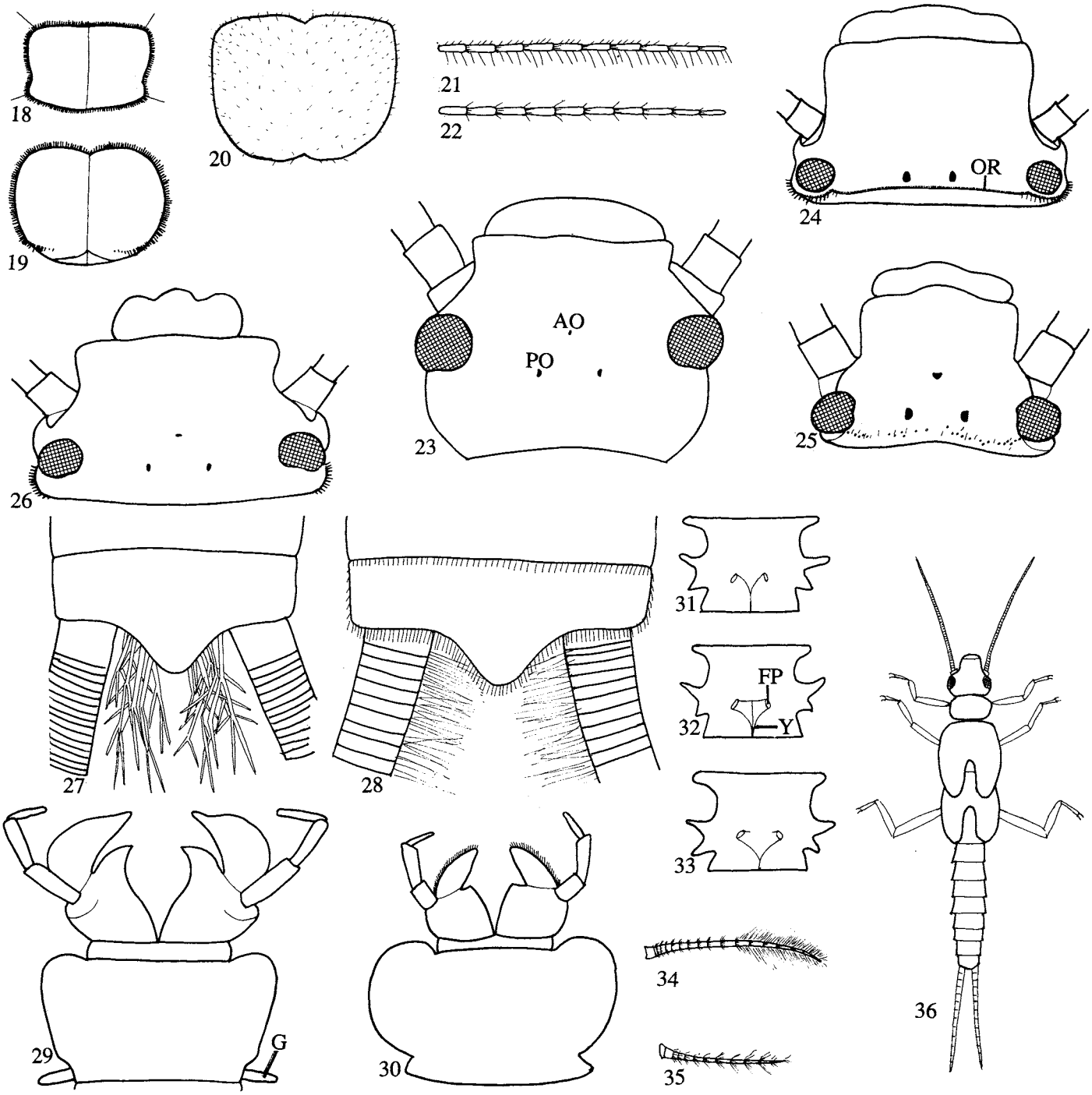
Gills absent; ninth sternum elongate (Fig. 17) . . . **13**

13(12). Thoracic terga and head yellow with distinct darker pattern; at most 1 fine seta dorsally on each basal cercal whorl . . . . . ***.Strophopteryx***

Thoracic terga and head uniformly brown, sometimes with indistinct light areas; 1-3 fine setae dorsally on each basal cercal whorl . . . . . ***.Oemopteryx***



Figures 1-17. Plecoptera Larvae. 1-4. Larva (dorsal view): 1. *Amphinemura*. 2. *Isoperla*. 3. *Paracapnia*. 4. *Leuctra*. 5-6: Meso- and metanotum of immature: 5. *Isoperla*. 6. *Paracapnia*. 7-8. Labium with glossae (G) and paraglossae (P): 7. *Nemoura*. 8. *Alloperla*. 9-10. Tarsomeres 1-3: 9. *Taeniopteryx*. 10. *Nemoura*. 11-12. Abdomen with lateral fold (LF): 11. *Allocapnia*. 12. *Leuctra*. 13-14. Wingpads: 13. *Allocapnia*. 14 *Capnia*. 15. Mesosternum of *Taeniopteryx* with gills (G). 16-17. Ninth abdominal sternum (9): 16. *Taeniopteryx*. 17. *Strophopteryx*.



Figures 18-36. Plecoptera Larvae. 18-20. Pronotum: 18. *Soyedina.* 19. *Nemoura.* 20. *Prostoia.* 21-22. Terminal segments of cercus (lateral): 21 *Shipsa.* 22. *Prostoia.* 23-26. Head (dorsal): 23. *Perlinella* with anterior ocellus (AO) and posterior ocellus (PO). 24. *Neoperla* with occipital ridge (OR). 25. *Perlesta.* 26. *Acroneuria.* 27-28 Terminal terga: 27. *Agnetina.* 28. *Paragnetina.* 29-30. Labium (ventral): 29. *Isogenoides* with submental gill (G). 30. *Isoperla.* 31-33. Mesosternum with Y-ridge (Y) and furcal pits (FP): 31. *Arcynopteryx.* 32. *Isogenoides.* 33. *Hydroperla.* 34-35. Cercus (lateral). 34. *Alloperla.* 35. *Haploperla.* 36. *Haploperla* (dorsal).

14(5). **NEMOURIDAE** - Four branched gills on prosternum. . . . . ***Amphinemura***
Prosternum without gills **15**

15(14). Pronotum with lateral fringe (Figs. 18-19) **16**
Pronotum without definite lateral fringe (Fig. 20). **17**

16(15). Pronotum with shallow notch laterally, angular corners, and a longer, thinner seta in lateral fringe at anterolateral and posterolateral angles (Fig. 18). . . . . ***Soyedina***
Pronotum rounded laterally, with longer, thinner setae absent from fringe (Fig. 19) . . . . . ***Nemoura***

17(15). Only ventral bristles of cercal whorls longer than other bristles (Fig. 21); legs indistinctly banded. . ***Shipsa***
Dorsal and ventral bristles of cercal whorls longer than lateral bristles (Fig. 22); legs not banded . . . . . ***Prostoia***

18(2). **PERLIDAE** - Eyes much anterior to hind margin of head (Fig. 23) . . . . . ***Perlinella***
Eyes close to hind margin of head (Figs. 24-26) . **19**

19(18). Anterior ocellus absent; distinct transverse occipital ridge across back of head (Fig. 24); subanal gills present (Fig. 27) . . . . . ***Neoperla***
Three ocelli present (Figs. 25-26) **20**

20(19). A closely set regular row of spinules inserted on a low occipital ridge completely across back of head (Fig. 24) **21**
Occipital ridge absent; spinules on back of head present mainly on sides, or arranged in a transverse row of varying completeness, but always at least a little wavy or irregular (Fig. 25) **22**

21(20). Branched subanal gills present (Fig. 27); basal cercal segments without dorsal fringe of long setae . . . . . ***Agnetina***
Branched subanal gills absent (Fig. 28); basal cercal segments with dorsal fringe of long setae. . . . . ***Paragnetina***

22(20). Back of head without spinules, except around eyes (Fig. 26) . . . . . ***Acroneuria***
Back of head with an irregular row of large spinules (Fig. 25) **23**

23(22). Branched subanal gills present (Fig. 27); head patterned; freckle-like spots on abdomen . ***Perlesta***
Branched subanal gills absent (Fig. 28); head unicolorous brown; abdomen without spots . . . . . ***Attaneuria***

24(4). **PERLODIDAE** - Submental gills present; usually twice as long as their greatest width (Fig. 29) . . **25**
Submental gills absent (Fig. 30) **27**

25(24). Arms of Y-ridge on mesosternum meet anterior corners of furcal pits (Fig. 31); 3 large pale spots on each abdominal tergum. . . . . ***Arcynopteryx***
Arms of Y-ridge meet posterior corners of furcal pits (Figs. 32-33); abdominal terga without large, pale spots **26**

26(25). Mesosternum with a transverse ridge joining anterior corners of furcal pits and connected to fork of Y-ridge by a median ridge (Fig. 32) . . . . ***Isogenoides***
Mesosternum without a transverse ridge or a median ridge (Fig. 33) . . . . . ***Hydroperla***

27(24). Abdominal terga each with 8 white spots (lateral spots often obscure) or solidly colored; distinct W-shaped pale area anterior to median ocellus, extending almost to antennae, pale area often extending posteriorly to lateral ocelli and compound eyes . . . . . ***Clioperla***
Abdominal terga with longitudinal stripes or transverse bands; pale area near median ocellus rounded, indistinct, or absent, if W-shaped, abdominal bands or stripes are distinct . . . . . ***Isoperla***

28(6). **CHLOROPERLIDAE** - Cercus with numerous long intersegmental setae dorsally and ventrally in apical half (Fig. 34) . . . . . ***Alloperla***
Setae on cercus confined to whorls at apex of each segment (Fig. 35) . . . . . ***Haploperla***

WISCONSIN SPECIES AND REFERENCES TO LARVAL KEYS

EUHOLOGNATHA

CAPNIIDAE (Harper and Hynes 1971a)
- *Allocapnia - frisoni, granulata, illinoensis, minima, nivicola, pygmaea, recta, rickeri, vivipara*
- *Capnia* - vernalis**
- *Capnura** (=*Capnia*) - *manitoba**
- *Paracapnia - angulata, opis*

LEUCTRIDAE (Hitchcock 1974, Harper and Hynes 1971b)
- *Leuctra - ferruginea, sibleyi, tenella, tenuis*
- *Zealeuctra - narfi*

NEMOURIDAE (Hitchcock 1974, Harper and Hynes 1971c)
- *Amphinemura - delosa, linda, varshava*
- *Nemoura - trispinosa*
- *Prostoia - completa, similis*
- *Shipsa - rotunda*
- *Soyedina - vallicularia*

TAENIOPTERYGIDAE (Hitchcock 1974, Harper and Hynes 1971d)
- *Oemopteryx - glacialis*
- *Strophopteryx - fasciata*
- *Taeniopteryx* (Fullington and Stewart 1980) - *burksi, nivalis, parvula*

SYSTELLOGNATHA

CHLOROPERLIDAE
- *Alloperla - atlantica*, banksi*, leonarda**
- *Haploperla* (=*Hastaperla*) - *brevis, orpha*

PERLIDAE (Hitchcock 1974)
- *Acroneuria - abnormis, carolinensis*, internata, lycorias*
- *Agnetina* (=*Phasganophora*) - *capitata*
- *Attaneuria - ruralis*
- *Neoperla - stewarti*
- *Paragnetina - media*
- *Perlesta - decipiens*
- *Perlinella* (Kondratieff et al. 1988) - *drymo, ephyre*

PERLODIDAE (Hilsenhoff and Billmyer 1973)
- *Arcynopteryx* - compacta**
- *Clioperla* (=*Isoperla*) - *clio*

*Hydroperla** (Ricker 1952) - *crosbyi**
Isogenoides (Ricker 1952) - *doratus*, frontalis, krumholzi*, olivaceus, varians**
Isoperla - bilineata, cotta, dicala, frisoni, lata, marlynia, nana, richardsoni, signata, slossonae, transmarina
PTERONARCYIDAE (Harden and Mickel 1952)
Pteronarcys - dorsata, pictetii

TRICHOPTERA - CADDISFLIES

Larvae and pupae of all species in this rather large holometabolous order are aquatic, with very few exceptions. About 1340 species are known from North America; only 245 have been collected in Wisconsin (Longridge and Hilsenhoff 1973 + additional records). Larvae and pupae are an important part of the insect fauna of most streams; larvae of some species in half of the families occur in lentic habitats, some even in temporary ponds. Feeding habits vary widely among and within families.

Trichoptera larvae are characterized by a pair of stemmata, chewing mouthparts, usually extremely short antennae, three pairs of thoracic legs with a single tarsal segment and claw, and a pair of fleshy prolegs on the last abdominal segment. Single or branched gills often occur on abdominal segments.

There are three suborders, Annulipalpia, Integripalpia, and Spicipalpia (Wiggins and Wichard 1989), modifying a proposed classification of Weaver and Morse (1986) by elevating one infraorder (Spicipalpia) to a suborder. Larvae of Annulipalpia use silk from labial glands to construct retreats and nets. Larvae in the three families of Spicipalpia in Wisconsin are either free-living (Rhyacophilidae), construct portable cases that are barrel-shaped or purse-like (Hydroptilidae, final instar), or saddle-shaped (Glossosomatidae). All pupate in a closed cocoon of parchment-like silk; most other caddisflies have openings in their pupal case to permit circulation of water. All larvae of Integripalpia use silk from labial glands to construct tubular cases, which vary greatly in size and shape. Many have distinctive cases, which can be used for generic and species identification. Larvae in six families (infraorder Plenitentoria of Weaver and Morse) have a prosternal horn, which is unique to this group.

Trichoptera larvae are well-adapted to live in aquatic environments. They respire through the integument, and in many families respiration is aided by abdominal gills. In Integripalpia, larvae enhance respiration by undulating their body to increase the flow of water and dissolved oxygen through their tubular case. Cases and retreats protect larvae from predators and the environment by acting as a physical barrier; they also camouflage the larva. Hard cases protect larvae from abrasive sand and gravel; streamlined cases or nets allow others to inhabit substrates in very swift currents. Annulipalpia larvae use their nets to strain algae and other food material from the current in streams. Some Leptoceridae larvae have fringes of long setae on their legs, allowing them to swim, and Brachycentridae larvae use fringes of setae on meso- and metathoracic legs to filter food particles from the current.

The terrestrial, moth-like adults of most species have wings covered with hair-like setae, which they fold roof-like over their body; most also have long filiform antennae. They lay eggs in masses in the water; a few lay their eggs on vegetation above the water or in moist soil of temporary ponds. The majority of species are univoltine, often with quite synchronized emergences; some have cohorts that emerge throughout the year, especially in warm weather. A few species are bivoltine, and some that develop in cold-water streams are semivoltine, especially in northern Wisconsin. Typically, larvae have five instars, and after completing development construct a pupal case either by sealing off the open end of the portable case or by constructing a case and cementing it to substrate. Feeding then ceases and the larva enters a quiescent prepupal stage with its appendages pressed against its body. Pupation occurs a few days to several weeks later, the pupa being of the exarate type, with appendages free from the body. Pupae in most families have well-developed mandibles, which pharate adults (adult within the pupal integument) use to cut their way out of the case. The pharate adult then swims to the water's surface to emerge, or it swims to the surface and then rapidly to shore where it crawls out of the water onto some object to emerge. Usually ecdysis is rapid.

Wiggins (1977) published excellent generic keys, descriptions, and illustrations for larvae; a second edition will be published in 1995. Earlier, Ross (1944) developed species keys for larvae and adults of many genera from the central United States. However, larvae of about half of the described species remain unknown, making accurate identification of larvae to species impossible in many genera and risky in others. Almost all adult caddisflies can be identified to species by using the many published keys and descriptions.

Relatively little is known about the life history and ecology of most caddisfly species. Wiggins (1977) summarized knowledge of the biology, ecology, morphology, and distribution of larvae in each genus, and more recently Mackay and Wiggins (1979) reviewed caddisfly ecology.

ANNULIPALPIA

DIPSEUDOPSIDAE (1 genus, 1 species)

Phylocentropus larvae occur uncommonly in sand and silt along margins of sandy streams and lakes. They feed on detritus that they collect with a net placed within tubes they construct in the sand and silt. The life cycle is univoltine, with emergence in late spring and early summer.

HYDROPSYCHIDAE (7 genera, 32 species)

Hydropsyche, Ceratopsyche, and *Cheumatopsyche* are the most abundant and widespread caddisfly genera. Their omnivorous larvae can be found in almost every stream that is not severely polluted. Here they build retreats on rocks, logs, and other submerged objects in various currents. Although most species are univoltine, some may be bivoltine because adults are present from May to November. *Diplectrona* and *Parapsyche* larvae occur among rocks only in cold, rapid streams, while *Macrostemum* larvae may be locally common

on rocks in medium-sized streams, mostly in the northern half of Wisconsin. *Potamyia* larvae burrow into water-logged wood in deeper and slower waters of large rivers in southern Wisconsin, being especially abundant in the Wisconsin River. *Arctopsyche* larvae have been found in several large, cold streams of Michigan's Upper Peninsula, but have not yet been collected in Wisconsin. Larvae of *Arctopsyche* and *Parapsyche* are mostly carnivorous, those of *Diplectrona* omnivorous, and those of *Macrostemum* mostly herbivorous; *Potamyia* larvae are mostly detritivores. All of the less common genera are apparently univoltine, with adults emerging during late spring or summer.

PHILOPOTAMIDAE (3 genera, 6 species)

The often orange *Chimarra* larvae are common in a variety of streams where they feed on diatoms, algae, and detritus collected by their fine silken nets. They usually construct retreats on undersides of rocks in areas of rapid current. Emergence occurs in late spring and early summer. Larvae of *Dolophilodes* are uncommon, those of *Wormaldia* are rare; both are restricted to small, cold, rapid streams. The only two species are probably univoltine. *Dolophilodes* adults emerge during almost every month; winter females are apterous.

POLYCENTROPODIDAE (4 genera, 18 species)

Larvae occur in a wide variety of streams where they construct silken retreats on rocks, decaying wood, or among debris. *Polycentropus* and *Neureclipsis* are fairly common and widespread genera; a species of the latter is probably the most tolerant of any caddisfly to organic pollution. *Polycentropus* larvae also occur along margins of lakes and in vernal ponds. *Paranyctiophylax* larvae are uncommon, and *Cyrnellus* larvae are rare in larger rivers. Larvae in all genera are primarily carnivores that feed on small insects and other animals captured by their nets; some also consume algae. All species are probably univoltine.

PSYCHOMYIIDAE (2 genera, 2 species)

Larvae of *Psychomyia* occur in a variety of streams, while those of *Lype* prefer cold, clean streams; they are relatively uncommon, occurring mostly among cracks in decaying wood where they feed on algae and detritus. Species in both genera are univoltine, with emergence from May to August.

SPICIPALPIA

GLOSSOSOMATIDAE (3 genera, 6 species)

Larvae are herbivorous, living mostly on rocks from which they scrape algae, diatoms, and some detritus. They inhabit clean, clear streams that are relatively free from organic enrichment. *Glossosoma* is common and widely distributed, with pupation during late autumn and winter, and emergence from April into the summer. *Agapetus* is rare in the north, and *Protoptila* larvae are difficult to find because of their very small size; they apparently are uncommon. Both genera are univoltine, with adults emerging in the summer.

HYDROPTILIDAE (10 genera, 48 species)

Because of their extremely small size, larvae of these "micro-caddisflies" are easily overlooked, but judging from numbers of adults collected at light traps, they are much more abundant than larval collections indicate. The herbivorous-detritivorous larvae can be found on stones, vegetation, sand, and a variety of other substrates in streams, lakes, and ponds. By using a hand lens or returning substrates to the laboratory for microscopic examination, many more specimens can be found. Most species are probably univoltine, but bivoltine species may exist; adults occur from May through August. *Hydroptila* larvae are most common, and those of *Leucotrichia* occur quite commonly in streams. *Oxyethira* larvae are uncommon along margins of lakes and rivers, and in springs. Larvae in other genera are apparently rare in Wisconsin.

RHYACOPHILIDAE (1 genus, 5 species)

Larvae of *Rhyacophila* occur only in rapid, cold streams, where they cling to moss-covered rocks or debris lodged among rocks. They have a one-year life cycle, with overlapping of cohorts. Larvae of Wisconsin species are mostly carnivores. Adults are on the wing from May through August.

INTEGRIPALPIA

BRACHYCENTRIDAE (2 genera, 8 species)

Larvae occur in a variety of rapidly flowing streams. *Brachycentrus* larvae attach to logs, rocks, and macrophytes, and may be abundant in spring-fed streams; *Micrasema* larvae mostly inhabit moss-covered rocks in cold streams. Species of *Brachycentrus* are univoltine in the south, but *B. americanus* is semivoltine in cold, northern streams. Emergence occurs from spring to late summer, depending on the species. Young *Brachycentrus* larvae are herbivores, but consume more animal material as they grow. *Micrasema* species are semivoltine, except *M. wataga,* which may be univoltine in the south. *Micrasema* larvae are probably herbivores.

GOERIDAE (1 genus, 1 species)

Goera larvae occur uncommonly in cold streams on cobbles in the current where they feed on periphyton, moss, or detritus. The only Wisconsin species is probably univoltine, but may be semivoltine in cold, northern streams.

HELICOPSYCHIDAE (1 genus, 1 species)

Larvae of *Helicopsyche* attach to rocks in a variety of clean streams where the current is not too rapid, and along windswept shores of clean lakes. The only species is univoltine, with emergence during the summer. Larvae are scrapers, feeding on algae and diatoms.

LEPIDOSTOMATIDAE (1 genus, 7 species)

Lepidostoma larvae inhabit a wide variety of cleaner streams, springs, and spring runs throughout the state, occurring on rocks, in debris, and among moss covering rocks. Occasionally they occur in lakes. The life cycle is one year, with emergence during the summer. Although larvae may

occasionally consume algae or animal material, they are mostly detritivores.

LEPTOCERIDAE (8 genera, 42 species)

Larvae inhabit rocks, sand, or vegetation in a variety of lotic and lentic habitats. Larvae of *Ceraclea, Oecetis,* and *Nectopsyche* are common and those of *Mystacides* and *Triaenodes* are fairly common. Larvae in these genera occur mostly in streams, but are also found in lakes and ponds. Larvae of *Leptocerus* are uncommon, and most often found in lentic habitats. *Setodes* larvae occur only in streams, and are rare. Larvae are generally omnivorous, except those of *Oecetis,* which are mostly carnivorous. Larvae of some species of *Ceraclea* feed on sponges. All species are probably univoltine, with emergence in late spring or summer.

LIMNEPHILIDAE (17 genera, 46 species)

The herbivorous larvae are widespread and often abundant in a variety of aquatic habitats. Some inhabit ponds, marshes, or slow streams (*Anabolia, Arctopora, Asynarchus, Glyphopsyche, Ironoquia, Limnephilus, Nemotaulius),* some more rapid streams (*Platycentropus, Pycnopsyche),* and others specialized habitats such as springs and spring runs (*Apatania, Frenesia, Hesperophylax, Pseudostenophylax),* small cold streams (*Onocosmoecus, Psychoglypha),* and small woodland streams (*Hydatophylax).* All are probably univoltine, with emergence from early spring to late autumn, depending on the species. In order of abundance, larvae of *Limnephilus, Pycnopsyche, Anabolia, Platycentropus,* and *Hesperophylax* are most common. Larvae of other genera are uncommon or rare, and *Leptophylax* larvae remain unknown.

MOLANNIDAE (1 genus, 5 species)

Molanna larvae are uncommon, occurring most frequently under logs or rocks in sand- and gravel-bottomed clean streams or lake margins where they feed on algae, diatoms, and invertebrates. They are univoltine, with emergence from late spring to mid-summer.

ODONTOCERIDAE (1 genus, 1 species)

Psilotreta larvae are uncommon in small, cool, sand- and gravel-bottomed creeks, where larvae feed on algae in the sand. They have a semivoltine life cycle, with pupation in spring and emergence mostly in June.

PHRYGANEIDAE (7 genera, 12 species)

Beothukus and *Hagenella* are very rare in northern Wisconsin, with larvae of *Beothukus* occurring in *Sphagnum* bog pools and those of *Hagenella* in floodwater pools. *Fabria* larvae, which inhabit macrophytes in shallow, slow streams, have not been collected. *Oligostomis* larvae are uncommon, inhabiting margins of fast, cool streams. Larvae of other genera are fairly common. *Banksiola* and *Agrypnia* larvae inhabit marshes, ponds, and lakeshore vegetation, while those of *Phryganea* and *Ptilostomis* are found among vegetation along streams and lake margins, the former also occurring in deeper waters of lakes and in ponds. All phryganeid species are apparently univoltine, emerging in late spring or early summer. Larvae are mostly carnivorous, but vegetation is also eaten, especially by early instars.

SERICOSTOMATIDAE (1 genus, 1 species)

Agarodes larvae are uncommon in medium to large streams or margins of lakes with a sand and gravel bottom where they feed on diatoms and detritus among the gravel. The life cycle is probably univoltine, with emergence in July and August.

UENOIDAE (1 genus, 3 species)

Larvae of *Neophylax* inhabit cobbles in cool streams where they feed mostly on diatoms; frequently they are abundant. The life cycle is univoltine, with larvae developing from late autumn into spring, when they enter a lengthy prepupal stage. Pupation occurs in late spring and adults emerge during the summer.

KEY TO GENERA OF TRICHOPTERA LARVAE IN WISCONSIN

1. Larva in spiral case of sand grains or tiny stones resembling a snail shell (Fig. 1); anal claw with many short teeth (Fig. 2) . . . . . .**HELICOPSYCHIDAE, *Helicopsyche***

Case not like a snail shell; anal claw not forming a comb with many teeth **2**

2(1). Each thoracic segment covered with a single dorsal plate, which may have a mesal or transverse fracture line. **3**

Metanotum with only scattered setae or small plates, or with 2 or more sclerites **21**

3(2). Abdomen with rows of branched gills; no portable case . . . . . .HYDROPSYCHIDAE **4**

Abdomen without branched gills, much enlarged in final instar; larvae < 5 mm long, final instar in barrel- or purse-like cases (Fig. 15a-h), which may be attached to substrate . . .HYDROPTILIDAE **11**

4(3). **HYDROPSYCHIDAE** - Head with an extensive dorsal, arcuate carina surrounding a broad, depressed, flat, area (Fig. 3); anterior of protibia and tarsus with dense brush of pale setae . . . . . .***Macrostemum***

Head lacking distinct carina, but flat dorsally; protibia and tarsus without dense, setal brush **5**

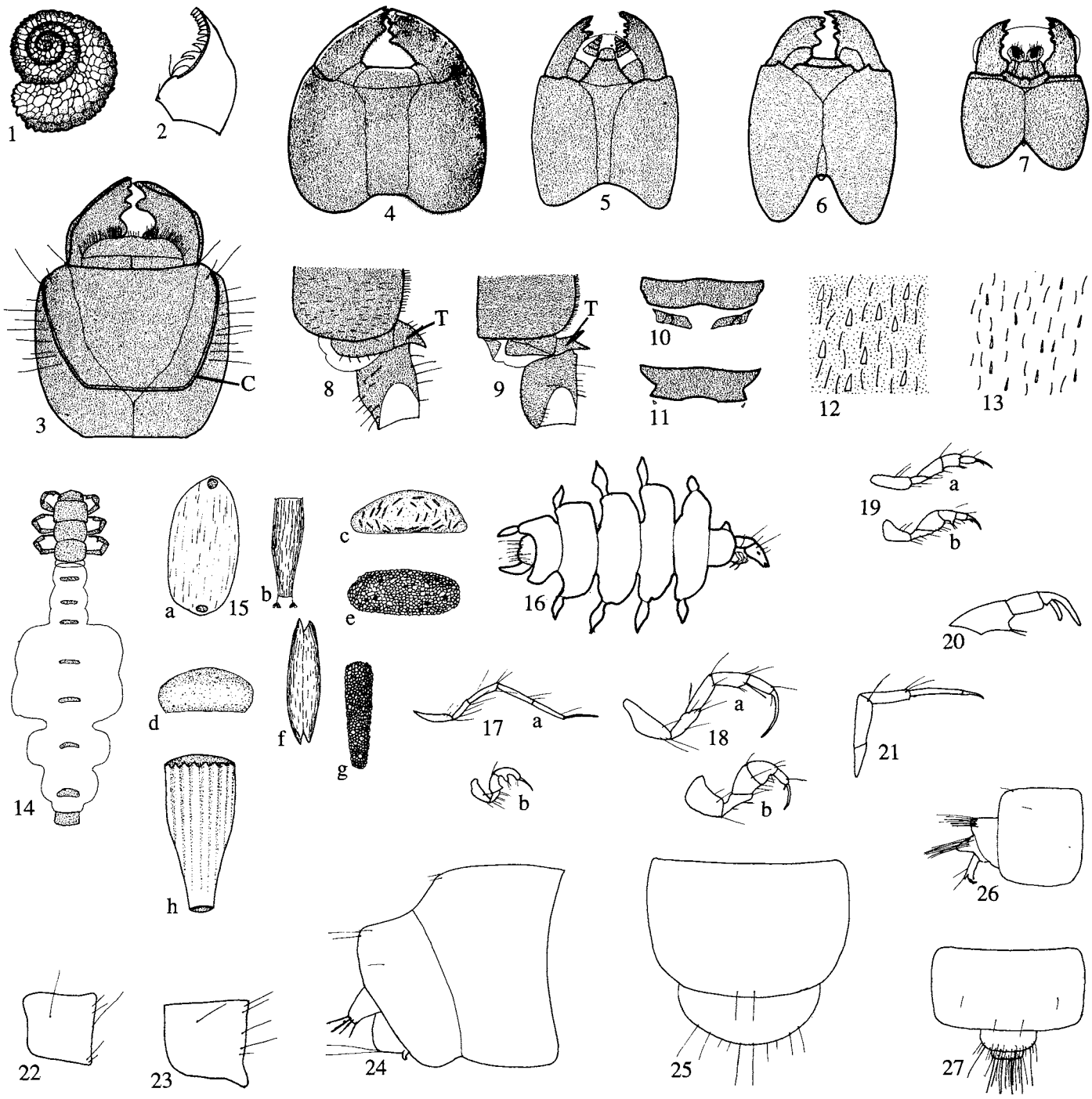
5(4). Genae completely separated by an elongate gula (Figs. 4-5) **6**

Genae fused for most of their length, dividing gula into anterior and posterior sclerites, the latter often reduced or absent (Figs. 6-7) **7**

6(5). Gula with sides nearly parallel (Fig. 4); abdomen with short, black, scalelike setae on dorsum, arranged in tufts along posterior margin . . . . . ***Parapsyche***

Gula narrowed posteriorly (Fig. 5); abdomen with only coarse setae of varying lengths . . . . . ***Arctopsyche***

7(5). Posterior gular triangle elongate (Fig. 6); meso- and metanotum divided by transverse fracture line in posterior third; protrochantin simple (Fig. 8) . . . . . ***Diplectrona***



Figures 1-27. Trichoptera Larvae. 1. Case *Helicopsyche*. 2. Anal claw *Helicopsyche*. 3. Head *Macrostemum* (dorsal) with carina (C). 4-7. Head (ventral): 4. *Parapsyche*. 5. *Arctopsyche*. 6. *Diplectrona*. 7. *Potamyia*. 8-9. Prothorax (lateral) with protrochantin (T): 8. *Diplectrona*. 9. *Cheumatopsyche*. 10-11. Prosternum: 10. *Hydropsyche*. 11. *Cheumatopsyche*. 12-13. Portion of abdominal tergum 2: 12. *Hydropsyche*. 13. *Ceratopsyche*. 14. *Leucotrichia* (dorsal). 15: Cases: 15a. *Leucotrichia*. 15b. *Oxyethira*. 15c. *Stactobiella*. 15d. *Hydroptila*. 15e. *Ochrotrichia*. 15f. *Orthotrichia*. 15g. *Neotrichia*. 15h. *Mayatrichia*. 16. *Ithytrichia* (lateral). 17. Legs a. mesothoracic, b. prothoracic *Oxyethira*. 18-19. Legs a. metathoracic, b. prothoracic: 18. *Agraylea*. 19. *Hydroptila*. 20. Metatibia and tarsus *Stactobiella*. 21. Metathoracic leg *Orthotrichia*. 22-23. Metanotum (lateral): 22. *Hydroptila*. 23. *Ochrotrichia*. 24-25. Abdominal segments 8-9 *Orthotrichia*: 24. lateral. 25. dorsal. 26-27. Abdominal segments 7-9 *Neotrichia*: 26. lateral. 27. dorsal.

Posterior gular triangle minute or absent (Fig. 7); meso- and metanotum entire; protrochantin usually forked (Fig. 9) or with a dorsal spur 8

8(7). Prosternal plate with a pair of detached, moderate-sized, posterior sclerites (Fig. 10) 9

Prosternal plate with at most a pair of detached, very minute, sclerotized dots (Fig. 11). 10

9(8). Dorsum of abdomen with minute spines on at least segments 1-3 (Fig. 12); scale setae present on at least last 3 abdominal terga (Fig. 12).***Hydropsyche***

Dorsum of abdomen lacking minute spines; scale setae absent, club setae present (Fig. 13) . ***Ceratopsyche***

10(8). Anterior gular sclerite with prominent anteromedian tubercle (Fig. 7); protrochantin simple, or with a small dorsal spur . . . . . ***Potamyia***

Anterior gular sclerite lacking prominent tubercle; protrochantin forked, dorsal fork subequal in length to ventral fork (Fig. 9) . . . . . ***Cheumatopsyche***

11(3). **HYDROPTILIDAE** - Abdomen enlarged, at least some part much thicker than thorax (Fig. 14) . .12

Abdomen slender, not appreciably thicker than thorax; no case (early instars) . . . . . Not Keyed

12(11). Each abdominal segment with a small, dark, dorsal sclerite (Fig. 14); case translucent, ovoid, and flattened (Fig. 15a) . . . . . ***Leucotrichia***

Abdominal segments 2 to 7 without dark, dorsal sclerites, at most with small delicate ring or very pale sclerites 13

13(12). Abdominal segments with conspicuous dorsal and ventral projections (Fig. 16) . . . . . ***Ithytrichia***

Abdominal segments without dorsal and ventral projections 14

14(13). Meso- and metathoracic legs almost 3 times as long as prothoracic leg (Fig. 17); case silken (Fig. 15b) . . . . . ***Oxyethira***

Meso- and metathoracic legs not > 1 1/2 times length of prothoracic leg (Figs. 18-19) 15

15(14). Tarsal claw about same length as tarsus (Figs. 18, 20); case purse-like (Figs. 15c-e) 16

Tarsal claw distinctly shorter than tarsus (Fig. 21); case purse-like of pure silk, or rounded (Figs. 15f-h) 19

16(15). Tarsal claw with long, stout, inner tooth (Fig. 20); larva robust; case purse-like, of silk, often with small strands of algae (Fig. 15c) . . . . ***Stactobiella***

Tarsal claw without stout inner tooth; case purse-like, mostly of sand or algae 17

17(16). Metatibia twice as long as deep (Fig. 18) . ***Agraylea***

Metatibia about as deep as long (Fig. 19) 18

18(17). Anteroventral angle of metanotum not produced, and with one or more setae at or near anteroventral angle (Fig. 22); 3 membranous gills on anal segment; case purse-like of sand (Fig. 15d) . . . . . ***Hydroptila***

Anteroventral angle of metanotum produced to form a small lobe, and with all setae well dorsad of lobe (Fig. 23); no gills on anal segment; purse-like case with sand or algae (Fig. 15e) . . . . . ***Ochrotrichia***

19(15). Anal legs apparently combined with body (Fig. 24); eighth abdominal tergum with only one or two pairs of weak setae (Fig. 25); purse-like case of pure silk (Fig. 15f) . . . . . ***Orthotrichia***

Anal legs distinctly projecting from body (Fig. 26); eighth abdominal tergum with many setae (Fig. 27) 20

20(19). Thoracic nota with long, slender, erect, inconspicuous setae (Fig. 28); case of sand grains and evenly tapered (Fig. 15g) . . . . . ***Neotrichia***

Thoracic nota with stout, black, conspicuous setae (Fig. 29); case tapered, semitranslucent, with dorsal raised ridges (Fig. 15h) . . . . . ***Mayatrichia***

21(2). Mesonotum entirely membranous, or with only small sclerites covering < half of notum (Figs. 52-53, 56) 22

Mesonotum mostly covered with sclerotized plates.44

22(21). Abdominal segment 9 with dorsum entirely membranous; no portable cases 23

Abdominal segment 9 with a sclerotized dorsal plate; with or without cases 33

23(22). Protrochantin broad, hatchet-shaped (Fig. 30) . . . . . .PSYCHOMYIIDAE 24

Protrochantin pointed (Fig. 31), or undeveloped . . 25

24(23). **PSYCHOMYIIDAE** - Anal claw with several long teeth ventrally (Fig. 32); mentum with a pair of high, quadrangular sclerites (Fig. 34) . ***Psychomyia***

Anal claw lacking ventral teeth (Fig. 33); mentum with pair of wide, short sclerites (Fig. 35). . . ***Lype***

25(23). Protrochantin poorly developed; head without muscle scars; labrum membranous and T-shaped (Fig. 36) . . . . . PHILOPOTAMIDAE 26

Protrochantin strong and pointed (Fig. 31); head usually with muscle scars (Figs. 37, 47); labrum sclerotized and widest near base (Fig. 37). 28

26(25). **PHILOPOTAMIDAE** - Apex of frontoclypeus deeply emarginate, often with a large or pointed left lobe and a smaller right one (Fig. 36) . . . . . ***Chimarra***

Apex of frontoclypeus at most slightly asymmetrical (Figs. 38-39) 27

27(26). Frontoclypeus almost perfectly symmetrical, widened abruptly near anterior margin (Fig. 38).***Wormaldia***

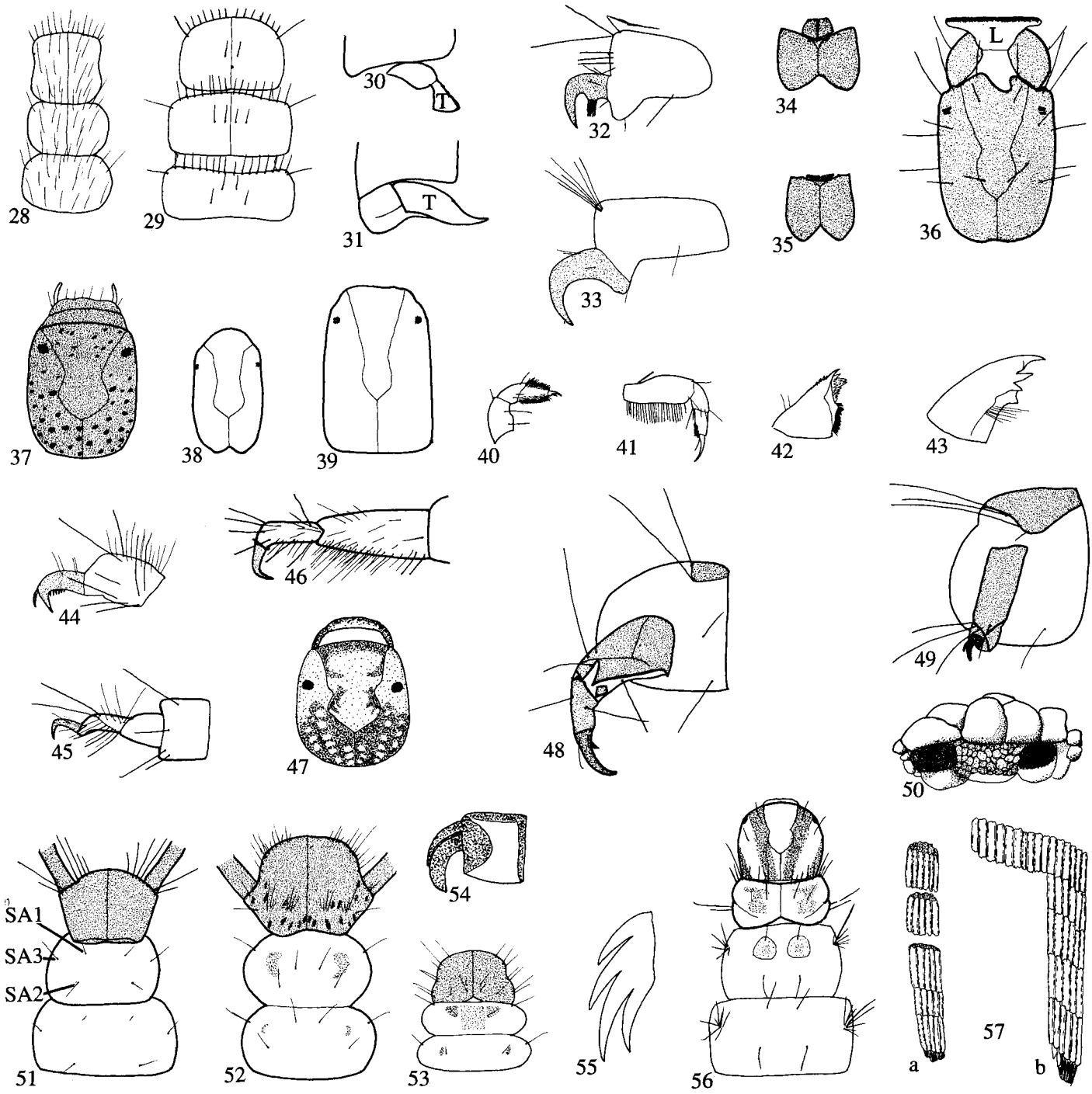
Frontoclypeus slightly asymmetrical, anterior portion uniformly widened (Fig. 39) . . . . . ***Dolophilodes***

28(25). Tarsus broad and densely pilose (Fig. 40); mandibles short and triangular, with a large, thick mesal brush (Fig. 42) . . **DIPSEUDOPSIDAE, *Phylocentropus***

Tarsus not densely pilose (Fig. 41); mandibles lacking mesal brush (Fig. 43). . . . . .POLYCENTROPODIDAE 29

29(28). **POLYCENTROPODIDAE** - Anal claw with well-developed ventral teeth (Fig. 44); muscle scars on head paler than background . . . ***Paranyctiophylax***

Anal claw without well-developed ventral teeth (Figs. 45-46); if tiny spines are present on anal claw, muscle scars on head are darker than background. 30



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30(29). Basal segment of anal proleg subequal to distal segment and without setae, except sometimes a few distally (Fig. 45); ventral margin of anal claw with a row of many tiny spines . . . . . ***Neureclipsis***

Basal segment of anal proleg about 1 1/2 times length of distal segment and with numerous setae (Fig. 46); anal claw without tiny spines **31**

31(30). Muscle scars on head lighter than surroundings (Fig. 47) . . . . . ***Cyrnellus***

Muscle scars on head darker than surroundings (Fig. 37) or indistinct **32**

32(31). Protarsus broad, half as long as protibia; or anal claw obtusely curved; or anal claw with 2 or 3 dorsal spines . . . . . ***Polycentropus***

Protarsus narrow, 2/3 length of protibia; anal claw curved about 90°; anal claw with 1 dorsal spine . . . . . ***Cernotina***

33(22). Setal area (SA) 3 on meso- and metanotum consisting of a single seta (Figs. 51-53); prosternal horn absent **34**

SA-3 on meso- and metanotum consisting of a cluster of setae (Figs. 56, 58-60); prosternal horn present; vegetation case readily vacated . . . . . PHRYGANEIDAE **37**

34(33). Anal claw long, about as long as elongate sclerite on anal leg (Fig. 48); protrochantin conspicuous; no portable case .**RHYACOPHILIDAE, *Rhyacophila***

Anal claw small, much shorter than elongate sclerite on anal leg (Fig. 49); protrochantin obscure; saddle-shaped or turtle-like case (Fig. 50); case readily vacated . . . . . GLOSSOSOMATIDAE **35**

35(34). **GLOSSOSOMATIDAE** - Mesonotum without sclerites (Fig. 51); gular suture about 1/4 length of genae; dark sclerotized line mesad of each proleg . . . . . ***Glossosoma***

Mesonotum with 2 or 3 sclerites (Figs. 52-53); gular suture > 1/2 length of genae; no dark sclerotized line mesad of each proleg . . . . . **.36**

36(35). Mesonotum with 2 sclerites (Fig. 52); anal claw with 1 large tooth and 1 smaller tooth (Fig. 54) . . . . . ***Agapetus***

Mesonotum with large median sclerite and two smaller lateral sclerites (Fig. 53); anal claw with many teeth (Fig. 55); < 4 mm long . . . . . ***Protoptila***

37(33). **PHRYGANEIDAE** - Mesonotum with a pair of small sclerites (Fig. 56); case a series of rings (Fig. 57a) **38**

Mesonotum without sclerites (Figs. 58-60); case of rings or spirally wound (Fig. 57) . . . . . **.39**

38(37). Lotic, in margins of small streams; case of wide leaf and bark pieces . . . . . ***Oligostomis***

Lentic, in bog pools; case of elongate pieces of sedges or grasses (Fig. 57a) . . . . . ***Beothukus***

39(37). Head and pronotum light brown, without dark stripes; case of leaf pieces in rings . . . . . ***Hagenella***

Head and pronotum with prominent dark stripes . . **40**

40(39). Pronotum with semicircular dark stripe behind anterior pale margin (Fig. 58); case a series of rings (Fig. 57a). . . . . ***Ptilostomis***

Pronotum either with diagonal dark stripes or dark anterior margin (Figs. 59-61); case a single spiral (Fig. 57b) . . . . . **.41**

41(40). Meso- and metanotum with 2 irregular, longitudinal, dark-reddish bands, separated by a pale area (Fig. 59); pronotum with black stripes parallel or converging posteriorly (Fig. 59) . . . . . ***Banksiola***

Meso- and metanotum with blotches or fairly uniform pigmentation . . . . . **.42**

42(41). Anterior margin of pronotum bordered with black, followed by dark brown band of variable width (Fig. 60); black stripe on fronto-clypeus (Fig. 60) . . . . . ***Phryganea***

Pronotum either with diagonal black stripes or uniformly black anterior margin (Fig. 61); fronto-clypeus with or without black stripe . . . . . **.43**

43(42). Fronto-clypeus with or without a black stripe; pronotum with or without diagonal stripes; if pronotum has an anterior black border, meso- and metanotum have dark blotches; case smooth . . . . . ***Agrypnia***

Fronto-clypeus without a black stripe; pronotum with anterior black border; meso- and metanotum uniformly pigmented; case bushy apically . ***Fabria***

44(21). Metathoracic leg elongate with very small claw: pro- and mesothoracic legs stout, 2/3 length of metathoracic leg, with elongate claws (Fig. 62); case of sand with lateral flanges (Fig. 63) . . . . . **MOLANNIDAE, *Molanna***

Structure of metathoracic leg and claw similar to that of mesothoracic leg . . . . . **.45**

45(44). Mesonotum weakly sclerotized, except for a pair of dark, sclerotized, narrow, curved or angled bars (Fig. 64); cases ovate or convex (Fig. 65a) . . . . . **.LEPTOCERIDAE, *Ceraclea***

Mesonotum without such a pair of sclerotized bars. **46**

46(45). Antenna long, ≥ 6 times width, arising near base of mandible (Figs. 66-67) . . . . LEPTOCERIDAE **47**

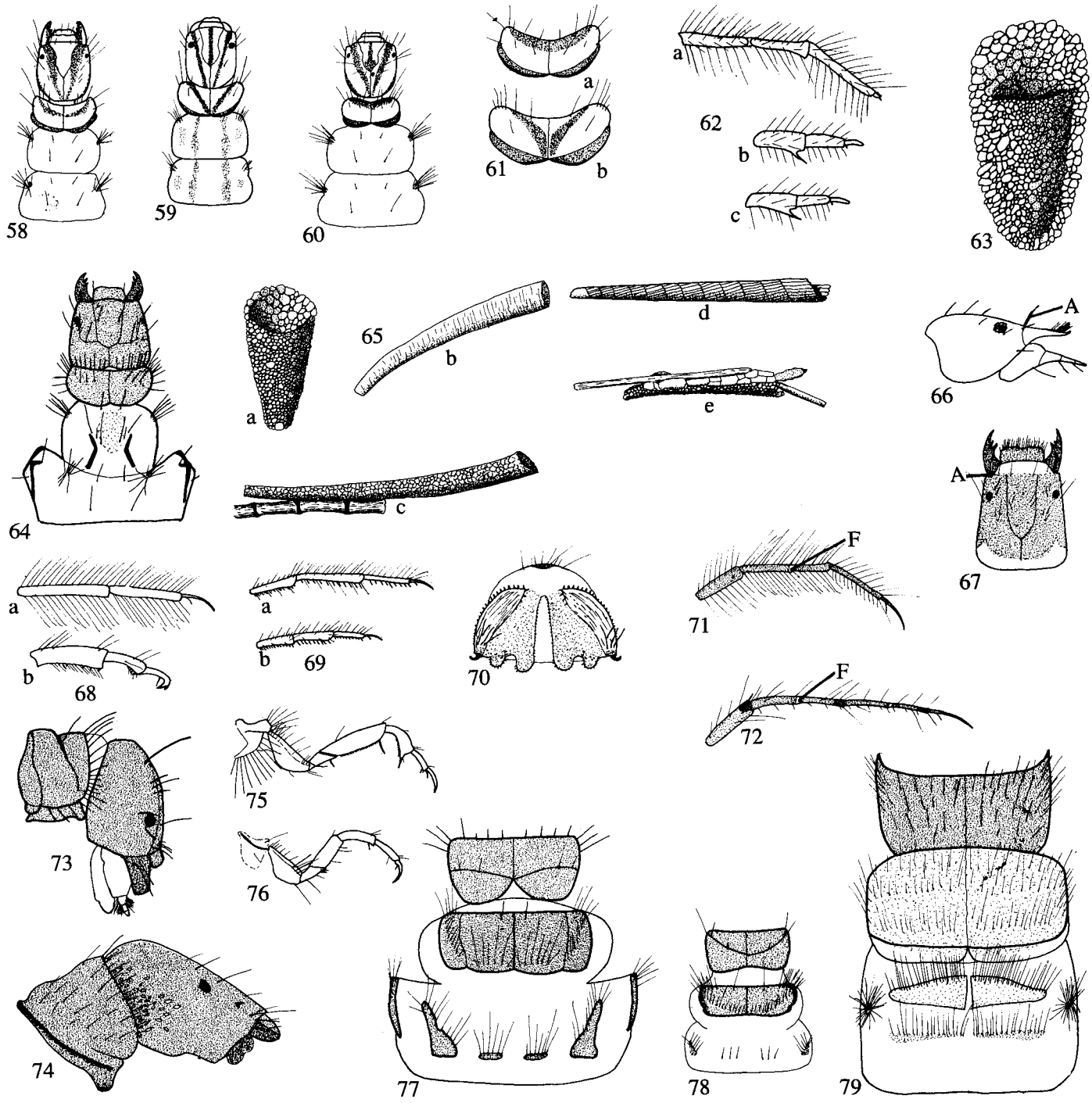
Antenna very short, ≤ 3 times as long as wide, often inconspicuous, arising at various points (Figs. 74, 82) **53**

47(46). **LEPTOCERIDAE** (part) - Mesothoracic leg with claw stout and hook-shaped, tarsus bent (Fig. 68); case slender and transparent (Fig. 65b).***Leptocerus***

Mesothoracic leg with claw slender, curved, tarsus straight (Fig. 69); case rarely transparent **48**

48(47). Mandible long, sharp at apex, with lateral teeth well below apex (Fig. 67); maxillary palp extending far beyond anterior edge of labrum (Fig. 66); case robust . . . . . ***Oecetis***

Mandible shorter, blunt at apex, with lateral teeth near apex (Fig. 64); maxillary palp extending little, if any, beyond labrum; case slender **49**



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49(48). Anal segment with a pair of sclerotized, concave plates, with spinose dorsolateral and mesal carinae, and an overhanging ventral flap (Fig. 70) . . . . . ***Setodes***

Anal segment convex and without carinae between anal hooks **50**

50(49). Metatibia entirely sclerotized, without a fracture in middle (Fig. 69a); gula a rounded triangle; case of various materials, often with projecting stick (Fig. 65c) . . . . . ***Nectopsyche***

Metatibia with a fracture near middle, which appears to divide it into 2 segments (Figs. 71-72); gula rectangular **51**

51(50). Metatibia with only irregularly placed hairs (Fig. 72); case of sand, stones, or vegetation, often with projecting pieces (Fig. 65e). . . . . ***Mystacides***

Metatibia with a regular fringe of long hair (Fig. 71); case of spirally arranged bits of vegetation (Fig. 65d) **52**

52(51). Head dorsally pale with black muscle scars and/or black, almost parallel, longitudinal stripes . . . . . ***Triaenodes***

Head dorsally light reddish-brown, darker laterad of epicranial suture, and with a distinct pale area containing black muscle scars adjacent to posterior margin . . . . . ***Ylodes***

53(46). Pronotum divided by a sharp furrow across middle, area in front of furrow depressed (Fig. 73); no seta or sclerite at SA-1 of metanotum; spacing tubercles lacking . . . . . BRACHYCENTRIDAE **54**

Pronotum with at most a shallow furrow (Fig. 74); setae or sclerites at SA-1 of metanotum; at least with lateral spacing tubercles present **55**

54(53). **BRACHYCENTRIDAE** - Metacoxa with ventral, semicircular lobe bearing a row of long setae (Fig. 75); mesonotum with 4 elongate sclerites (Fig. 77); metanotal plates heavily sclerotized.***Brachycentrus***

Metacoxae without ventral lobe bearing setae (Fig. 76); mesonotum with 2 very wide sclerites that may be longitudinally divided near lateral margins (Fig. 78); metanotal plate lightly sclerotized . . . . . ***Micrasema***

55(53). Anterolateral margins of pronotum sharp, forward-projecting points (Figs. 79-81) **56**

Anterolateral margins of pronotum rounded **58**

56(55). Lateral plates of mesonotum formed into long, projecting sclerites (Fig. 81); tubular sand case with pebbles along sides (Fig. 83). **GOERIDAE,** ***Goera***

Mesonotum rounded anterolaterally (Figs. 79-80); curved sand case (Fig. 84) **57**

57(56). Tibia and tarsus tan; pronotum uniformly colored (Fig. 79); case readily crushed . . . . . **SERICOSTOMATIDAE,** ***Agarodes***

Tibia and tarsus black; pronotum black anteriorly (Fig. 80); case extremely hard . . . . . **ODONTOCERIDAE,** ***Psilotreta***

58(55). Antenna very close to eye (Fig. 82); no dorsal spacing tubercle on abdominal segment 1; case tapered, of bits of vegetable matter (Fig. 85) or sand . . . . . **LEPIDOSTOMATIDAE,** ***Lepidostoma***

Antenna about mid-way between eye and base of mandible (Fig. 74); dorsal spacing tubercle usually prominent **59**

59(58). Anterior margin of mesonotum with mesal rectangular emargination (Fig. 87); head elongated; case of sand grains and tiny stones (Fig. 88) . . . . . **UENOIDAE,** ***Neophylax***

Mesonotum without mesal emargination (Fig. 91); head nearly ovoid . . . . . LIMNEPHILIDAE **60**

60(59). **LIMNEPHILIDAE** - All gills single **61**

Most gills in clusters of 3 or more **65**

61(60). Femur, tibia, and tarsus annulate with black (Fig. 86) . . . . . ***Psychoglypha***

Legs lacking contrasting annuli **62**

62(61). Basal seta of tarsal claw extending almost to tip of claw (Fig. 89); anterior mesothoracic plates (SA-1) replaced by transverse row of setae (Fig. 91); case cornucopia-shaped of sand grains . . . . . ***Apatania***

Basal seta of tarsal claw extending far short of tip (Fig. 90); anterior metathoracic plates (SA-1) present **63**

63(62). Head brown with inconspicuous muscle scars posteriorly (Fig. 74); lateral spacing tubercle without sclerite; case of sand grains, slightly tapered and curved (Fig. 92a) . . . . . ***Pseudostenophylax***

Head pale with dark muscle scars and blotches; small sclerite at posterior of lateral spacing tubercle; case of vegetable matter or sand **64**

64(63). Abdominal sterna 2-7 with chloride epithelia (Fig. 93) . . . . . ***Hydatophylax***

Abdominal sterna 3-7 with chloride epithelia (Fig. 94) . . . . . ***Pycnopsyche***

65(60). Some gills in clusters of 4 or more on basal abdominal segments **66**

No gills in clusters of more than 3 . . . . . **68**

66(65). Some gills on basal segments in clusters of 4, never 6; case of vegetable matter (Fig. 92e) . . . . . ***Onocosmoecus***

Most gills on basal segments in clusters of 6 or more **67**

67(66). Meso- and metafemur with about 5 long setae along ventral edge (Fig. 95); case of bark and leaves (Fig. 92c) or sand; in temporary ponds or streams . . . . . ***Ironoquia***

Meso- and metafemur with about 2 long setae along ventral edge (Fig. 96); case of sand grains (Fig. 92b); in permanent streams . . . . . ***Hesperophylax***

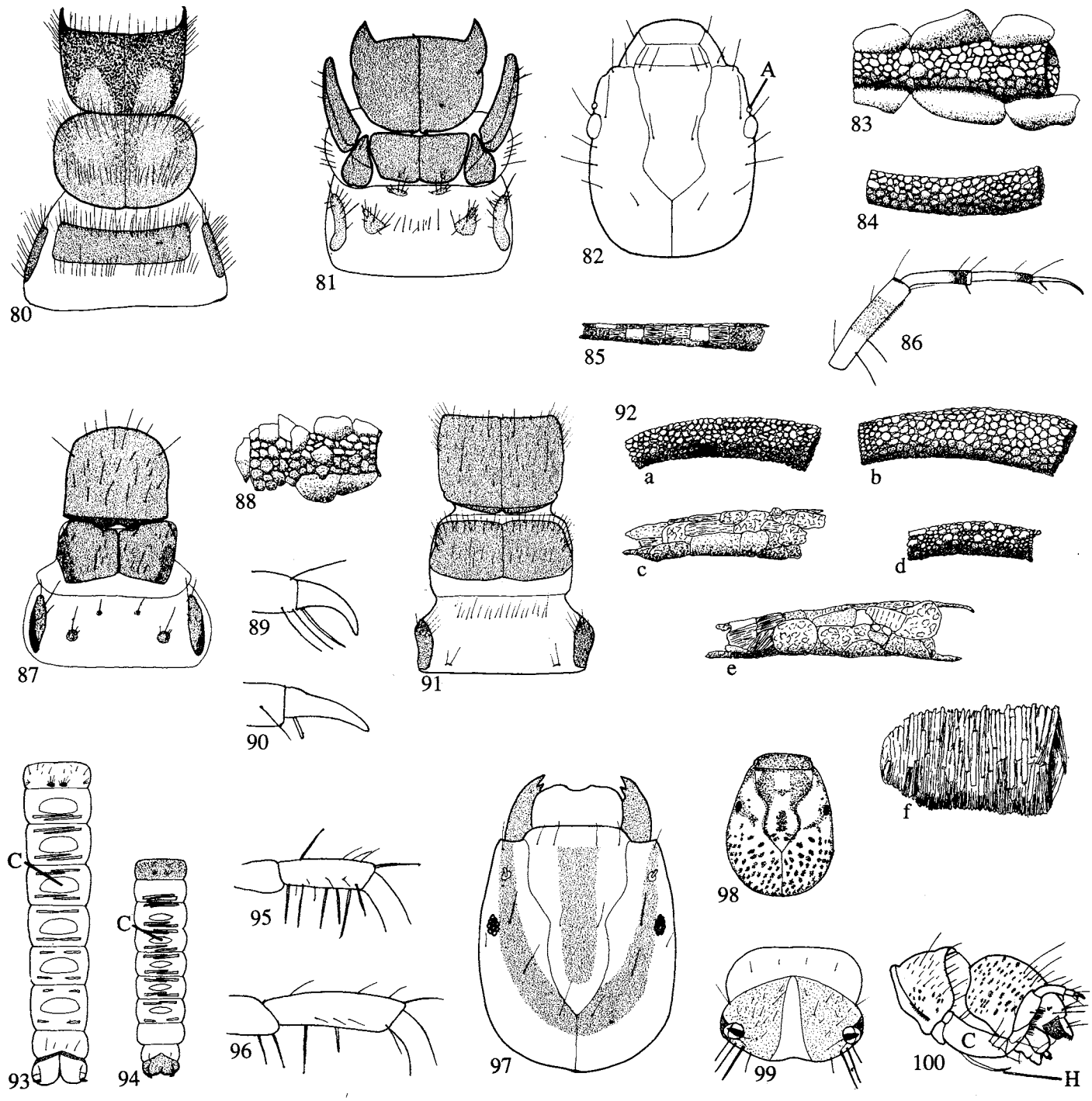
68(65). Leg with contrasting black annuli; case of sticks . . . . . ***Glyphopsyche***

Leg not annulate **69**

69(68). Dorsum of head with dark stripes or large blotches (Fig. 97) **70**

Dorsum of head uniformly colored, except for some muscle scars and small blotches (Figs. 98, 100).**72**

70(69). SA-1 of mesonotum consists of a single seta; case of leaf pieces . . . . . ***Nemotaulius***



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SA-1 of mesonotum consists of more than one seta 71

71(70). Chloride epithelia both dorsally and ventrally on most abdominal segments; case of plant and mineral materials . . . . . ***Asynarchus***

Chloride epithelia absent dorsally, present ventrally on most abdominal segments; case of a wide variety of materials . . . . . ***Limnephilus***

72(69). Anterior margin of pronotum with numerous stout, pale setae; setae on bulbous ventral portion of prolegs (Fig. 99); head uniformly brown with light muscle scars posteriorly; case of sand and tiny pebbles (Fig. 92d) . . . . . ***Frenesia***

Pronotum lacking numerous stout pale setae along anterior margin; no setae on bulbous ventral portion of prolegs 73

73(72). SA-2 of metanotum with few setae (usually 2) and no sclerite; case of elongate leaf pieces arranged in a smooth cylinder . . . . . ***Arctopora***

SA-2 of metanotum with a sclerite and more than 2 setae 74

74(73). Head with numerous dark spots, coalescing along margins of fronto-clypeus to form diffuse blotches (Fig. 98); small patch of minute spines at anterolateral corner of pronotum; case of vegetation . . . . . ***Anabolia***

Head often with numerous dark spots, but spots not coalescing along margins of fronto-clypeus 75

75(74). Prosternal horn extending beyond apices of procoxae (Fig. 100); case of vegetation placed transversely (Fig. 92f) . . . . . ***Platycentropus***

Prosternal horn at most reaching apices of procoxae 76

76(75). Chloride epithelia both dorsally and ventrally on most abdominal segments; case of plant and mineral materials . . . . . ***Asynarchus***

Chloride epithelia absent dorsally, present ventrally on most abdominal segments; case variable . . . . . ***Limnephilus***

WISCONSIN SPECIES AND REFERENCES TO LARVAL KEYS

ANNULIPALPIA

DIPSEUDOPSIDAE (=POLYCENTROPODIDAE, part)

Phylocentropus - placidus

HYDROPSYCHIDAE (Schmude and Hilsenhoff 1986)

Arctopsyche - ladogensis**

Ceratopsyche (=*Symphytopsyche*) (Schefter and Wiggins 1986) - *alhedra, alternans, bronta, morosa, slossonae, sparna, ventura*, vexa, walkeri*

Cheumatopsyche - aphanta, campyla, gracilis, lasia, minuscula, oxa, pasella, pettiti, sordida, speciosa, wabasha**

Diplectrona - modesta

Hydropsyche - aerata, alvata*, arinale, betteni, bidens, confusa*, cuanis, dicantha, frisoni*, hageni*, leonardi, orris, phalerata, placoda, rossi*, scalaris, simulans, valanis**

Macrostemum (=*Macronema*) - *zebratum*

Parapsyche - apicalis

Potamyia - flava

PHILOPOTAMIDAE (Ross 1944)

Chimarra - aterrima, feria, obscura, socia

Dolophilodes - distinctus

Wormaldia - moesta

POLYCENTROPODIDAE

Cernotina - spicata**

Cyrnellus - fraternus

*Neureclipsis - bimaculata, crepuscularis, valida**

Paranyctiophylax (=*Nyctiophylax*) (Flint 1964) - *affinis, banksi*, celta, moestus, uncus**

Polycentropus (Ross 1944) - *albipunctatus*, aureolus, centralis, cinereus, confusus, crassicornis, flavus, glacialis, interruptus, melanae*, milaca*, nascotius, pentus, picicornis*, remotus, sabulosus*, weedi*

PSYCHOMYIIDAE

Lype - diversa

Psychomyia - flavida

SPICIPALPIA

GLOSSOSOMATIDAE

Agapetus - hessi, rossi, tomus**

Glossosoma - intermedium, nigrior

Protoptila - erotica, lega, maculata, talola*, tenebrosa*

HYDROPTILIDAE

Agraylea - costello, multipunctata

Hydroptila (Ross 1944) - *ajax, albicornis, amoena, ampoda*, armata, berneri, callia, consimilis, delineata*, grandiosa, hamata, jackmanni, metoeca*, novicola*, perdita, quinola*, salmo, scolops, spatulata, strepha, tortosa*, valhalla, virgata, waskesia*, waubesiana, wyomia*

Ithytrichia - clavata

Leucotrichia - pictipes

Mayatrichia - ayama

Neotrichia - falca, halia, okopa, vibrans

*Ochrotrichia - spinosa, tarsalis, wojcickyi**

Orthotrichia - aegerfasciella, baldufi, cristata

Oxyethira - anabola, araya, coercens, forcipata, michiganensis, obtatus, pallida, rivicola, rossi, serrata, sida, verna, zeronia

Stactobiella - delira, palmata

RHYACOPHILIDAE (Flint 1962)

Rhyacophila - angelita, brunnea, fuscula, lobifera, mainensis*, manistee*, vibox*

INTEGRIPALPIA

BRACHYCENTRIDAE (Hilsenhoff 1985)

Brachycentrus (Flint 1984) - *americanus, fuliginosus*, incanus, lateralis, numerosus, occidentalis*

Micrasema (Chapin 1978) - *gelidum, rusticum, wataga*

GOERIDAE (LIMNEPHILIDAE, part)

Goera - stylata

HELICOPSYCHIDAE

Helicopsyche - borealis

LEPIDOSTOMATIDAE (Weaver 1988)

Lepidostoma - bryanti, cinereum, costale, griseum, libum,*

sackeni, togatum, unicolor, vernale*

LEPTOCERIDAE

Ceraclea (Resh 1976) - *alagma, albosticta*, alces, ancylus, annulicornis, arielles, brevis* cancellata, diluta, erratica, excisa, flava, maculata, mentiea, neffi*, nepha*, punctata, resurgens, spongillovorax*, submacula*, tarsipunctata, transversa, wetzeli*

Leptocerus - americanus

Mystacides (Yamamoto and Wiggins 1964) - *interjecta, sepulchralis*

Nectopsyche (Haddock 1977) - *albida, candida, diarina, exquisita, pavida*

Oecetis (Floyd 1995) - *avara, cinerascens, immobilis, inconspicua, ochracea, osteni, persimilis*

Setodes - guttatus, incertus, oligius*

Triaenodes (Glover 1996) - *abus, baris, flavescens*, ignitus, injustus, marginatus, melacus*, nox*, tardus*

Ylodes (=*Triaenodes*, part) (Glover 1996) - *frontalis*

LIMNEPHILIDAE (Flint 1960)

Anabolia - bimaculata, consocia, ozburni, sordida

Apatania (Chen 1992) - *incerta, zonella*

Arctopora - pulchella

*Asynarchus - montanus, mutatus**

Frenesia - missa

Glyphopsyche - irrorata

Hesperophylax - designatus

Hydatophylax - argus

Ironoquia - lyrata, punctatissima

Leptophylax - gracilis

Limnephilus - arcocurvus, argenteus, canadensis, dispar, externus, hyalinus, indivisus, infernalis, janus, moestus, ornatus, partitus*, parvulus, perpusillus, rhombicus, rossi, secludens*, sericeus, sublunatus*, submonilifer*

Nemotaulius - hostilis

Onocosmoecus - unicolor

Platycentropus - amicus, indistinctus, radiatus*

Pseudostenophylax - sparsus, uniformis

Psychoglypha - subborealis

Pycnopsyche - aglona, antica, circularis, guttifera, lepida, limbata, luculenta, rossi, subfasciata*

MOLANNIDAE (Sherberger and Wallace 1971)

Molanna - blenda, flavicornis, tryphena, ulmerina, uniophila

ODONTOCERIDAE

Psilotreta - indecisa

PHRYGANEIDAE (Wiggins 1960)

Agrypnia - glacialis, improba*, macdunnoughi*, straminea, vestita*

Banksiola - crotchi, dossuaria, smithi

Beothukus (=*Fabria*, part) - *complicatus*

Fabria - inornata**

Hagenella - canadensis

Oligostomis - ocelligera

Phryganea - cinerea, sayi

Ptilostomis - angustipennis, ocellifera, postica*, semifasciata*

SERICOSTOMATIDAE

Agarodes - distinctus

UENOIDAE (=LIMNEPHILIDAE, part)

Neophylax - concinnus, consimilis, fuscus, nacatus*, oligius*

MEGALOPTERA - FISHFLIES AND ALDERFLIES

This very small holometabolous order contains two families with aquatic larvae; it once was included in Neuroptera. Only 11 species have been collected in Wisconsin; a few others may occur.

Larvae are distinctive, having seven or eight pairs of lateral filaments and large, conspicuous mandibles. They can be confused only with some aquatic Coleoptera larvae that have lateral filaments. The predatory larvae often attain a very large size, and may exert significant pressure on populations of macroinvertebrates living in the same habitat. Larvae of most species occur only in relatively oxygen rich environments because they usually obtain oxygen through their integument directly from the water in which they live. Their lateral filaments greatly increase surface area, allowing them to do this. Species inhabiting lentic habitats that may at times be low in oxygen use long caudal respiratory tubes to obtain air at the surface. All larvae have spiracles and are capable of living out of water in moist areas; some species survive in temporary streams.

There are 10 or 11 larval instars, and life cycles range from one to four years depending on species and climate. While larvae are aquatic, other stages are terrestrial. Eggs are laid in masses on objects above the water, and pupation takes place in cells on land. The terrestrial adults are short-lived and generally secretive, but because of their large size and often conspicuous mandibles, they attract attention when discovered. They are weak fliers that are often attracted to lights. Adults fold their net-veined wings roof-like over their abdomen when at rest. Species of adults are well known, and larvae of most species can also be identified.

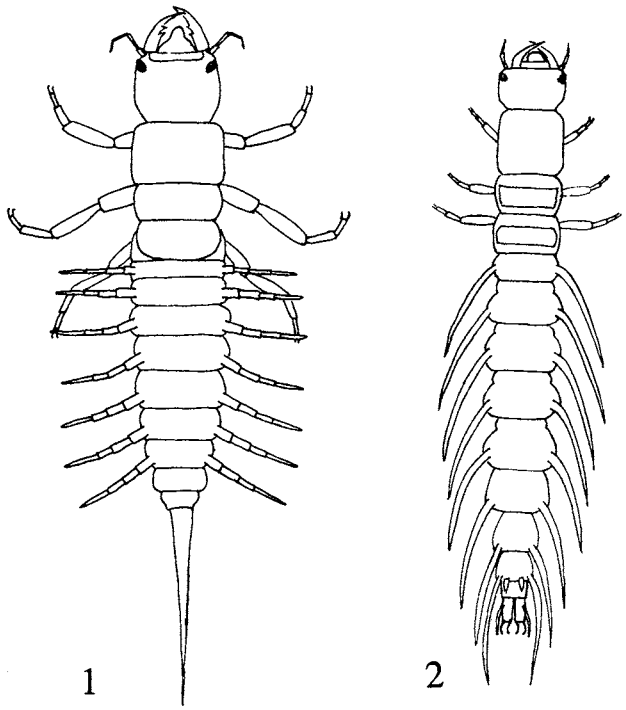
CORYDALIDAE - Fishflies and Dobsonflies (3 genera, 4 species)

Species in this family are among our largest insects. *Corydalus* larvae are uncommon statewide under rocks in well aerated streams of all sizes, while *Nigronia* larvae are often numerous under larger rocks in small, spring-fed streams. *Chauliodes* larvae are fairly common in weedy ponds, marshes, lake margins, and vegetated margins of streams. All have a semivoltine life cycle, with *Nigronia* taking four years to complete development and *Corydalus* and *Chauliodes* perhaps a year or two less in their warmer habitat. Adults emerge mostly in June.

SIALIDAE - Alderflies (1 genus, 7 species)

Larvae of *Sialis* occur in both lotic and lentic habitats, usually in deposits of silt. They are fairly common in stream pools and littoral and sublittoral zones of some lakes, where they have been found up to a mile from shore. Most species probably have a two-year life cycle, but some may be univoltine. Adults emerge from May through July, depending

on the species.



Figures 1-2. Megaloptera Larvae. 1. *Sialis* (dorsal). 2. *Nigronia* (dorsal)

KEY TO GENERA OF MEGALOPTERA LARVAE IN WISCONSIN

1. Last abdominal segment with a long median filament (Fig. 1) . . . . . **SIALIDAE, *Sialis***
   Last abdominal segment without a median filament, but with a pair of lateral hooks (Fig. 2) . . . . . CORYDALIDAE **2**

2(1). **CORYDALIDAE** - A large tuft of filamentous gills at the base of each lateral process . . . . ***Corydalus***
   No filamentous gills at the base of each lateral process 3

3(2). Dorsal respiratory tubes on abdominal segment 8 short, not reaching past middle of abdominal segment 9 . . . . . ***Nigronia***
   Dorsal respiratory tubes on abdominal segment 8 long, reaching past end of abdomen . . . . . ***Chauliodes***

WISCONSIN SPECIES AND REFERENCES TO LARVAL KEYS

CORYDALIDAE
Chauliodes (Cuyler 1958) - *pectinicornis, rastricornis*
Corydalus - *cornutus*
Nigronia (Neunzig 1966) - *fasciatus*, serricornis*
SIALIDAE (Canterbury 1978)
Sialis - *aequalis*, americana, driesbachi, hasta*, infumata, itasca, joppa, mohri, vagans, velata*

AQUATIC HETEROPTERA - AQUATIC AND SEMIAQUATIC BUGS

Because all aquatic and semiaquatic bugs are Heteroptera and none are Homoptera, I follow Henry and Froeschner (1988) and refer to this group of insects as the order Heteroptera rather than Hemiptera, or Hemiptera: suborder Heteroptera. The name for this group of insects has been controversial; pros and cons are discussed by Henry and Froeschner.

Heteroptera is a medium-sized paurometabolous order that is primarily terrestrial. Two of the 7 suborders have aquatic species. Adults and nymphs in the suborder Gerromorpha walk on the water's surface, and are considered to be "semiaquatic"; those in the suborder Nepomorpha spend their entire life under water, except for dispersal flights, and are referred to as "aquatic Heteroptera". Flightless species of Nepomorpha are the most aquatic of all insects, rarely, if ever, leaving the water. In Wisconsin, all species in six families of Nepomorpha are aquatic and all species in five families of Gerromorpha are semiaquatic or occasionally riparian. Two riparian families, Gelastocoridae (Nepomorpha) and Saldidae (Leptopodomorpha), are included in the key because adults may be collected along with aquatic species. Sixty-seven aquatic and 26 semiaquatic species are known from Wisconsin,which represents almost 30% of North American Nepomorpha and Gerromorpha species.

Heteroptera adults can be distinguished from other aquatic insects by their sucking mouthparts that are formed into a broad tube or "rostrum", and by their mesothoracic wings, or hemelytra, which are hardened in the basal half and membranous apically. Many adults of semiaquatic species are apterous or brachypterous. There are normally five nymphal instars; a few species have only four. Nymphs resemble adults, except that they lack wings and genitalia, and are distinctly less sclerotized. Usually, they associate with adults in the same habitat.

Most species of aquatic and semiaquatic Heteroptera are lentic; however, several lotic species also occur, and adults and nymphs of many lentic species fly to streams to overwinter. Almost all species are carnivores as nymphs and adults, feeding mostly on small invertebrates and occasionally on vertebrates such as minnows and tadpoles. Corixidae, the largest family, is an exception, with most species being primarily detritivores. Many aquatic and semiaquatic Heteroptera are avoided by fish, probably because of secretions from scent glands.

Adults of all species in Wisconsin can be readily identified. Families, genera, and even some species are often so distinctive it is possible to recognize them in the field. Nymphs, however, have not been well studied, except for Gerridae (Calabrese 1974). Many cannot be identified to species, and some cannot be identified to genus. Since studies by H.B. Hungerford and others 40 to 60 years ago, few species have been added to the known fauna of North America.

NEPOMORPHA

Adults and nymphs are adapted for swimming by having fringes of long setae on their legs, especially the metathoracic legs. They obtain oxygen from air stored under the hemelytra or from a bubble held ventrally on hydrofuge setae. Air stores are renewed at the surface through air straps (Belostomatidae), air tubes (Nepidae), the pronotum (Corixidae), and the apex of the abdomen (Notonectidae and Naucoridae). The ventral air bubble in Corixidae, Notonectidae, Pleidae, and Naucoridae is relatively large and acts as a physical gill; oxygen diffuses from the water into the bubble and carbon dioxide from respiration diffuses out of it. This allows prolonged submergence in oxygen-rich water.

Adults of most species that breed in shallow lentic habitats fly to deep lentic habitats or larger streams to overwinter; they return to breeding sites in late April or May to mate and oviposit. Eggs are laid on vegetation or other substrates, usually in the water, and subsequently adults die. Some univoltine species spend the winter as diapausing eggs. Exceptionally large numbers of adults of both lotic and lentic species can be collected in autumn from along banks of large streams where the current is slow, but adults of some lentic species do not fly to streams.

BELOSTOMATIDAE - Giant Water Bugs (2 genera, 3 species)

Giant water bugs, especially *Belostoma,* are common statewide, and sometimes are called "electric light bugs" because of their attraction to lights. These large predators breed in weedy ponds and lake margins where they complete one or two generations and then fly to streams or deep lentic habitats in autumn to spend the winter months. *Lethocerus* adults, which are less numerous than those of *Belostoma,* lay eggs in masses on vegetation above the water; *Belostoma* females lay eggs on backs of males, which brood the eggs.

CORIXIDAE - Water Boatman (9 genera, 49 species)

Water boatmen, especially *Hesperocorixa, Sigara,* and *Trichocorixa,* are abundant throughout the state in a variety of aquatic habitats. *Corisella* and *Palmacorixa* adults are less frequently encountered. *Callicorixa* adults are common in northern Wisconsin; those of *Cenocorixa, Cymatia,* and *Ramphocorixa* are rare. Adults fly frequently and can be readily captured by light traps. In autumn, after completing one or two generations, adults of most pond species fly to larger lakes and rivers, where they overwinter. Their primarily herbivorous feeding habits are unique among the normally carnivorous Heteroptera.

NAUCORIDAE - Creeping Water Bugs (1 genus, 1 species)

Predatory *Pelocoris* adults and nymphs are locally common in spring ponds, impoundments, sloughs, and adjacent stream margins in southern Wisconsin. They are univoltine, with adults overwintering in deeper water of their breeding habitat or in streams.

NEPIDAE - Water Scorpions (2 genera, 4 species)

Nepa adults and nymphs are rare among trash and debris in slow streams, ponds, and lake margins where they overwinter, and in extremely shallow water along margins of ponds and seeps, where they breed. *Ranatra* adults are common summer inhabitants of weedy ponds, lake margins, and river sloughs; in autumn most fly into streams to overwinter under the banks. Wisconsin species are mostly univoltine. Adults feed on other insects, small fish, and other aquatic animals they are able to catch.

NOTONECTIDAE - Backswimmers (2 genera, 9 species)

Adults and nymphs of *Notonecta* are very common statewide in ponds, ditches, and lake margins with emergent vegetation; those of *Buenoa* are fairly common in deeper ponds and small lakes. *Notonecta undulata* is bivoltine, but other *Notonecta* and all *Buenoa* species are univoltine. Most *Notonecta* overwinter as adults along streams or in deeper lentic habitats; *Buenoa* and *Notonecta borealis* overwinter as eggs. They are fierce predators, and winged adults disperse widely.

PLEIDAE - Pygmy Backswimmers (1 genus, 1 species)

Adults of *Neoplea* become abundant in permanent weedy ponds and lake margins throughout Wisconsin in late summer and early autumn, but by November they disappear into deeper water to overwinter. Adults feed on tiny insects and crustacea, probably completing at least two generations each summer. Although many adults have metathoracic wings, there is no evidence of flight in Wisconsin; mesothoracic wings are completely sclerotized and resemble elytra of Coleoptera adults.

GERROMORPHA

Apterous and brachypterous adults are common in most semiaquatic Heteroptera. Apterous adults are distinguished from nymphs by the presence of genitalia, greater sclerotization of the body, and because they have two tarsal segments instead of one on most legs. Adults and nymphs of semiaquatic Heteroptera have hydrofuge setae on their tarsi to enable them to walk on water; those of the larger and heavier Gerridae and Veliidae also have preapical claws. Nymphs and adults feed mostly on invertebrates of an appropriate size in the surface film. Those of Gerridae, and probably most other Gerromorpha, use sensillae on their femora and trochanters to detect vibrations in the surface film, enabling them to find prey. Adults and nymphs are most readily collected by sighting them on the water's surface and sweeping them from the surface film with an aquatic net.

Adults reach peak abundance in September, after which most find protected terrestrial sites in which to overwinter; adults of species that overwinter as eggs die. Species that overwinter as adults are bivoltine or multivoltine; most species that overwinter as eggs are univoltine. Eggs are laid on substrates at the water's surface.

GERRIDAE - Water Striders (7 genera, 12 species)

Water striders are common throughout the state, especially in late summer. Adults of *Gerris, Limnoporus,* and *Trepobates* are especially common in lentic habitats and margins of lotic habitats, while those of *Rheumatobates* are less common. *Neogerris* adults are rare on impoundments in southern Wisconsin. Adults of *Metrobates* occur commonly on larger streams, and those of *Aquarius* are common in small, spring-fed streams. *Gerris* species are bivoltine and *Limnoporus* is univoltine; adults in both genera overwinter. *Metrobates, Rheumatobates, Trepobates,* and probably *Neogerris* overwinter as eggs and are univoltine. Apterous and brachypterous forms are common.

HEBRIDAE - Velvet Water Bugs (2 genera, 4 species)

The tiny adults of *Hebrus* and *Merragata* crawl rather slowly across the surface of very shallow, still water that is covered with vegetation. *Merragata* adults are common. Those of *Hebrus* are uncommon, perhaps because they frequently leave the water and are more riparian than aquatic. Life cycles are multivoltine, with adults overwintering.

HYDROMETRIDAE - Marsh Treaders (1 genus, 1 species)

Hydrometra martini has been thoroughly studied. It is generally uncommon throughout the state where adults and nymphs may be found walking on algal mats or among vegetation in shallow, quiet water. The life cycle is multivoltine, with adults living as long as one year. Brachypterous adults are frequently encountered.

MESOVELIIDAE - Water Treaders (1 genus, 1 species)

Mesovelia mulsanti adults are very common in late summer, but are absent in early spring because they overwinter as eggs. They have several summer generations, and by autumn large numbers of these tiny yellow-green bugs can be found running rapidly across duckweed or algal mats in sheltered areas of ponds and lake margins. Apterous and brachypterous adults are much more common than macropterous ones.

VELIIDAE - Broad-shouldered Water Striders (2 genera, 8 species)

Microvelia adults and nymphs are very common statewide; most inhabit weedy lake margins, ponds, and marshes; those of two species inhabit stream margins. All species are multivoltine and most overwinter as adults; *M. pulchella* overwinters as an egg. Apterous, brachypterous, and macropterous adults occur. Adults and nymphs of *Rhagovelia* are fairly common, and occur only in streams. Both species are apterous, overwinter as eggs, and have a predominantly univoltine life cycle. Adults and nymphs run very rapidly across the water's surface.

KEY TO ADULT AQUATIC AND SEMIAQUATIC HETEROPTERA IN WISCONSIN

1. Antenna shorter than head, concealed in groove beneath eye; aquatic . . . . . .NEPOMORPHA **2**
   Antenna as long as head or longer, usually plainly visible; semiaquatic **8**

2(1). Rostrum broad, blunt, triangular, and indistinctly segmented (Fig. 1); front tarsus (pala) a one-segmented scoop (Figs. 1-2) . . . .CORIXIDAE **13**
   Rostrum cylindrical or cone-shaped, distinctly 3- or 4-segmented; front tarsus not scoop-like **3**

3(2). Abdomen with long, slender, rounded respiratory appendages (Fig. 3) . . . . . .NEPIDAE **23**
   Apical respiratory appendages, if present, short and flat (Fig. 4). **4**

4(3). Eyes protuberant (Fig. 5); ocelli present; metathoracic leg without natatory setae; 7-9 mm long; riparian . . . . . **GELASTOCORIDAE, *Gelastocoris***
   Eyes not protuberant (Figs. 6-8, 14-16); ocelli absent; metathoracic leg with natatory setae **5**

5(4). Length ≥ 18 mm; short, flat, retractile apical appendages present (Fig. 4) . . . . . BELOSTOMATIDAE **22**
   Length < 16 mm; apical appendages absent **6**

6(5). Profemur almost as wide as long; body flattened (Fig. 6); 10-12 mm long . . . **NAUCORIDAE, *Pelocoris***
   Profemur elongate; body elongate or hemispherical (Figs. 7-8); backswimmers **7**

7(6). Hemispherical (Fig. 7); 2.0-2.5 mm long . . . . . .**PLEIDAE, *Neoplea***
   Elongate (Fig. 8); > 5 mm long . . . . . ,NOTONECTIDAE **24**

8(1). Claws of at least protarsus inserted before apex (Fig. 9) **9**
   Claws of all tarsi at apex (Fig. 10) **10**

9(8). Metafemur very long, greatly surpassing apex of abdomen . . . . . GERRIDAE **25**
   Metafemur short, not, or only slightly surpassing apex of abdomen . . . . . VELIIDAE **31**

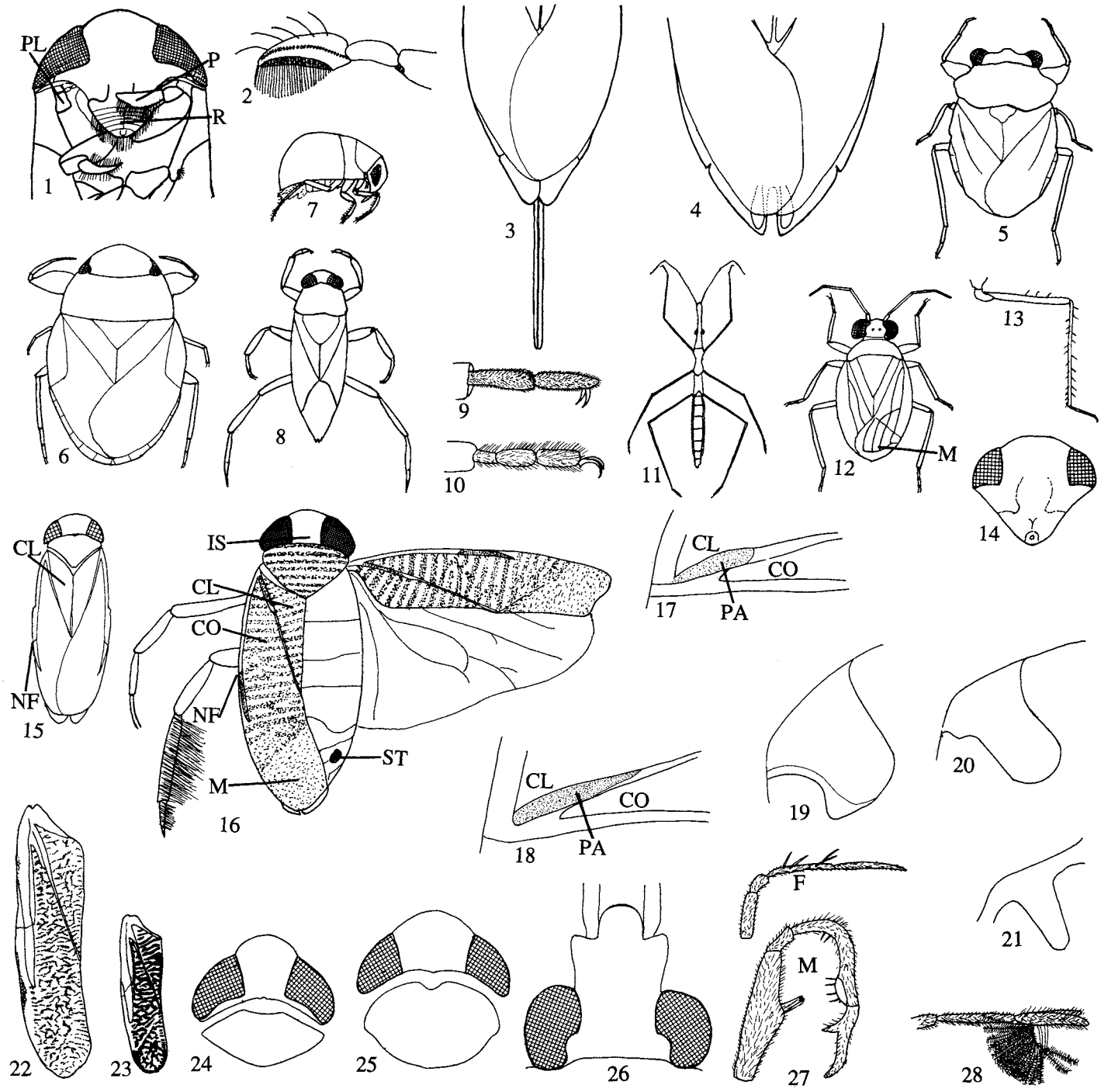
10(8). Head as long as entire thorax, very slender, eyes set about halfway to base (Fig. 11); 7.5-10.0 mm long . . . . . .**HYDROMETRIDAE, *Hydrometra***
   Head short and stout, eyes near posterior margin . .**11**

11(10). Wingless, or if winged, without veins in the membrane . . . . . .GERROMORPHA **12**
   Winged, with veins in membrane of hemelytra (Fig. 12); riparian . . . . . .LEPTOPODOMORPHA - **SALDIDAE**

12(11). Lower part of head grooved to receive rostrum; legs without bristles; < 2.5 mm long . . HEBRIDAE **32**
   Lower part of head not grooved; legs with scattered, stiff, black bristles (Fig. 13); 2.5-4.0 mm long . . . . . .**MESOVELIIDAE, *Mesovelia***

13(2). **CORIXIDAE** - Rostrum without transverse grooves (Fig. 14); pronotum without transverse dark bands; 5.9-8.3 mm long . . . . . ***Cymatia***
   Rostrum with transverse grooves (Fig. 1); pronotum with transverse bands, which may be indistinct . **14**

14(13). Entire hemelytral pattern usually effaced; upper surface of male pala deeply incised; vertex of male acuminate; 5.0-5.5 mm long . . . . .***Ramphocorixa***
   Hemelytral pattern distinct, although limited areas may be effaced in some species **15**



Figures 1-28. Heteroptera Adults. 1. Head and prothorax (ventral) *Sigara* with prothoracic lobe (PL), pala (P) and rostrum (R). 2. Male pala *Sigara*. 3-4. Apex of abdomen (dorsal): 3. *Nepa*. 4. *Belostoma*. 5. *Gelastocoris* (dorsal). 6. *Pelocoris* (dorsal). 7. *Neoplea* (lateral). 8. *Notonecta* (dorsal). 9-10. Protarsus: 9. *Gerris*. 10. *Mesovelia*. 11. *Hydrometra* (dorsal). 12. *Salda* (dorsal) with membrane (M). 13. Metathoracic leg *Mesovelia*. 14. Head (ventral) *Cymatia*. 15. *Trichocorixa* (dorsal) with clavus (CL) and nodal furrow (NF). 16. *Sigara* (dorsal) with interocular space (IS), clavus (CL), corium (CO), nodal furrow (NF), membrane (M), and strigil (ST). 17-18. Pruinose area (PA) of claval suture between clavus (CL) and corium (CO): 17. *Hesperocorixa*. 18. *Sigara*. 19-20. Prothoracic lobe (ventrolateral): 19. *Hesperocorixa*. 20. *Sigara*. 21. *Corisella*. 22-23. Hemelytron: 22. *Corisella*. 23. *Sigara*. 24-25. Pronotum and head: 24. *Palmacorixa*. 25. *Corisella*. 26. Head (dorsal) *Gerris*. 27. Antenna *Rhagovelia* female (F), male (M). 28. Mesotarsus *Rhagovelia*.

15(14). Small shining corixids, males with elongate or round strigil dorsally on left side of abdomen; apex of clavus not, or scarcely, exceeding a line drawn through coastal margins at nodal furrows (Fig. 15); 2.8-4.6 mm long . . . . . ***Trichocorixa***

Male strigil, if present, on right side of abdomen (Fig. 16); apex of clavus plainly exceeding a line drawn through costal margins at nodal furrows (Fig. 16); > 4.6 mm long or with 2 black stripes on corium **16**

16(15). Dark markings on clavus transverse, those on corium transverse, longitudinal, or reticulate (Figs. 16, 23) **17**

Dark markings on clavus and corium narrow and broken, usually open reticulate with many interconnections (Fig. 22) **19**

17(16). Pruinose area at base of claval suture short, broadly rounded at apex (Fig. 17); prothoracic lobe (Fig. 1) truncate (Fig. 19); 6.3-11.4 mm long . . . . . ***Hesperocorixa***

Pruinose area at base of claval suture elongate, narrowly rounded or pointed at apex (Fig. 18); prothoracic lobe rounded (Fig. 20) **18**

18(17). Either prothoracic lobe **or** posterior third of first metatarsal segment deeply infuscate or black; corial pattern transverse and with little contrast; male strigil absent; male pala with two rows of pegs; 6.9-8.1 mm long . . . . . ***Callicorixa***

Prothoracic lobe and metatarsus pale, at most lightly infuscate; corium usually with contrasting pattern, either transverse, longitudinal, or reticulate; male strigil present; male pala usually with one row of pegs (Fig. 2); 3.6-9.2 mm long . . . . . ***Sigara***

19(16). Rear margin of head sharply curved, embracing very short pronotum (Fig. 24); interocular space much narrower than width of eye (Fig. 24); 4.0-6.0 mm long . . . . . ***Palmacorixa***

Rear margin of head gently curved (Fig. 25); interocular space about equal to width of eye (Fig. 25) **20**

20(19). Clavus rather smooth, shining; male pala triangular; prothoracic lobe tapering to narrowed apex (Fig. 21); 5.3-8.0 mm long . . . . . ***Corisella***

Clavus rastrate, dull; prothoracic lobe not narrowed **21**

21(20). Eyes protuberant with inner anterior angles broadly rounded; postocular space broad; 7.6-9.2 mm long. . . . . ***Dasycorixa***

Eyes normal; postocular space narrow; 6.8-7.8 mm long . . . . . ***Cenocorixa***

22(5). **BELOSTOMATIDAE** - 18-24 mm long. ***Belostoma***
47-65 mm long . . . . . ***Lethocerus***

23(3). **NEPIDAE** - Body oval, more than 1/3 as wide as long; 18-20 mm long . . . . . ***Nepa***

Body slender, sub-cylindrical, stick-like; 23-42 mm long . . . . . ***Ranatra***

24(7). **NOTONECTIDAE** - Slender; antenna 3-segmented; 4.1-8.3 mm long . . . . . ***Buenoa***

Robust; antenna 4-segmented; 8.5-15.5 mm long . . . . . ***Notonecta***

25(9). **GERRIDAE** - Inner margin of eyes concave behind middle (Fig. 26) **26**

Inner margin of eyes rounded **29**

26(25). Protarsomere 2 twice length of 1; pronotum shining; head with broad, transverse, basal, pale mark; 4.7-6.5 mm long . . . . . ***Neogerris***

Protarsomere 2 < 1.5 times length of 1; pronotum dull; head with narrow, broadly V-shaped, pale mark at base **27**

27(26). Pronotum black, contrasting sharply with red-brown mesonotum, and having broad yellow median and lateral stripes: 11.5-15.5 mm long . . . ***Limnoporus***

Pronotum similar in color to mesonotum, with lateral stripes lacking in species > 9 mm long **28**

28(27). Large, > 11 mm long; apical abdominal spines curve slightly outward; lotic; 11.0-16.0 mm long . . . . . ***Aquarius***

Smaller, < 11 mm long; apical abdominal spines usually curve slightly or distinctly inward; lentic or lotic; 6.8-10.8 mm long . . . . . ***Gerris***

29(25). Antennomere 1 subequal in length to 2-4 combined; 3.0-5.0 mm long . . . . . ***Metrobates***

Antennomere 1 much shorter than 2-4 combined . . **30**

30(29). Antennomere 3 with several stiff bristles (Fig. 27); 2.3-3.5 mm long . . . . . ***Rheumatobates***

Antennomere 3 with only fine pubescence; 3.0-4.3 mm long . . . . . ***Trepobates***

31.(9). **VELIIDAE** - Mesotarsus with plumose setae and leaf-like claws (Fig. 28); 3.4-4.6 mm long . ***Rhagovelia***

Mesotarsus without plumose setae; 1.5-3.0 mm long. . . . . ***Microvelia***

32(12). **HEBRIDAE** - Antenna 4-segmented; 1.7-2.2 mm long . . . . . ***Merragata***

Antenna 5-segmented; 1.8-2.2 mm long . . . . ***Hebrus***

WISCONSIN SPECIES AND REFERENCES TO ADULT KEYS

NEPOMORPHA (Bennett and Cook 1981, Hilsenhoff 1984a)

BELOSTOMATIDAE (Menke 1979)

Belostoma - flumineum

*Lethocerus - americanus, griseus, uhleri**

CORIXIDAE (Hungerford 1948)

Callicorixa - alaskensis, audeni*

Cenocorixa (Jansson 1972) - *bifida*. dakotensis, utahensis*

Corisella - edulis, tarsalis

Cymatia - americana

*Dasycorixa** - *hybrida**

Hesperocorixa (Dunn 1979) - *atopodonta, interrupta, kennicottii, laevigata, lobata, lucida, michiganensis, minorella, nitida*, obliqua, scabricula, semilucida, vulgaris*

Palmacorixa - buenoi, gillettei, nana

Ramphocorixa - acuminata

Sigara - alternata, bicoloripennis, compressoidea,

conocephala, decorata, decoratella, defecta, dolabra, douglasensis, grossolineata, hubbelli, johnstoni, knighti, lineata, mackinacensis, macropala, mathesoni, modesta*, mullettensis, penniensis, signata, solensis, transfigurata, trilineata, variabilis*

Trichocorixa (Sailer 1948) - *borealis, calva, kanza, macroceps*, naias*

NAUCORIDAE

Pelocoris - femoratus

NEPIDAE (Sites and Polhemus 1994)

Nepa - apiculata

Ranatra - fusca, kirkaldyi, nigra

NOTONECTIDAE

Buenoa (Truxal 1953) - *confusa, limnocastoris, macrotibialis, margaritacea*

Notonecta (Hungerford 1933) - *borealis, insulata, irrorata, lunata, undulata*

PLEIDAE

Neoplea (=*Plea*) - *striola*

GERROMORPHA (Hilsenhoff 1986)

GERRIDAE (Drake and Harris 1934, Kuitert 1942)

Aquarius (=*Gerris*, part) - *remigis*

Gerris (Calabrese 1974) - *alacris*, argenticollis*, buenoi, comatus, insperatus, marginatus*

Limnoporus (=*Gerris*, part) - *dissortis*

Metrobates - hesperius

Neogerris (=*Limnogonus*) - *hesione*

Rheumatobates - palosi

Trepobates (Kittle 1977) - *knighti, pictus, subnitidus*

HEBRIDAE (Porter 1950)

Hebrus - buenoi, burmeisteri

Merragata - brunnea, hebroides

HYDROMETRIDAE

Hydrometra - martini

MESOVELIIDAE (Polhemus and Chapman 1979)

Mesovelia - amoena, cryptophila*, mulsanti*

VELIIDAE (Smith and Polhemus 1978)

Microvelia - albonotata, americana, buenoi, fontinalis, hinei, pulchella

Rhagovelia - obesa, oriander

AQUATIC LEPIDOPTERA - AQUATIC CATERPILLARS

Larvae in several genera of this large, primarily terrestrial order, are associated with aquatic habitats. They feed on emergent parts of aquatic macrophytes, mine stems of these plants, or feed externally on algae, *Lemna*, or submerged parts of macrophytes; only those feeding externally in water are considered here. All are in the family Pyralidae and almost all in the subfamily Nymphulinae.

Aquatic caterpillars have three pairs of thoracic legs and pairs of prolegs ringed with hook-like crochets on abdominal segments three to seven (p. 41, Fig. 1). They are not likely to be confused with any other aquatic insect larvae. However, because terrestrial Lepidoptera may be collected inadvertently from emergent vegetation, only larvae with filamentous gills covering their body and those living in portable cases of aquatic vegetation can be recognized with certainty as being aquatic. Those that live in cases are so well camouflaged they often escape notice, even after capture with a net. Larvae occasionally become sufficiently abundant to have an impact on the aquatic plant community.

Respiration is cutaneous, and is enhanced by numerous filamentous gills in larvae of *Petrophila*, which inhabit rocks in streams, and in *Parapoynx*. At least one species has hydrofuge setae, enabling it to maintain a plastron that it uses as a physical gill. Larvae pupate in a cocoon, usually in the larval habitat. Emerging adults swim or crawl to the surface of the water; legs of species that swim have long natatory setae. Adults are nondescript small moths that hold their wings roof-like over their body and remain in the vicinity of their larval habitat. Adults of stream species crawl or swim under the water to oviposit on rocks, while those of most lentic species deposit rows of eggs just below the water's surface on the preferred food plant. Most species are univoltine or bivoltine, and have five larval instars.

Adults can be identified to species (Munroe 1972), and while larvae of several species have been reared and described, too many remain unknown to construct a reliable key. The key below, based mostly on larval descriptions by Munroe, is tentative.

PYRALIDAE (6 genera, 9 species)

Larvae inhabit a variety of permanent aquatic habitats. *Petrophila* larvae live in silken retreats on rocks in lotic environments where they feed on algae and diatoms. Larvae in the remaining genera are predominantly lentic and construct cases from their food plants. They inhabit rooted aquatic macrophytes or duckweed (*Lemna)* in ponds or along margins of streams and lakes.

KEY TO GENERA OF AQUATIC LEPIDOPTERA LARVAE IN WISCONSIN*

1. Filamentous gills present . . . . . **.2**
Filamentous gills absent . . . . . **.3**

2(1). Gills branched, with up to 400 gill filaments; larva in case of material cut from lentic food plant (*Nuphar, Potamogeton, Vallisneria,* etc.) . . . . . ***.Parapoynx***
Gills unbranched, with about 120 gill filaments; larva in retreat on rocks in lotic habitats . . . ***.Petrophila***

3(1). Larva in case or retreat constructed from its food plant; crochets not projecting from body, arranged in two almost parallel rows to form a lateral oval **4**
Larva free-living, without a case; crochets often in a circle and projecting from body . . . . . not aquatic

4(3). Living in retreats on aquatic macrophytes; anterior row of crochets more than twice length of posterior row . . . . . ***.Acentria***
Living in portable cases; anterior row of crochets never more than twice length of posterior row. . .**5**

5(4). In bogs, case of *Cephalozia;* prothorax with very large blackish-brown shield dorsally and vestigial spiracles . . . . . ***.Nymphuliella***

Case of other materials; prothorax with functional spiracles 6

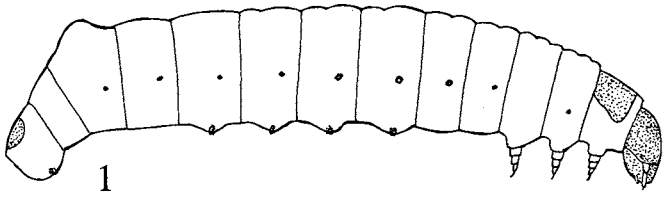
6(5). Spiracles on abdominal segments 2-4 twice as large as those on 1, and 5-8; case of *Lemna* or fragments of other plants . . . . . ***Nymphula***

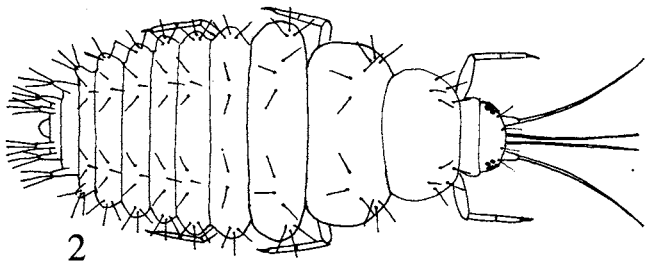
Spiracles on abdominal segments 1-4 larger than other spiracles; case of *Potamogeton, Nymphaea, Lemna,* or other plants 7

7(6). Anterior row of crochets on prolegs subequal in size to posterior row . . . . . ***Munroessa***

Anterior row of crochets on prolegs distinctly larger than posterior row . . . . . ***Synclita***

**Neocataclysta* not keyed*





Figures 1-2. Neuroptera and Lepidoptera Larvae. Fig. 1. *Nymphula* (lateral). Fig. 2. *Climacia* (dorsal).

WISCONSIN SPECIES

PYRALIDAE

Acentria - ephemerella
Munroessa - faulalis, gyralis*, icciusalis*
Neocataclysta - magnificalis**
*Nymphula - ekthlipsis**
Nymphuliella - daekealis**
Parapoynx - allionealis, badiusalis, curviferalis, maculalis, obscuralis*
Petrophila (=*Parargyractis*) *- bifascialis, canadensis**, undescribed species (Huggins)
Synclita - obliteralis

AQUATIC NEUROPTERA - SPONGILLAFLIES

Neuroptera is a fairly large terrestrial order; larvae in only one family are aquatic. They are parasitic on several genera of freshwater sponges (Spongillidae) that occur in permanent lotic or lentic habitats. Three species occur in Wisconsin, based on collections of adults.

The small (< 8 mm), setose, aquatic larvae are distinctive (Fig. 2). They have sucking mouthparts consisting of a pair of long stylets, and have no special adaptations for living in water. Oxygen is obtained from the water through the cuticle, and they swim by repeatedly arching their abdomen forward while in a vertical position and snapping it back. Eggs, pupae, and adults are terrestrial.

Most species are probably multivoltine, the larvae having three instars. Eggs are normally laid in very small masses, mostly in crevices in vegetation or supports above aquatic habitats that contain freshwater sponges. Larvae hatch after about one week, drop into the water, and swim or are carried by currents until they encounter a suitable species of sponge to parasitize. After completing development, larvae swim or crawl to shore, crawl out of the water, and spin a double-walled cocoon in a crack or crevice, or on a flat surface, which may be several meters from the water. They pupate inside the cocoon, the outer wall of which has a distinctive mesh-like construction. After several days, pharate adults use pupal mandibles to cut their way out of the cocoon and emerge. Adults feed on nectar and apparently live no more than a few weeks. Most species overwinter in sponges as larvae; some overwinter on land as prepupae in the cocoon.

SISYRIDAE - (2 genera, 3 species)

Larvae of *Climacia* were rare, being collected from only 9 sites throughout Wisconsin; larvae of *Sisyra* were not found. Larvae occurred in all sizes of streams. Most were obtained by removing sponges from the water and collecting larvae from the sponge as it dried.

KEY TO GENERA OF AQUATIC SISYRIDAE LARVAE IN WISCONSIN

1. Each pronotal sclerite with 4 anterior setae on distinct tubercles and a posterior seta on a small tubercle; dorsal sclerites on abdominal segment 6 each with 3 setae on long tubercles . . . . . ***Climacia***

Pronotal sclerites with 3 anterior setae on indistinct tubercles and 2 sessile posterior setae; dorsal sclerites on abdominal segment 6 each with 1 of 3 setae on an elongate tubercle . . . . . ***Sisyra***

WISCONSIN SPECIES AND REFERENCE TO LARVAL KEY

SISYRIDAE (Parfin and Gurney 1956)

Climacia - areolaris
Sisyra - fuscata, vicaria

AQUATIC COLEOPTERA - AQUATIC BEETLES

About 3% of Coleoptera species have an aquatic stage, but because this is the largest insect order, they constitute a large portion of the aquatic insect fauna. The 369 aquatic species collected in Wisconsin represent about one-third of the North American species of aquatic Coleoptera.

Two suborders of Coleoptera have aquatic representatives in Wisconsin. In Adephaga there are four families (Dytiscidae, Gyrinidae, Haliplidae, and Noteridae) in which all species are aquatic both as larvae and adults; they are referred to as "Hydradephaga". The suborder Polyphaga has ten families in which adults and/or larvae are aquatic. In Elmidae all adults and larvae are aquatic, and in Hydrophilidae most adults and many larvae are aquatic. In Dryopidae and Hydraenidae only adults are aquatic, and in Scirtidae, Lutrochidae, and Psephenidae only larvae are aquatic. Curculionidae has several species with aquatic adults and a few also with aquatic larvae, while Chrysomelidae has several species with aquatic larvae and two also with aquatic adults. At least one species Lampyridae has aquatic larvae. Riparian Coleoptera also are occasionally collected while sampling margins of aquatic habitats. Almost all larvae pupate on land; only Noteridae and Chrysomellidae have aquatic pupae.

Adult water beetles are 1 to 42 mm long and vary greatly in structure. All have chewing mouthparts, shell-like mesothoracic wings called elytra, and spiracles to obtain atmospheric oxygen for respiration. Adult Adephaga carry a bubble of air under their elytra, which is renewed by swimming to the surface and breaking the surface film with the tip of the abdomen. In oxygen-poor water, the air supply is renewed frequently, but in oxygen-rich water or in cold water, which slows metabolism, beetles may remain submerged for long periods. Adults of a few species obtain oxygen from plants. Elmidae and Dryopidae adults (riffle beetles) live in oxygen-rich water and maintain a plastron of air that is carried on hydrofuge setae. The plastron is a physical gill, with oxygen for respiration diffusing into it from the water, and carbon dioxide from respiration diffusing out. Other Polyphaga adults retain air on hydrofuge setae, which they must renew by swimming (most Hydrophilidae) or crawling (Hydraenidae and some Hydrophilidae) to the surface. Adult Polyphaga break the surface film with their antennae.

Size and general morphology of aquatic Coleoptera larvae varies widely. They have three pairs of thoracic legs, chewing or biting mouthparts, and most are relatively well sclerotized, especially in the last instar. Some have lateral filaments and resemble Megaloptera larvae. Most rely on cutaneous respiration, which may be enhanced by gills or filaments. Some larger larvae of Dytiscidae and Hydrophilidae obtain oxygen at the water's surface through posterior spiracles. Larvae of Chrysomellidae and Noteridae are able to utilize oxygen from plant tissues, and by this mechanism are able to pupate under water. Early instars of Coleoptera larvae lack lateral spiracles, but in almost all genera larvae have lateral abdominal and mesothoracic spiracles in the final instar, which allows them to leave the water to pupate on land.

Adults of Dytiscidae, Noteridae, Haliplidae, and many Hydrophilidae are adapted for swimming by having long natatory setae or swimming hairs on at least their metathoracic legs; Gyrinidae adults have greatly flattened legs for swimming. Larvae of some Dytiscidae also have natatory setae on their legs, but most aquatic Coleoptera larvae crawl on vegetation or other substrates. Gyrinidae larvae swim rapidly with an undulating motion when disturbed. Life cycles, habitat, feeding habits, and distribution vary widely from family to family.

Much of the taxonomy of adult water beetles in North American was completed more than 50 years ago, but some genera still need revision and several species remain undiscovered. Adults of almost all species can be reliably identified, but their distribution remains poorly defined in North America because aquatic beetles have not been studied in many areas.

Unlike adults, very few larvae can be identified to species, and a few cannot even be identified to genus; parts of the generic key to Wisconsin larvae must be considered tentative. In most genera too few species are known to permit development of reliable keys. To develop larval keys, larva-adult associations must be obtained by laboratory rearing. The most promising method for doing this is to capture mated females, or male-female pairs, allow females to oviposit, and then rear larvae that hatch from the eggs. By using this "ex ovo" method (Alarie et al. 1989), all larval instars can be associated with the adult.

ADEPHAGA

DYTISCIDAE - Predaceous Water Beetles (32 genera, 143 species)

Most genera are fairly common to abundant, and widely distributed in Wisconsin. In order of abundance, the most abundant are *Hygrotus, Neoporus, Laccophilus, Hydroporus, Agabus, Liodessus, Acilius, Coptotomus, Colymbetes,* and *Graphoderus.* Uncommon and rare genera include *Oreodytes* and *Lioporeus* (very rare), *Heterosternuta* and *Sanfilippodytes* (rare), and *Agabetes, Celina, Copelatus,* and *Nebrioporus* (uncommon). Other genera are fairly common to common. Both larvae and adults are predators, mainly on other aquatic arthropods; adults are also scavengers. Larvae have 3 instars, with most species completing development in spring or early summer and pupating on land. Adults emerge in late spring or summer; most overwinter in the water or in protected terrestrial sites. A few species overwinter as larvae, especially lotic species, and some overwinter as eggs. Life cycles and ecology of Wisconsin species were described by Hilsenhoff (1992, 1993a,b,c, 1994, 1995a). Larvae and adults of most species inhabit a variety of shallow, debris-laden, or vegetation-choked lentic habitats; many are not very habitat specific. Lotic species include all *Heterosternuta, Lioporeus, Nebrioporus, Oreodytes,* and *Sanfilippodytes,* some *Agabus* and many *Neoporus*; many lentic species enter streams or deeper lentic habitats in autumn to overwinter. Adults often fly, especially just after emergence; occasionally they are collected at lights. Bottle traps are especially advantageous for collecting larger adult Dytiscidae (Hilsenhoff 1987).

GYRINIDAE - Whirligig Beetles (2 genera, 25 species)

Adults and larvae of *Dineutus* and *Gyrinus* are common inhabitants of Wisconsin's ponds, lakes, and streams. Larvae complete 3 instars during late spring and summer, and pupate on shore. Adults emerge in summer and often congregate in large schools of mixed species. Most species that inhabit ponds fly to wintering sites along large streams and lakes in

autumn and return to lentic habitats in early spring. Larvae are predators; adults are scavengers. Special efforts are needed to capture adult Gyrinidae, which swim on the surface in deeper water. In late summer large schools often appear in shallow bays of lakes and streams where they can be captured with a net after herding them toward shore. Lentic and lotic species congregate in streams in the fall to overwinter, and very large numbers of mixed species can be collected with a net from undercut banks where there is a current and the water is at least 1/2 meter deep.

HALIPLIDAE - Crawling Water Beetles (2 genera 19 species)

Adults and larvae of *Haliplus* and *Peltodytes* occur among matted vegetation and debris along shores of lakes, ponds, and slow streams; often they are abundant. Eggs are laid in the spring, larvae complete three instars on vegetation where they feed mostly on algae, and then pupate on shore under a stone or log. The aquatic adults, which emerge in spring or summer, are also mostly herbivorous. Adults and some larvae overwinter in terrestrial as well as aquatic habitats.

NOTERIDAE - Burrowing Water Beetles (2 genera, 2 species)

Although adults resemble small Dytiscidae in structure and habits, larvae are very different. The herbivorous larvae feed on plant roots and pupate within air-filled cocoons on roots in late summer. Adults emerge in autumn and overwinter. *Suphisellus* is uncommon in southern Wisconsin, and *Hydrocanthus* is very rare.

POLYPHAGA

CHRYSOMELIDAE (3 genera, 22 species)

Larvae and pupae in three genera inhabit and feed upon roots, rhizomes, and stems of aquatic plants, but are infrequently collected. *Donacia* larvae occur mostly on burreed and water lilies (*Sparganium, Nymphaea,* and *Nuphar), Neohaemonia* larvae usually inhabit *Potamogeton, and Plateumaris* larvae feed on a variety of aquatic plants. Oxygen is obtained from the plant through caudal spines, but larvae are capable of prolonged submergence without attachment to a plant. Adults of two species are also aquatic, feeding on plant stems; they cannot be readily separated from other Chrysomelidae and are difficult to identify.

CURCULIONIDAE - Weevils (9 genera, 28 species)

Species in several genera of this very large family have adapted to the aquatic environment. Larvae and adults feed on aquatic host plants, which are usually specific for each species of weevil. Larvae are miners and borers; a few are aquatic and may swim from plant to plant. *Lissorhoptrus* larvae feed externally on roots of aquatic plants. Adults have varied aquatic adaptations. Most can swim, some walk on the surface of the water, but most of the time they simply crawl under water on their food plant. Numbers of these beetles in collections are usually not representative of their abundance because of nocturnal activity patterns. Terrestrial species that feed on emergent or riparian vegetation occasionally are collected while sampling aquatic habitats, and cannot be separated from aquatic species by the key. The most recent key to curculionid genera is Kissinger (1964).

DRYOPIDAE - Long-toed Riffle Beetles (1 genus, 2 species)

The environment and habits of *Helichus* adults are very similar to those of Elmidae, but larvae are not aquatic. Although distributed statewide, they are most common in the southwestern Wisconsin.

ELMIDAE - Riffle Beetles (6 genera, 24 species)

Larvae and adults are common in waterlogged wood (*Macronychus, Ancyronyx, Stenelmis, Dubiraphia),* in gravel substrate of streams (*Stenelmis, Optioservus),* and among stream vegetation (*Dubiraphia);* they occasionally occur along margins of clean lakes (*Ancyronyx, Macronychus, Stenelmis, Dubiraphia)* and in spring ponds (*Dubiraphia). Microcylloepus* is rare in clean streams of central and northwest Wisconsin. The herbivorous larvae have about six instars, and most species are probably semivoltine. Adults are also herbivores, and may live more than a year. Upon emergence from the terrestrial pupal chamber, they fly and disperse widely, but after entering water they rarely leave the aquatic environment.

HYDRAENIDAE - Minute Moss Beetles (2 genera, 3 species)

Adults of *Hydraena* and *Ochthebius* live in very shallow water along margins of streams and ponds; larvae are riparian. A third genus, *Gymnochthebius,* probably also occurs in Wisconsin. Adults are scavengers, feeding on dead animals and plant material. Very few have been collected in Wisconsin because of their very small size (1-2 mm) and because no special effort has been made to collect them. Adults are most easily collected by disturbing their substrate, and collecting them from the surface film (Perkins 1976). Because they cannot swim and float ventral side up, their shiny air-bubble can be easily seen and many can be collected with a small net or strainer.

HYDROPHILIDAE - Water Scavenger Beetles (15 genera, 75 species)

Adults are aquatic, except those In the subfamily Sphaeridiinae. Occurring statewide are *Tropisternus, Enochrus, Hydrochus, Anacaena, Berosus,* and *Helophorus* (abundant), *Hydrochara, Paracymus,* and *Hydrobius* (very common), and *Cymbiodyta, Hydrophilus,* and *Laccobius* (common). Adults of *Crenitis* and *Sperchopsis* are rare and those of *Helocombus* adults are uncommon. Larvae of *Berosus, Tropisternus, Hydrochara,* and *Hydrophilus* are aquatic: in other genera larvae are riparian. Some riparian larvae (*Cymbiodyta, Enochrus, Helocombus, Hydrobius,* and *Sperchopsis)* live close to the water and may be collected while sampling aquatic habitats. Most adults are primarily lentic, preferring weedy ponds, marshes, swamps, and lake margins. Adults of *Sperchopsis, Crenitis,* some species of *Cymbiodyta* and *Laccobius,* and single species of *Tropisternus* and *Hydrobius* are lotic. Larvae have 3 instars and are predators, while adults are scavengers that feed on a variety of

food. Almost all species are univoltine, with larvae being most numerous in spring and early summer, and adults being most abundant in late summer and autumn. Some lotic species are semivoltine and occasionally a second generation occurs in some univoltine species. Most species overwinter as adults in aquatic or terrestrial habitats; larvae or eggs of a few species overwinter. *Tropisternus* adults frequently use stream margins as overwintering sites. Life cycles and habitats were described by Hilsenhoff (1995b,c).

LAMPYRIDAE (1 genus)

Larvae of at least one genus occur uncommonly in shallow lentic and semilotic habitats. They are predaceous, feeding on snails or other insects.

LUTROCHIDAE (1 genus, 1 species)

Larvae of *Lutrochus* are very rare in warm, calcareous streams in southeast Wisconsin where they occur on submerged wood and in travertine encrustations on rocks in shallow riffles. The riparian adults enter the water to oviposit on wood or travertine.

PSEPHENIDAE - Water Penny Beetles (2 genera, 3 species)

Only larvae are aquatic, attaching to rocks in streams or windswept lake shores where they scrape algae and diatoms from rocks. They apparently have 6 instars and a two-year life cycle. Pupation occurs in summer on moist rocks near the stream; adults emerge in less than 2 weeks. Adults are riparian, but enter the water to oviposit. *Ectopria* larvae are fairly common statewide, while *Psephenus* larvae are confined to eastern Wisconsin, where they are numerous in some streams.

SCIRTIDAE (=HELODIDAE) - Marsh Beetles (4 genera, 21 species)

The herbivorous larvae can be frequently found in a variety of shallow lentic habitats, including tree holes. Almost nothing is known about their life cycle or biology, and larvae cannot be identified to species. Larvae of *Cyphon* are fairly common statewide in marshes and margins of ponds and streams, those of *Scirtes* are uncommon in lentic habitats, and *Prionocyphon* and *Flavohelodes* larvae are rare, the latter being found mostly in tree holes.

KEY TO GENERA OF ADULT AQUATIC COLEOPTERA IN WISCONSIN

1. Head formed into a snout or beak anteriorly (Fig. 1); antenna geniculate (Fig. 1) . . . . . .CURCULIONIDAE **69**

Head not formed into a beak or snout; antenna not geniculate **2**

2(1). A dorsal and a ventral pair of eyes divided by sides of head; meso- and metathoracic legs short,flattened; tarsi folding fan-wise . . . . . .GYRINIDAE **10**

One pair of eyes; meso- and metathoracic legs not extremely flat; tarsi not folded fan-wise **3**

3(2). Metacoxae expanded into large plates that cover 2 or 3 abdominal sterna and bases of metafemora (Fig. 2) . . . . . .HALIPLIDAE **11**

Metacoxae not expanded into large plates **4**

4(3). Prosternum with postcoxal process extending to mesocoxae (Fig. 3); first visible abdominal sternum completely divided by metacoxae (Fig. 3) **5**

Prosternum with postcoxal process absent or short; first visible abdominal sternum entirely posterior to metacoxae (Fig. 4) **7**

5(4). Ventral surface of body in lateral view with anterior of prosternum, its postcoxal process, and meso- and metasternum in same plane (Fig. 5); pro- and mesotarsi distinctly 5-segmented, segment 4 as long as 3 . . . . . .**6**

Ventral surface of body in lateral view with anterior of prosternum greatly depressed and not in same plane as its postcoxal process and meso- and metasternum (Fig. 6); pro- and mesotarsi apparently 4-segmented (except *Bidessonotus)* with segment 4 very small and concealed between lobes of segment 3; < 7 mm long . . . . . DYTISCIDAE (part) **14**

6(5). Prosternal process usually spear-shaped, and pointed apically, or rounded apically; protibia without large, curved, apical spur; > 4 mm long . . . . . DYTISCIDAE (part) **30**

Prosternal process widened and nearly truncate apically; protibia with large, curved spur at apex (Fig. 7); < 5.5 mm long . . . . . NOTERIDAE **13**

7(4). Antenna short, club-shaped, with segment 4, 5, or 6 modified to form a cupule (Fig. 8); maxillary palp usually longer than antenna **8**

Antenna filiform or pectinate, usually longer than maxillary palp **9**

8(7). Antenna with 5 segments past cupule; < 2.5 mm long . . . . . HYDRAENIDAE **45**

Antenna with 3 segments past cupule; 1.5-40 mm long . . . . . .HYDROPHILIDAE **47**

9(7). Antenna slender, filiform; < 4.5 mm long . . . . . ELMIDAE **64**

Antenna short with pectinate club (Fig. 9); 5.0-6.3 mm long . . . . . .**DRYOPIDAE, *Helichus***

10(2). **GYRINIDAE** - Scutellum visible; elytra with distinct rows of sharp punctures; 3.4-8.2 mm long ***.Gyrinus***

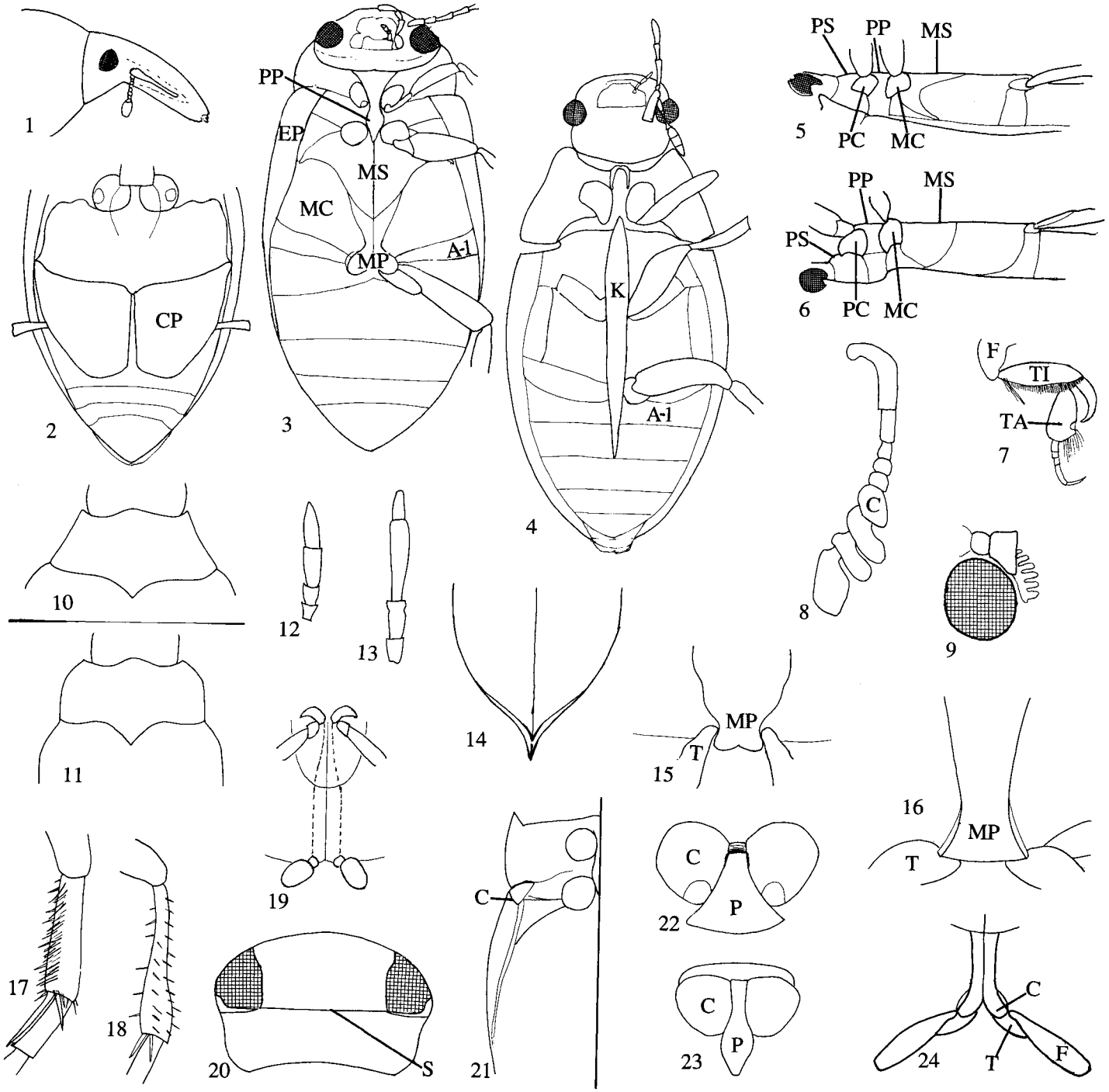
Scutellum not visible; elytral punctures scattered and indistinct; 10.0-13.1 mm long . . . . . ***Dineutus***

11(3). **HALIPLIDAE** - Pronotum with sides widest at base convergent anteriorly (Fig. 10) **12**

Pronotum with sides of basal 2/3 nearly parallel (Fig. 11); 4.0-4.5 mm long . . . . . ***.Brychius***

12(11). Last maxillary palpomere conical, about as wide and long as next to last (Fig. 12); pronotum with a pair of black, basal spots; 3.3-4.5 mm long . . . . . ***.Peltodytes***

Last maxillary palpomere narrower and much shorter than next to last (Fig. 13); pronotum sometimes with basal black mark, but without paired black spots 2.5-4.9 mm long . . . . . ***.Haliplus***



Figures 1-24. Coleoptera Adults. 1. Head Curculionidae. 2. Metasternum and abdomen *Haliplus* with metacoxal plates (CP). 3. *Agabus* (ventral) with prosternal process (PP), epipleuron (EP), abdominal segment 1 (A-1), metacoxal process (MP), metacoxal plates (MC) and metasternum (MS). 4. *Tropisternus* (ventral) with abdominal segment 1 (A-1) and sternal keel (K). 5-6. Thoracic sterna (lateral - ventral side up) showing prosternum (PS), prosternal process (PP), mesosternum (MS), procoxa (PC), and mesocoxa (MC): 5. *Agabus*. 6. *Hydroporus*. 7. Profemur (F), tibia (TI) and tarsus (TA) *Hydrocanthus*. 8-9. Antenna: 8. *Tropisternus* (ventral) with cupule (C). 9. *Helichus* (dorsal). 10-11. Pronotum: 10. *Haliplus*. 11. *Brychius*. 12-13. Antenna: 12. *Peltodytes*. 13. *Haliplus*. 14. Apex elytra and abdomen *Celina*. 15-16. Metacoxal process (MP) and trochanter (T): 15. *Desmopachria*. 16. *Hydroporus*. 17-18. Metatibia: 17. *Desmopachria*. 18. *Liodessus*. 19. Metasternum *Bidessonotus*. 20. Head (dorsal) *Liodessus* with transverse suture (S). 21. Right meso- and metasternum *Hygrotus* with carina (C) on epipleuron. 22-23. Procoxae (C) and prosternal process (P): 22. *Hydrovatus*. 23. *Hygrotus*. 24. Metacoxal lobes (C), trochanters (T), and femora (F) *Laccornis*.

13(6). **NOTERIDAE** - Elytra with transverse pale fascia; small, 2.9-3.3 mm long . . . . . ***Suphisellus***
Elytra without transverse fascia; larger, 4.9-5.3 mm long . . . . . ***Hydrocanthus***

14(5). **DYTISCIDAE** (in part) - Apices of elytra and last abdominal sternum produced into sharp point (Fig. 14); scutellum visible; 3.8-4.6 mm long . . . ***Celina***
Apex of elytra and abdomen not produced into sharp point; scutellum covered by elytra **15**

15(14). Metacoxal process not produced laterally, base of trochanter entirely visible in ventral view (Fig. 15); < 2.2 mm long **16**
Metacoxal process produced laterally, obscuring base of trochanter in ventral view (Figs. 16, 24-28); > 2.3 mm long (except *Hygrotus farctus,* which has spine-like tubercle on prosternum **19**

16(15). Metatibia straight, almost uniform in width (Fig. 17); metatarsal claws unequal; 1.7-2.0 mm long. . . . . ***Desmopachria***
Metatibia arcuate, narrow at base (Fig. 18); metatarsal claws equal in length **17**

17(16). Pro- and mesotarsi distinctly 5-segmented, segment 3 linear; metasternum slightly depressed, with metacoxal lines converging anteriorly across mid-metasternum to nearly meet at mesocoxae (Fig. 19); 1.9-2.2 mm long . . . . . ***Bidessonotus***
Pro- and mesotarsi appear 4-segmented, segment 3 bilobed; metasternum not depressed and metacoxal lines not continuing onto mid-metasternum **18**

18(17). Head with transverse suture between posterior margin of eyes (Fig. 20); 1.6-2.2 mm long . . . . ***Liodessus***
Head without transverse suture between posterior margin of eyes; 1.6-2.0 mm long . . . . . ***Uvarus***

19(15). Diagonal carina crossing epipleura near base (Fig. 21) **20**
No carina crossing epipleura near base **21**

20(19). Prosternal process fan-shaped, broadly rounded at apex, as wide as procoxa (Fig. 22); 2.4-2.6 mm long . . . . . ***Hydrovatus***
Prosternal process spear-shaped, pointed at apex, much narrower than procoxa (Fig. 23); 1.9-5.4 mm long . . . . . ***Hygrotus***

21(19). Base of metafemur reaching metacoxal lobe (Fig. 24); 4.5-7.2 mm long . . . . . ***Laccornis***
Metafemur separated from metacoxal lobe by part of trochanter **22**

22(21). Posterior margin of metacoxal process incised at middle, with lateral lobes rounded (Fig. 25) . . . **23**
Posterior margin of metacoxal process truncate (Fig. 26), angularly prominent at middle (Fig. 27), or sinuate laterad of middle (Fig. 28) **25**

23(22). Metacoxal plate (Fig. 3) micropunctate and with many large punctures; pronotum with distinct sulci laterally; 3.4-4.9 mm long . . . . . ***Oreodytes***
Metacoxal plate densely micropunctate, without large punctures; pronotum without lateral sulci **24**

24(23). Outline of pronotum and elytra forming a relatively uniform arc; lateral margin of elytron without subapical tooth; 3.9-5.0 mm long . . . ***Stictotarsus***
Outline of pronotum and elytra not forming a uniform arc, posterior angles of pronotum rounded; lateral margin of elytron with small, acute, subapical tooth; 4.8-5.4 mm long . . . . . ***Nebrioporus***

25(22). Apex of metacoxal process truncate, or nearly so (Fig. 26); dorsum dark rufous to black, without distinct maculae or vittae; lentic; 2.5-6.4 mm long . . . . . ***Hydroporus***
Apex of metacoxal process angulate at middle (Figs. 27-28); dorsum often maculate or vittate; lentic or lotic **26**

26(25). Apex of metacoxal process not distinctly sinuate laterad of middle (Fig. 27) **27**
Apex of metacoxal process distinctly sinuate laterad of middle (Fig. 28) **28**

27(26). Ovate, distinctly < twice as long as wide; if venter is black, pronotum lacks infuscations; penis not bifid; elytra with dark stripes or pale maculae; lentic or lotic; 2.2-4.8 mm long . . . . . ***Neoporus***
Elongate, at least twice as long as wide or nearly so or with black venter and pronotal infuscations; penis bifid; elytra usually distinctly fasciate; lotic; 3.1-4.0 mm long . . . . . ***Heterosternuta***

28(26). Elytra widest in basal third, tapering to narrow apex; each elytron with 2 large, square, pale areas and a pale apex; lotic; 3.5-4.4 mm long . . . . ***Lioporeus***
Elytra usually widest at or past middle; elytra without large, square, pale areas; lotic or lentic. **29**

29(28). Metatrochanter relatively short and stout, length of posterior margin slightly > half distance from its distal apex to apex of femur; lentic; 2.9-4.2 mm long . . . . . ***Hydroporus oblitus*-group**
Metatrochanter relatively long, length of posterior margin nearly equal to distance from its distal apex to apex of femur; lotic; 2.7-3.5 mm long . . . . . ***Sanfilippodytes***

30(6). **DYTISCIDAE** (in part) - Very large, 23-42 mm long **31**
Smaller, 4-18 mm long **32**

31(30). Large spurs at apex of metatibia subequal in width; beetle widest near middle; 25-42 mm long . . . . . ***Dytiscus***
One large spur at apex of metatibia twice as broad as other; beetle widest at posterior third; 27-34 mm long . . . . . ***Cybister***

32(30). Scutellum not visible; metatarsus with a single stout claw; 3.9-5.5 mm long . . . . . ***Laccophilus***
Scutellum fully visible; metatarsus with 2 claws . **33**

33(32). Anterior margin of eye emarginate above base of antenna (Fig. 29) **34**
Eye not emarginate above base of antenna **42**

34(33). Prosternum with median longitudinal furrow from near front margin to apex of prosternal process; 7.5-9.4 mm long . . . . . ***Matus***
Prosternum without longitudinal furrow **35**

35(34). Elytra uniformly brown, with 8 to 10 impressed, longitudinal striae on each elytron; mesal margins of metacoxae coming so close together posteriorly they almost touch median line of metacoxal process (Fig. 30); 4.5-5.5 mm long ..... ***Copelatus***

Elytra without 8 to 10 impressed longitudinal striae; metacoxal lines not converging so close to median line (Fig. 3); > 5.6 mm long **36**

36(35). Metatarsal claws subequal in length **37**

Metatarsal claws distinctly unequal in length **39**

37(36). Elytra densely sculptured with short, deep, irregular, longitudinal aciculations; apex of maxillary palp conical (Fig. 31) ..... ***Agabetes***

Elytra without aciculations, or aciculations becoming transverse apically; last segment of maxillary palp emarginate or truncate (Figs. 32-33) **38**

38(37). Elytra irrorated with dark blotches on a pale background; thoracic sterna pale; last segment of maxillary palp widened and emarginate apically (Fig. 32); 7.0-8.5 mm long ..... ***Coptotomus***

Elytra usually dark, **if vittate**, thoracic sterna are black; last segment of maxillary palp truncate to slightly emarginate apically (Fig. 33) .... ***Agabus***

39(36). Larger, > 13.5 mm long **40**

Smaller, < 13.0 mm long **41**

40(39). Elytra sculptured with numerous parallel transverse grooves; 14.1-18.1 mm long ..... ***Colymbetes***

Elytra without parallel transverse grooves; 13.7-16.7 mm long ..... ***Neoscutopterus***

41(39). Yellow dorsally, with black markings **or** entirely black with posterior margin of pronotum deeply sinuate (Fig. 34); 9.5-11.9 mm long .... ***Rhantus***

Black dorsally, usually with sub-apical and sub-lateral yellow spots on elytra, and two rufous spots on head; posterior margin of pronotum not sinuate (Fig. 35); 7.5-12.9 mm long ..... ***Ilybius***

42(33). Outer margin of metasternal wing straight (Fig. 36); outer spur at apex of metatibia acute; 10.8-15.2 mm long ..... ***Hydaticus***

Outer margin of metasternal wing arcuate (Fig. 37); outer spur at apex of metatibia blunt, more or less emarginate **43**

43(42). Elytra densely punctate, usually fluted and setose in females; 10.6-16.6 mm long ..... ***Acilius***

Elytral punctation extremely fine or absent; females without fluted elytra **44**

44(43). Posterior margin of mesofemur with stiff setae as long as or longer than width of femur (Fig. 38); 9.4-14.4 mm long ..... ***Thermonectus***

Setae on posterior margin of mesofemur about half as long as width of femur (Fig. 39); 10.4-16.0 mm long ..... ***Graphoderus***

45(8). **HYDRAENIDAE** - Maxillary palpomere 3 longer, broader than 4; pronotum with transparent borders **46**

Maxillary palpomere 3 not longer, broader than 4; pronotum without transparent borders .. ***Hydraena***

46(45). Sclerotized area of pronotum with anterolateral lobes and with pair of emarginations on each side separated by a sharp point (Fig. 40) ..... ***Gymnochthebius***

Sclerotized area of pronotum lacking anterolateral lobes and with only posterolateral emarginations (Fig. 41) ..... ***Ochthebius***

47(8). **HYDROPHILIDAE** - Pronotum with 7 longitudinal grooves, including marginal grooves; 2.0-7.1 mm long ..... ***Helophorus***

Pronotum without 7 longitudinal grooves **48**

48(47). Pronotum much narrower than elytral base and scutellum very small (Fig. 42); pronotum granular or with large punctures; 2.2-5.3 mm long ..... ***Hydrochus***

Pronotum not much narrower than base of elytra, **or** scutellum elongate; pronotum not granular, large punctures lacking **49**

49(48). First 2 abdominal sterna excavated, usually containing a hyaline mass supported by dense setal fringe on first abdominal sternum; small, < 2.0 mm long ... ***Chaetarthria*** (riparian)

First 2 abdominal sterna not excavated **50**

50(49). Metatarsus 5-segmented with segment 1 much longer than 2: antenna usually longer than maxillary palp, with palpomere 2 much thicker than 3 or 4 ..... **SPHAERIDIINAE** (terrestrial)

Metatarsus 4-segmented, or 5-segmented with segment 1 much shorter than 2; antenna subequal to or shorter than maxillary palp, with palpomere 2 subequal in thickness to 3 and 4 ..... **51**

51(50). Meso- and metasternum with continuous, median, longitudinal keel, prolonged posteriorly into a spine between metacoxae (Fig. 4) **52**

Meso- and metasternum without continuous, median, longitudinal keel **55**

52(51). Length 8-19 mm **53**

Length 31-42 mm **54**

53(52). Prosternum sulcate (Fig. 4) to receive anterior part of keel; smaller, 8.0-12.1 mm long. .... ***Tropisternus***

Prosternum carinate; larger, 14.8-18.9 mm long ... ***Hydrochara***

54(52). Prosternum sulcate, closed anteriorly; 33-42 mm long ..... ***Hydrophilus***

Prosternum bifurcate, open anteriorly; 31-36 mm long ..... ***Dibolocelus***

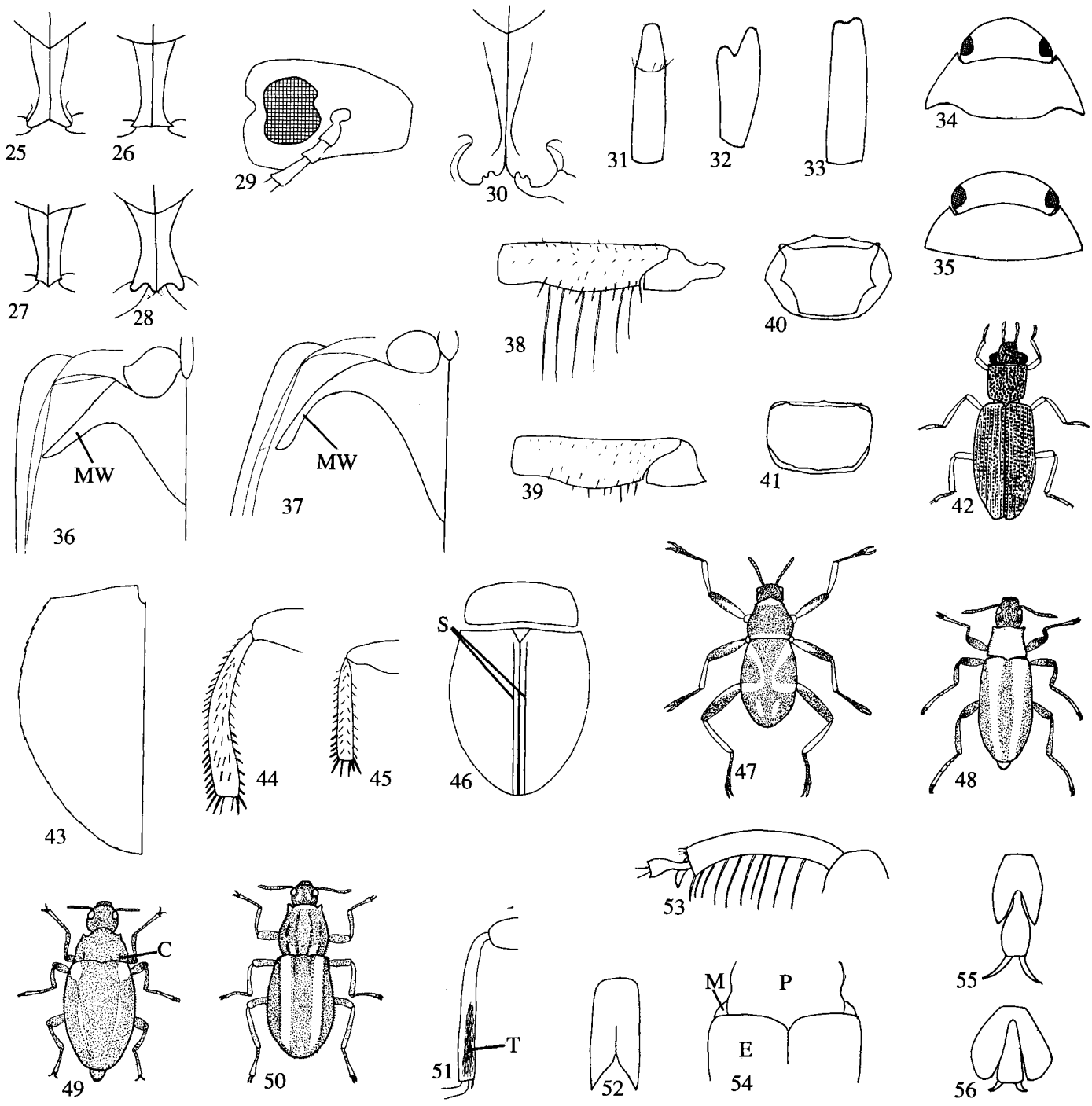
55(51). Meso- and metatibia with fringe of long natatory setae; head strongly deflexed; scutellum elongate; 3.3-7.1 mm long ..... ***Berosus***

Meso-and metatibia without fringe of long natatory setae; head not strongly deflexed; scutellum almost as wide as long **56**

56(55). Apical maxillary palpomere longer than penultimate palpomere; maxillary palp short, about same length as antenna, except in ***Sperchopsis*** **57**

Penultimate maxillary palpomere as long or longer than apical palpomere; maxillary palp elongate, distinctly longer than antenna **62**

57(56). Larger, > 6.0 mm long **58**



Figures 25-56. Coleoptera Adults. 25-28. Metacoxal process: 25. *Stictotarsus*. 26. *Hydroporus*. 27. *Neoporus*. 28. *Hydroporus oblitus*-group. 29. Head (lateral) *Agabus*. 30. Metacoxal process *Copelatus*. 31-33. Terminal maxillary palpomere: 31. *Agabetes*. 32. *Coptotomus*. 33. *Agabus*. 34-35. Pronotum and head: 34. *Rhantus sinuatus*. 35. *Ilybius*. 36-37. Metasternum with metasternal wing (MW): 36. *Hydaticus*. 37. *Acilius*. 38-39. Mesofemur: 38. *Thermonectus*. 39. *Graphoderus*. 40-41. Pronotum: 40. *Gymnochthebius*. 41. *Ochthebius*. 42. *Hydrochus* (dorsal). 43. Elytron *Sperchopsis*. 44-45. Metatibia: 44. *Laccobius*. 45. *Anacaena*. 46. Elytra *Anacaena* with sutural striae (S). 47-50 (dorsal): 47. *Ancyronyx*. 48. *Dubiraphia*. 49. *Optioservus* with carina (C). 50. *Stenelmis*. 51. Protibia (posterior) *Microcylloepus* with tomentum (T). 52. Tarsal claws *Lixus*. 53. Mesotibia *Lissorhoptrus*. 54. Pronotum (P), elytra (E), and mesoepimeron (M) *Litodactylus*. 55-56. Metatarsomeres 3-4: 55. *Onychylis*. 56. *Endalus*.

Smaller, < 3.4 mm long 59

58(57). Lateral margins of elytra weakly serrate basally (Fig. 43); meso- and metatarsi with scattered fine setae dorsally; elytra and venter brown; lotic; 7.9-9.3 mm long . . . . . ***Sperchopsis***

Lateral margins of elytra without serrations; meso- and metatarsi with dorsal fringe of fine natatory setae; elytra green, rust, or olive, venter black; lotic or lentic; 6.0-9.7 mm long . . . . . ***Hydrobius***

59(57). Metatibia arcuate (Fig. 44); elytra without sutural striae; 2.2-3.6 mm long . . . . . ***Laccobius***

Metatibia not arcuate (Fig. 45); elytra with sutural striae (Fig. 46) **60**

60(59). Metafemur shiny ventrally, at most sparsely pubescent at base; elytra usually with greenish or olive reflections; prosternum longitudinally carinate; 1.2-3.0 mm long . . . . . ***Paracymus***

Metafemur densely pubescent ventrally in basal 3/4 or with distinct microsculpture; elytra without greenish or olive reflections; prosternum not carinate . . . **61**

61(60). Metafemur dull, densely pubescent ventrally in basal 3/4; eye anteriorly not protruding from margin of head; lotic or lentic; 2.1-3.0 mm long . . ***Anacaena***

Metafemur rather shiny with longitudinal microsculpture, not densely pubescent; eye anteriorly protruding from margin of head; lotic; 2.6-3.4 mm long . . . . . ***Crenitis***

62(56). Ten deeply impressed striae on each elytron; 6.4-8.0 mm long . . . . . ***Helocombus***

Elytral striae, if present, weak and confined to mesal and lateral areas **63**

63(62). All tarsi 5-segmented, first segment very short; 3.0-8.3 mm long . . . . . ***Enochrus***

Meso- and metatarsi 4-segmented; 3.0-6.3 mm long. . . . . ***Cymbiodyta***

64(9). **ELMIDAE** - Elytra with conspicuous orange, crescent-shaped markings (Fig. 47); legs very long; 2.4-3.0 mm long . . . . . ***Ancyronyx***

Elytra without orange, crescent-shaped markings . . **65**

65(64). Unicolorous dark brown elytra; antenna short, 7-segmented, curled under eye; legs very long as in Fig. 47; 2.8-3.6 mm long . . . . . ***Macronychus***

Usually with pale marks or stripes on elytra (Figs. 48-50); antenna long, 11-segmented, projecting from head; legs usually shorter (Figs. 48-50) **66**

66(65). Surface of pronotum smooth, except for basal carinae and/or punctures (Figs. 48-49) **67**

Surface of pronotum rough, with costae, granules, sulci, and tubercles (Fig. 50) **68**

67(66). Pronotal surface smooth, except for punctures; lateral margin of pronotum smooth; elongate beetles (Fig. 48); 2.0-3.5 mm long . . . . . ***Dubiraphia***

Pronotal surface with basal carinae (Fig. 49); lateral margin of pronotum weakly serrated; ovate beetles . . . . . ***Optioservus***

68(66). Larger, 2.7-4.5 mm long; tomentum absent from protibia . . . . . ***Stenelmis***

Smaller, 1.8-2.3 mm long; tomentum present on protibia (Fig. 51) . . . . . ***Microcylloepus***

69(1). **CURCULIONIDAE** - Funicle of antenna 7-segmented (Fig. 1) **70**

Funicle of antenna 6-segmented **72**

70(69). Tarsal claws fused at base (Fig. 52); large, elongate beetles > 10 mm long . . . . . ***Lixus***

Tarsal claws distinctly separated at base; smaller, usually < 10 mm long **71**

71(70). Prosternum with deep median anterior sulcus to receive rostrum; **and/or** metatarsomere 3 linear or cordate, not bilobed; **and/or** ≤ 3 mm long ***Bagous***

Prosternum without rostral sulcus; metatarsomere 3 distinctly bilobed; beetles ≥ 3.5 mm long . . . . . ***Listronotus***

72(69). Mesotibia strongly curved and with long natatory setae (Fig. 53); metatarsomere 3 usually simple; antennal club asymmetrical, apical 1/10 pubescent . . . . . ***Lissorhoptrus***

Mesotibia without long natatory setae; metatarsomere 3 bilobed or emarginate; antennal club symmetrical, completely pubescent **73**

73(72). Elytral humerus truncated, exposing strongly ascending mesoepimeron in dorsal view (Fig. 54) **74**

Elytral humerus not truncated, not exposing mesoepimeron in dorsal view **75**

74(73). Tarsi lacking long, fine setae; lateral tubercles of pronotum large and acute; interval 5 of elytra strongly elevated at base . . . . . ***Phytobius***

Tarsi with fine, sparse setae as long as, or longer than diameter of tarsal segments; pronotal tubercles not prominent, reduced; elytral interval 5 not elevated at base . . . . . ***Euhrychiopsis***

75(73). Frons between eyes 1/2 as wide as rostrum at base of antennae; < 1.75 mm long . . . . . ***Tanysphyrus***

Frons not narrower than rostrum at base of antennae; > 1.75 mm long **76**

76(75). Metatarsomere 4 distinctly projecting beyond lobes of 3 (Fig. 55); < 2.5 mm long . . . . . ***Onychylis***

Metatarsomere 4 not or barely projecting beyond lobes of 3 (Fig. 56); usually > 2.5 mm long . . ***Notiodes***

KEY TO GENERA OF AQUATIC COLEOPTERA LARVAE IN WISCONSIN*

1. Each tarsus with 2 claws **2**

Each tarsus with 1 claw **4**

2(1). Abdomen with 10 pairs of lateral filaments; 4 conspicuous hooks on last segment (Fig. 1) . . . . . GYRINIDAE **11**

Abdomen without lateral filaments or with only 6 pairs; without conspicuous hooks on last segment.**3**

3(2). Urogomphi usually longer than last abdominal segment (Fig. 2); **if shorter**, legs elongate with natatory setae; mandibles elongate, pointed for piercing . . . . . .DYTISCIDAE **15**

Urogomphi shorter than last abdominal segment (Fig. 3); legs short, stout, without natatory setae; mandibles short, adapted for chewing . . . . . NOTERIDAE **14**

4(1). Legs distinctly 5-segmented; abdomen terminating in 1 or 2 long filaments (Figs. 4, 15) . . . . . HALIPLIDAE **12**

Legs appearing to be 4-segmented; abdomen not terminating in long filaments **5**

5(4). Mandibles large, readily visible from above (Fig. 5). . . . . HYDROPHILIDAE **46**

Mandibles not readily visible from above **6**

6(5). Antenna long, filiform, as long as head and thorax combined (Fig. 6) . . . . . SCIRTIDAE **55**

Antenna much shorter than head and thorax combined **7**

7(6). Body oval and extremely flat (Figs. 7, 44); head completely concealed from dorsal view . . . . . PSEPHENIDAE **59**

Body elongate, round, or triangular in cross section; head exposed (Figs. 8-10) **8**

8(7). Each thoracic and abdominal segment covered by a flat, plate-like sclerite dorsally (Fig. 8); last abdominal segment with clump of large papillae ventrally . . . . . **LAMPYRIDAE** (no generic key)

Thoracic and abdominal segments rounded dorsally; without clump of large papillae ventrally **9**

9(8). All terga rounded and pale; grub-like larva with 2 spines on last abdominal segment (Fig. 10) . . . . . **CHRYSOMELIDAE, Donaciinae** (no generic key)

Body elongate and sclerotized, with ventral movable operculum closing caudal chamber containing gills (Fig. 9) **10**

10(9). Last abdominal tergum apically notched (Fig 11); a group of 5 stemmata posterior to base of antenna . . . . . ELMIDAE **60**

Last abdominal tergum broadly rounded (Fig. 12); one ventral stemma below base of antenna in addition to 5 stemmata posterior to base . . . . . **LUTROCHIDAE, *Lutrochus***

11(2). **GYRINIDAE** - Head narrowed posteriorly to form a distinct collar (Fig. 13) . . . . . ***Dineutus***

Elongate head not narrowed posteriorly to form a collar (Fig. 14) . . . . . ***Gyrinus***

12(4). **HALIPLIDAE** - Each body segment with 2 or more long, spine-like filaments, each half as long as body (Fig. 15) . . . . . ***Peltodytes***

Spines on body segments < length of segment (Fig. 4) **13**

13(12). Third antennomere 2-3 times as long as 2 . ***Haliplus***

Antennomere 3 shorter than 2 . . . . . ***Brychius***

14(3). **NOTERIDAE** - Antennomere 3 no longer than 4 . . . . . ***Suphisellus***

Antennomere 3 twice as long as 4 . . . ***Hydrocanthus***

15(3). **DYTISCIDAE** - Lateral filaments on abdominal segments 1 to 6 . . . . . ***Coptotomus***

No lateral filaments on abdominal segments **16**

16(15). Head with frontal projection (Fig. 19) **17**

Head without frontal projection **31**

17(16). Urogomphus with only 7 primary setae (Fig. 16) . **18**

Urogomphus with secondary setae, at least basally (Fig. 17) **27**

18(17). Last abdominal segment with lateral recurved tracheal trunks projecting to apex of urogomphi (Fig. 18) . . . . . ***Celina***

Last abdominal segment without projecting tracheal trunks **19**

19(18). Urogomphus very short, about half length of last abdominal segment . . . . . ***Laccornis***

Urogomphus as long or longer than last abdominal segment **20**

20(19). Body greatly widened at middle, width > 1/4 total length (Fig. 19); abdominal sterna 2-6 with a sclerotized plate **21**

Body at middle not much wider than pronotum; abdominal stern 2-6 not sclerotized **22**

21(20). Legs with natatory setae . . . . . ***Desmopachria***

Legs without natatory setae . . . . . ***Hydrovatus***

22(20). Basal segment of urogomphus > 1.5 times length of last abdominal segment; < 4.00 mm long . . . . . ***Liodessus***

Basal segment of urogomphus ≤ length of last abdominal segment; often > 4.00 mm long **23**

23(22). Lotic, often in springs . . . . . ***Sanfilippodytes***

Lentic **24**

24(23) Three long setae on urogomphomere 1 well separated; frontal projection without lateral notches; ≤ 3.4 mm long . . . . . ***Uvarus***

Two basal long setae on urogomphomere 1 nearly contiguous, third more distal; > 3.4 mm long **or** frontal projection notched laterally **25**

25(24) Antennomere 2 with a dorsomedian seta (Fig. 20); stemmata small, width across area containing stemmata subequal to greatest width of antennomere 1 . . . . . ***Hydroporus oblitus*-group**

Antennomere 2 without a dorsomedian seta; stemmata larger, width across area containing stemmata twice width of antennomere 1 . . . . . **26**

26(25). Antennomere 3 with a primary laterobasal pore and a ventroapical spinule (Fig. 21) (visible under a compound microscope) . . . . . ***Hydroporus***

Antennomere 3 without a primary laterobasal pore and ventroapical spinule . . . . . ***Hygrotus***

27(17). Without lateral spiracles on abdominal segments 1-7 and mesothorax **28**

With lateral spiracles on abdominal segments 1-7 and mesothorax **29**

28(27). Tibiae and tarsi with long natatory setae; lotic or lentic . . . . . ***Neoporus***

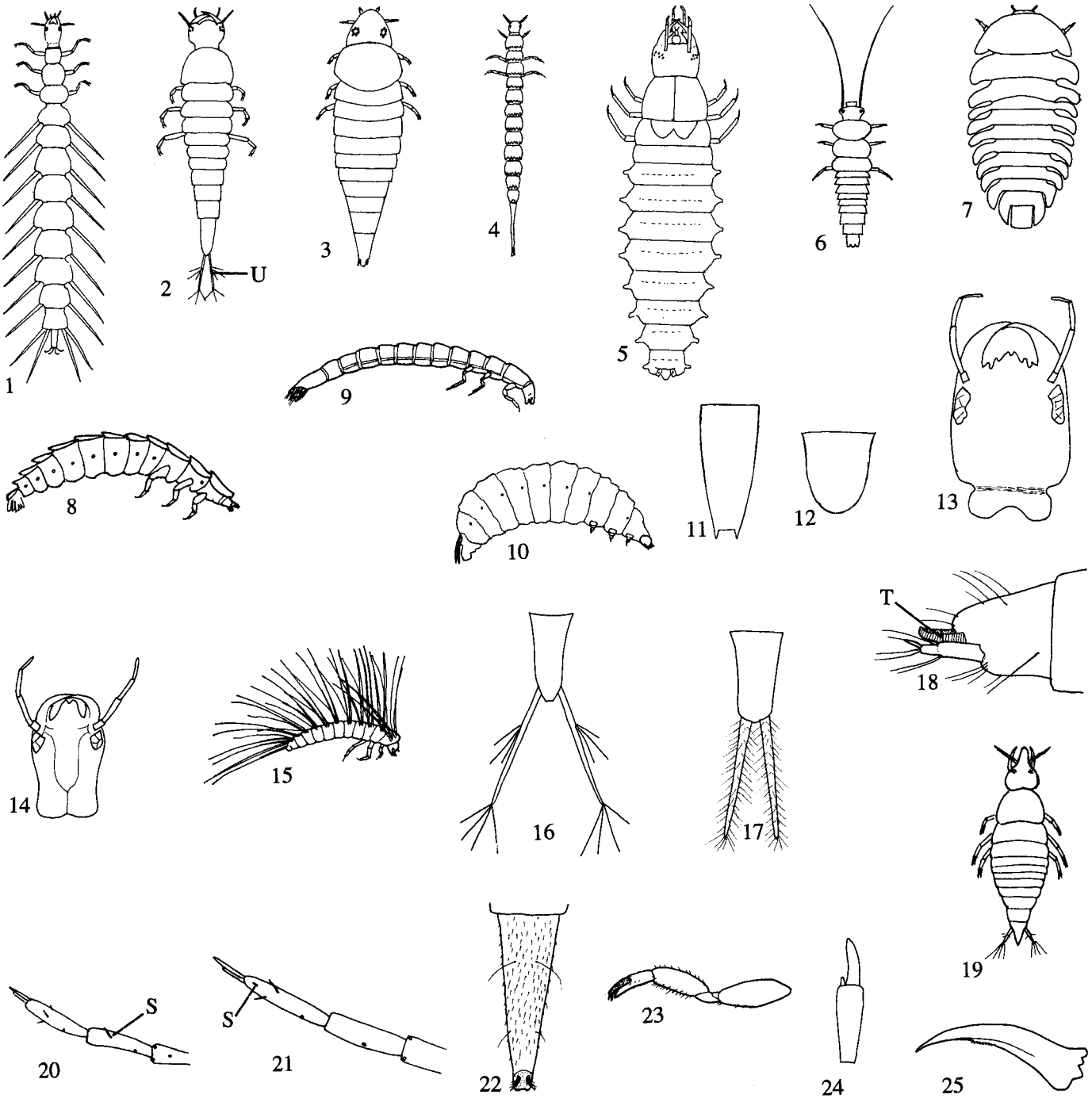
Tibiae and tarsi without long natatory setae; lotic . . . . . ***Heterosternuta***

29(27). Legs without natatory setae; lotic . . . . . ***Oreodytes***

Legs with natatory setae; lentic or lotic **30**

30(29). Lotic . . . . . ***Nebrioporus***

Lentic . . . . . ***Stictotarsus***



Figures 1-25. Coleoptera Larvae. 1-7. (Dorsal): 1. *Dineutus*. 2. *Agabus* with urogomphi (U). 3. *Hydrocanthus*. 4. *Haliplus*. 5. *Tropisternus*. 6. *Scirtes*. 7. *Ectopria*. 8-10. (lateral): 8. Lampyridae. 9. *Stenelmis*. 10. *Donacia*. 11-12. Last abdominal tergum: 11. *Stenelmis*. 12. *Lutrochus*. 13-14. Head (dorsal): 13. *Dineutus*. 14. *Gyrinus*. 15. *Peltodytes* (lateral). 16-18. Last abdominal tergum and urogomphi: 16. *Agabus*. 17. *Laccophilus*. 18. *Celina* (lateral) with tracheal trunk (T). 19. *Hydrovatus* (dorsal). 20. Antennomeres 2-4 (dorsal) *Hydroporus oblitus*-group with dorsomedian seta (S). 21. Antennomeres 2-4 (ventral) *Hydroporus* with ventroapical spinule (S). 22. Last abdominal sternum *Agabetes*. 23. Prothoracic leg *Matus*. 24. Apical antennomeres *Copelatus*. 25. Mandible *Copelatus*.

31(16). Abdominal segments 7 and 8 with lateral fringe of long natatory setae 41
Abdominal segments 7 and 8 without lateral fringe of long natatory setae 32

32(31). Urogomphus extremely short, ventral, difficult to see (Fig. 22) . . . . . ***Agabetes***
Urogomphus at least 1/4 length of last abdominal segment 33

33(32). Pro- and mesothoracic legs chelate, with inner apex of tibia formed into long serrated process parallel to and as long as tarsus (Fig. 23) . . . . . ***Matus***
Legs not chelate 34

34(33). Urogomphus with only primary setae, usually 7 in 2 whorls (Fig. 16) 35
Urogomphus with numerous secondary setae (Figs. 17, 26-27) 37

35(34). Antennomere 4 double, one half very short (Fig. 24); mandible with area of serrations on inner edge (Fig. 25) . . . . . ***Copelatus***
Antennomere 4 single; mandible without serrations.36

36(35). Dorsal seta of basal urogomphal whorl distinctly posterior to ventral seta; anteroventral spines on metatarsus not paired with posteroventral spines, which are usually less numerous or absent; last abdominal segment usually with long, thin setae in addition to spine-like setae . . . . . ***Agabus***
Dorsal seta of basal urogomphal whorl not posterior to other two setae; anteroventral spines on metatarsus more or less paired with posteroventral spines; last abdominal segment without long thin setae . . . . . ***Ilybius***

37(34). Antennomere 4 > 2/3 length of 3 38
Antennomere 4 < 1/2 length of 3 40

38(37). Tarsal claws without small spines on lower margin in basal half; labium distinctly emarginate apically . . . . . ***Neoscutopterus***
Tarsal claws with small spines on lower margin in basal half; labium truncate apically 39

39(38). Head capsule width < 2.6 mm; urogomphus with one short, spine-like seta ventrolaterally in basal half, or with many such setae dorsally, laterally, and ventrolaterally (Fig. 26) . . . . . ***Rhantus***
Head capsule width > 2.8 mm; setae on urogomphus may be short, but never spine-like (Fig. 27) . . . . . ***Colymbetes***

40(37). Row of spines on posterolateral margin of head; antennomere 4 < 1/4 length of 3; head < 1.3 mm wide; lentic . . . . . ***Laccophilus***
No spines on posterolateral margin of head; antennomere 4 about 1/3 length of 3; head > 1.3 mm wide; lotic . . . . . ***Agabus***

41(31). Length of maxillary stipes ≥ 4 times width (Fig. 28) 42
Length of maxillary stipes ≤ 3 times width (Fig. 29). 44

42(41). Labroclypeus with long teeth anteriorly; urogomphi absent . . . . . ***Cybister***
Labroclypeus without long teeth anteriorly; urogomphi present 43

43(42). Urogomphus with lateral fringe; labium without projecting lobes . . . . . ***Dytiscus***
Urogomphus without lateral fringe; labium with 2 projecting lobes (Fig. 30) . . . . . ***Hydaticus***

44(41). Ligula apically bifid (Fig. 31) . . . . . ***Acilius***
Ligula simple or with 2, thin, elongate processes (Figs. 32-33) 45

45(44). Ligula simple, length ≥ labial palpomere 1 (Fig. 32) . . . . . ***Graphoderus***
Ligula with 2 elongate processes at tip, length < labial palpomere 1 (Fig. 33) . . . . . ***Thermonectus***

46(5). **HYDROPHILIDAE** - First 7 abdominal segments with long lateral filaments; some 2-3 times width of a segment . . . . . ***Berosus***
Lateral filaments absent or shorter than width of a segment 47

47(46). Antennomere 1 at most slightly longer than 2+3 (Fig. 34); femur without fringe of long natatory setae; riparian 48
Antennomere 1 at least twice length of 2+3 together (Fig. 35); femur with fringe of long natatory setae; aquatic 52

48(47). Mandibles asymmetrical, right with 2 teeth, left with 1; prolegs on abdominal segments 3 to 7.***Enochrus***
Mandibles symmetrical, each with 2 or 3 inner teeth; abdomen without prolegs 49

49(48). Labroclypeus with more than 6 teeth, those on right not clearly defined 50
Labroclypeus with 4 or 5 prominent teeth 51

50(49). Labroclypeus with tooth on left side smaller than tooth on right side . . . . . ***Cymbiodyta***
Labroclypeus with tooth on left side equal in size to tooth on right side . . . . . ***Helocombus***

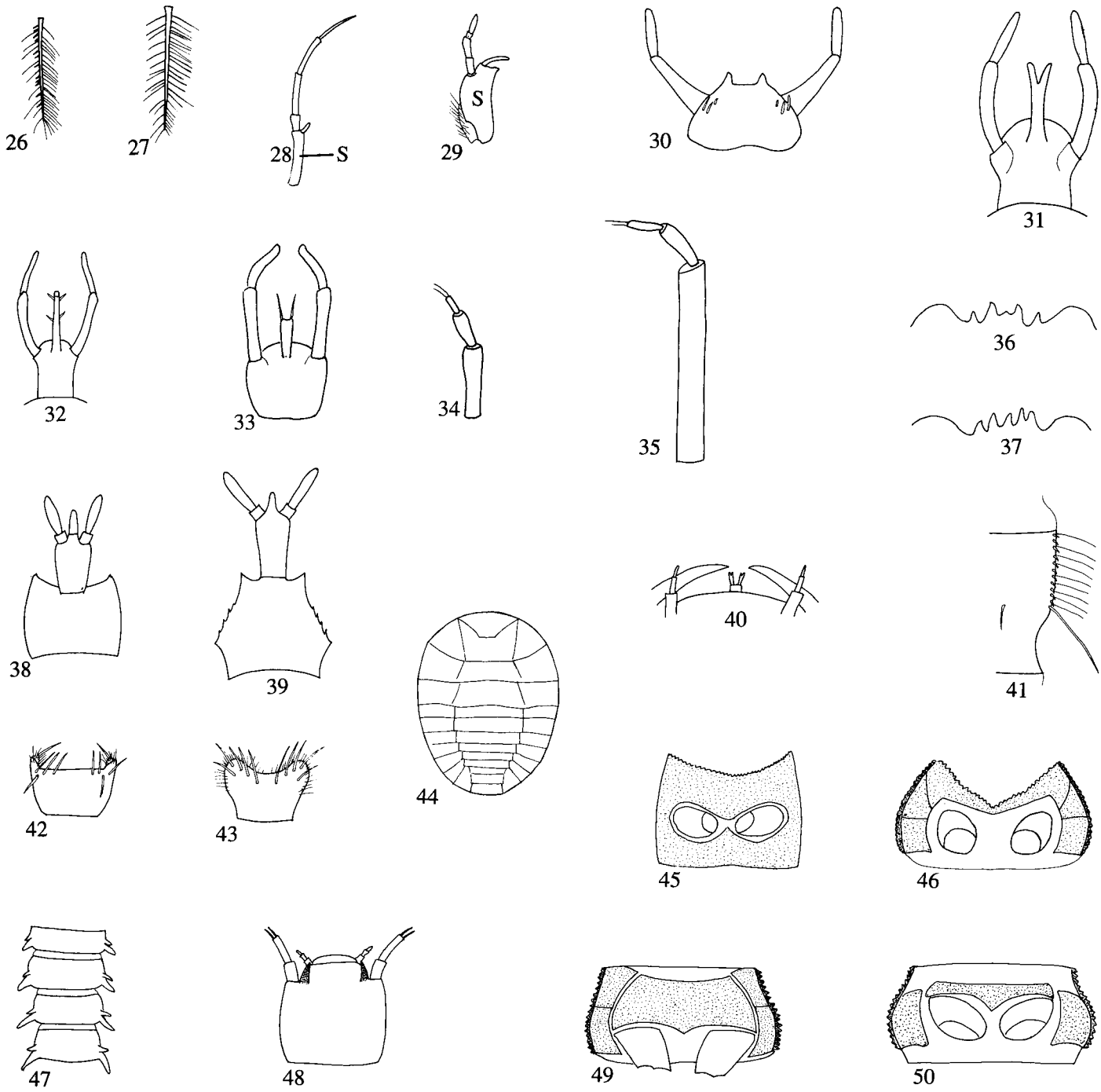
51(49). Middle tooth on labroclypeus smaller than others (Fig. 36); prosternum entire . . . . . ***Sperchopsis***
All teeth of labroclypeus subequal (Fig. 37); prosternum with mesal fracture . . . . . ***Hydrobius***

52(47). Head subspherical; antenna 4-segmented in 2nd and 3rd instars; pronotum not entirely sclerotized . . .53
Head subquadrangular, narrowed behind (Fig. 5); antenna 3-segmented; pronotum entirely sclerotized. 54

53(52). A pair of setiferous lobes on abdominal segments 1-8; left mandible without tooth . . . . . ***Dibolocelus***
No setiferous lobes on abdominal segments; left mandible with small tooth . . . . . ***Hydrophilus***

54(52). Mentum with sides nearly parallel (Fig. 38); lateral filaments rudimentary tubular projections with several terminal setae . . . . . ***Tropisternus***
Mentum with sides convergent apically and basally (Fig. 39); lateral filaments fairly well developed and pubescent . . . . . ***Hydrochara***

55(6). **SCIRTIDAE** - Anterior margin of hypopharynx with a central cone bearing 1 pair of flat spines (Fig. 40); head with 3 stemmata on each side . ***Flavohelodes***



Figures 26-50. Coleoptera Larvae. 26-27. Urogomphus: 26. *Rhantus.* 27. *Colymbetes.* 28-29. Right maxilla with stipes (S): 28. *Dytiscus.* 29. *Acilius.* 30-33. Labium: 30. *Hydaticus.* 31. *Acilius.* 32. *Graphoderus.* 33. *Thermonectus.* 34-35. Antenna: 34. *Hydrobius.* 35. *Tropisternus.* 36-37. Anterior margin frontoclypeus: 36. *Sperchopsis.* 37 *Hydrobius.* 38-39. Labium: 38. *Tropisternus.* 39. *Hydrochara.* 40. Anterior margin of head (ventral) *Flavohelodes.* 41. Lateral margin abdominal tergum 6 *Scirtes.* 42-43. Labrum (dorsal): 42. *Prionocyphon.* 43. *Scirtes.* 44. *Psephenus* (dorsal). 45-46. Prosternum: 45. *Stenelmis.* 46. *Optioservus.* 47. Abdominal terga *Ancyronyx.* 48. Head (dorsal) *Stenelmis.* 49-50. Mesosternum and pleurae: 49. *Macronychus.* 50. *Optioservus.*

Cone bearing 2 pairs of flat spines; head with 1 or 2 stemmata on each side **56**

56(55). Sides of abdominal segments with setae similar to those on dorsum, although usually more numerous **57**

Sides of abdominal segments 3-6 with a regular row of very short, flattened setae that differ markedly from setae on dorsum (Fig. 41) . . . . . **.58**

57(56). Apical maxillary palpomere very small, about 1/6 length of penultimate palpomere . . . . . ***Cyphon***

Apical maxillary palpomere large, about 1/2 length of penultimate palpomere . . . . . ***Microcara***

58(56). Anterior of labrum straight, with corners bent under to expose inner portion in dorsal view (Fig. 42) . . . . . ***.Prionocyphon***

Anterior of labrum simply emarginate (Fig. 43) . . . . . ***Scirtes***

59(7). **PSEPHENIDAE** - Abdominal pleurae separated (Fig. 7); no gills on abdominal sterna 2-6 . . . . ***Ectopria***

Abdominal pleurae contiguous (Fig. 44); gills on abdominal sterna 2-6 . . . . . ***Psephenus***

60(10). **ELMIDAE** - Posterior sternum on prothorax (Fig. 45) . . . . . **.61**

Prothorax without posterior sternum (Fig. 46) . . . . **.63**

61(60). Posterolateral angles of anterior abdominal segments produced (Fig. 47) . . . . . ***Ancyronyx***

Posterolateral angles of abdominal segments not produced . . . . . **.62**

62(61). Abdominal terga covered with granules; anterior margin of head with distinct tooth mesad of each antenna (Fig. 48) . . . . . ***Stenelmis***

Abdominal terga with granules in longitudinal rows; anterior margin of head without distinct tooth mesad of each antenna . . . . . ***Microcylloepus***

63(60). Last abdominal segment 5 times longer than wide . . . . . ***.Dubiraphia***

Last abdominal segment < 3 times as long as wide **64**

64(63). Mesopleuron divided (Fig. 49) . . . . . ***.Macronychus***

Mesopleuron undivided (Fig. 50) . . . . . ***.Optioservus***

*Last instar larvae, which have lateral spiracles, except in *Heterosternuta* and *Neoporus;* earlier instars lack lateral spiracles.

WISCONSIN SPECIES AND REFERENCES TO ADULT AND LARVAL (L) KEYS

ADEPHAGA

DYTISCIDAE (Hilsenhoff 1992, 1993a, 1993b, 1993c, 1994, 1995a)

Acilius (L Hilsenhoff 1993a) - *fraternus*, mediatus, semisulcatus, sylvanus*

Agabetes - acuductus

Agabus (Larson 1989, 1991, 1994) - *aeruginosus, ajax*, ambiguus, antennatus, anthracinus, bicolor, bifarius, canadensis, confinis, confusus, discolor, disintegratus, erichsoni, falli, fuscipennis*, gagates, immaturus, inscriptus, leptapsis, obtusatus*, opacus*, phaeopterus, punctulatus, semipunctatus, semivittatus, seriatus, subfuscatus, thomsoni*, wasastjernae*

Bidessonotus -inconspicuus**

Celina - hubbelli

Colymbetes (Zimmerman 1981, L Hilsenhoff 1993b) - *exaratus, paykulli, sculptilis*

Copelatus (Young 1963) - *chevrolati, glyphicus*

Coptotomus (Hilsenhoff 1980) - *lenticus, longulus, loticus*

Cybister - fimbriolatus

Desmopachria - convexa

Dytiscus (Roughley 1990) - *alaskanus, carolinus, circumcinctus*, cordieri, dauricus, fasciventris, harrisii, hybridus, verticalis*

Graphoderus (L Hilsenhoff 1993a) - *fascicollis, liberus, manitobensis, occidentalis, perplexus*

Heterosternuta (=*Hydroporus*, part) (Matta and Wolfe 1981) - *pulcher, wichami*

Hydaticus (Roughley and Pengelly 1981, L Hilsenhoff 1993a) - *aruspex, piceus*

Hydroporus (Gordon 1969, 1981) - *badiellus, columbianus, dentellus, despectus, dichrous, fuscipennis, larsoni, melsheimeri, morio, niger, notabilis, obscurus, puberulus, rectus, rufinasus, signatus, striola, tartaricus, tenebrosus, tristis*

Hydroporus oblitus-group (=*Hydroporus*, part) - *paugus, persimilis, rubyae, stagnalis*

Hydrovatus - pustulatus

Hygrotus (Anderson 1970, 1975, 1983) - *acaroides, compar, dissimilis, falli, farctus, impressopunctatus, laccophilinus, marklini, nubilus, patruelis, picatus, sayi, sellatus*, suturalis*, sylvanus, turbidus*

Ilybius (Larson 1987) - *angustior, biguttulus, confusus, discedens, fraterculus, ignarus, incarinatus, oblitus*, picipes, pleuriticus, subaeneus*

Laccophilus (Zimmerman 1970, L Hilsenhoff 1992) - *biguttatus, fasciatus*, maculosus, proximus, undatus*

Laccornis (Wolfe and Roughley, 1990) - *conoideus, deltoides, latens*

Liodessus (Larson and Roughley 1990) - *affinis, cantralli, flavicollis, fuscatus*

Lioporeus (=*Hydroporus*, part) - *triangularis*

Matus (Young 1953, L Hilsenhoff 1993b) - *bicarinatus, ovatus*

Nebrioporus (=*Deronectes*, part) - *rotundatus*

Neoporus (=*Hydroporus*, part) (Wolfe 1984) - *clypealis, hybridus, mellitus*, semiflavus*, solitarius, superioris, tennetum, undulatus, vitiosus*, vittatus*

Neoscutopterus (L Hilsenhoff 1993b) - *angustus, hornii*

Oreodytes - scitulus

Rhantus (Zimmerman and Smith 1975) - *binotatus, consimilis, gutticollis, sericans, sinuatus, suturellus, wallisi*

Sanfilippodytes (=*Hydroporus*, part) - *pseudovilis*

Stictotarsus (=*Deronectes*, part) - *griseostriatus*

Thermonectus (McWilliams 1969) - *basillaris, ornaticollis*

Uvarus (Young 1954) - *granarius, lacustris*

GYRINIDAE (Hilsenhoff 1990)
Dineutus - assimilis, discolor, hornii, nigrior
Gyrinus (Oygur and Wolfe 1991) - *aeneolus, affinis, analis, aquiris, bifarius, cavatus, confinis, dichrous, frosti, gehringi, impressicollis, latilimbus, lecontei, maculiventris, marginellus, parcus, pectoralis, piceolus*, pugionis, sayi, ventralis, wallisi*
HALIPLIDAE (Hilsenhoff and Brigham 1978)
Brychius - hungerfordi**
Haliplus - apostolicus, blanchardi, borealis, canadensis, connexus, cribrarius, fasciatus, immaculicollis, leopardus, longulus, nitens, ohioensis, pantherinus, subguttatus, tortilipenis, triopsis,*
Peltodytes - duodecimpunctatus, edentulus, lengi, sexmaculatus, tortulosus*
NOTERIDAE
Hydrocanthus - iricolor
Suphisellus - puncticollis
POLYPHAGA
CHRYSOMELIDAE (Hoffman 1939)
Donacia - aequalis, biimpressa, cincticornis, distincta, flavipes, fulgens, hirticollis*, hypoleuca, piscatrix, porosicollis, proxima, pubescens, pubicollis, quadricollis, rufescens, subtilis, texana, tuberculifrons*
Neohaemonia - nigricornis
Plateumaris - diversa, emarginata, fulvipes, germari, sulcicollis
CURCULIONIDAE (listed in Kissinger 1964)
Bagous - americanus, blanchardi, cavifrons, magister, mammillatus*, nebulosus*, obliquus,* planatus*, *puritanus*, restrictus*, tanneri, transversus*
Euhrychiopsis - lecontei
Lissorhoptrus - buchanani, oryzophilus*
Listronotus (+Lixellus) - appendiculatus, caudatus, delumbis, filiformis, frontalis, hubbardi, lutulentus, nebulosus, oregonensis, sordidus, squamiger, tuberosus
Lixus - macer, punctinasus, rubellus, terminalis
*Notiodes (=Endalus) - limatulus, ovalis**
Onychylis - longulus, nigrirostris*
Phytobius - leucogaster
Tanysphyrus - lemnae
DRYOPIDAE (Hilsenhoff and Schmude 1992)
Helichus - fastigiatus, lithophilus, striatus*
ELMIDAE (Hilsenhoff and Schmude 1992)
Ancyronyx - variegata
Dubiraphia - bivittata, minima, quadrinotata, robusta, vittata
Macronychus - glabratus
Microcylloepus - pusillus
Optioservus (L Hilsenhoff and Schmude 1992) - *fastiditus, trivittatus*
Stenelmis (Schmude 1992) - *antennalis, bicarinata, cheryl, crenata, decorata, douglasensis, fuscata, grossa, knobeli, mera, musgravei, quadrimaculata, sandersoni, sexlineata*
HYDRAENIDAE (Hilsenhoff 1995b, Perkins 1980)
Gymnochthebius - nitidus**
Hydraena - angulicollis, pennsylvanica
Ochthebius - cribricollis, kaszabi*, lineatus*
HYDROPHILIDAE (Hilsenhoff 1995b, 1995c, Smetana 1988)
Anacaena - lutescens
Berosus (Van Tassell 1966) - *aculeatus, fraternus, hatchi, infuscatus, ordinatus*, pantherinus, peregrinus, striatus, stylifer*
Crenitis - digesta
Cymbiodyta (Smetana 1974) - *acuminata, blanchardi, chamberlaini, minima, semistriata, toddi, vindicata*
Dibolocelus - ovatus**
Enochrus (Gundersen 1978) - *blatchleyi*, cinctus, collinus, consors*, consortus, diffusus, hamiltoni, horni, ochraceus, perplexus, pygmaeus, sayi*
Helocombus - bifidus
Helophorus (Smetana 1985) - *angusticollis, furius, grandis, inflectus, lacustris, latipenis, linearis, lineatus, marginicollis, nitiduloides, nitidulus*, oblongus, orchymonti, orientalis, sempervarians, smetanai, tuberculatus*
Hydrobius - fuscipes, melaenus
Hydrochara (Smetana 1980) - *leechi, obtusata, simula, soror, spangleri*
Hydrochus (Smetana 1988) - *brevitarsis*, currani, granulatus, neosquamifer, pseudosquamifer, rufipes, scabratus, setosus, squamifer, subcupreus*
Hydrophilus - triangularis
Laccobius (Gentili 1985, 1986) - *agilis, fuscipunctatus, minutoides, reflexipenis, spangleri, truncatipenis*
Paracymus (Wooldridge 1966) - *despectus*, subcupreus*
Sperchopsis - tesselata
Tropisternus (Spangler 1960) - *blatchleyi*, columbianus, ellipticus, glaber, lateralis, mixtus, natator*
LUTROCHIDAE
Lutrochus - laticeps
PSEPHENIDAE (L Hilsenhoff and Schmude 1992)
Ectopria - leechi, nervosa
Psephenus - herricki
SCIRTIDAE (=HELODIDAE) (No larval key)
Cyphon - americanus, collaris, craigi, modestus, nebulosus, neoveriabilis, obscurus, ochreatus, punctatus, perplexus, pusillus, setulipennis, shenefelti, variabilis* (+ *aliceae*, craigi, elutus* in Tetrault 1967)
Flavohelodes (=Elodes) - fuscipennis, pulchella, thoracica
Microcara - explanata**
*Prionocyphon - discoideus, limbatus**
Scirtes - orbiculatus, tibialis

AQUATIC DIPTERA - AQUATIC FLIES AND MIDGES

Although primarily a terrestrial order, Diptera is the dominant order of aquatic insects, with at least 660 species estimated to occur in Wisconsin. Larvae and pupae of many species are aquatic, accounting for more than one-third of all aquatic insect species that occur in Wisconsin, and more than one-third of aquatic Diptera species belong to one family, Chironomidae. Larvae inhabit all types of aquatic

environments, and frequently predominate lentic habitats. Unfortunately it is not possible to identify larvae to species in most families; only in Chaoboridae, Culicidae, Simuliidae, Sciomyzidae, and Tabanidae can most larvae be identified to species. The terrestrial adults in most families can be identified, but sometimes it is not possible to know which species have aquatic larvae. Lists of aquatic species known to, or likely to occur in Wisconsin are appended. For several families, Stone et al. (1965) was relied upon to determine these species. No list is provided for Chironomidae and Empididae because adults in these families have not been studied in Wisconsin and few species records have been verified.

Diptera has two suborders, Nematocera and Brachycera (McAlpine et al. 1981); most aquatic species are Nematocera. Cyclorrhapha, once considered a suborder, is included in Brachycera as infraorder Muscomorpha and often referred to as "cyclorrhaphous" Brachycera; other Brachycera are called "orthorrhaphous" Brachycera. More than half of the families of Nematocera have some aquatic species, and in 12 families all or almost all species have aquatic larvae and usually also aquatic pupae. Normally there are 4 larval instars, but some families have more. Families of Brachycera with aquatic species, except Athericidae and Sciomyzidae, are predominantly terrestrial or semiaquatic; life histories are poorly known.

Diptera larvae are easily recognized because they lack segmented thoracic legs. Nematocera larvae have a completely sclerotized, rounded, head capsule (except most Tipulidae), and have mandibles that move laterally and usually have subapical teeth. The head of cyclorrhaphous Brachycera larvae is reduced to an internal cephalopharyngeal skeleton that is not visible; in orthorrhaphous Brachycera the head is not rounded and often poorly formed. Larval mandibles in Brachycera are called "mouth hooks"; they move vertically and lack subapical teeth.

Larvae have many adaptations that allow them to live in aquatic environments. Those in oxygen-rich environments usually rely on cutaneous respiration, which may be aided by gills. Some larvae of Chironomidae have a hemoglobin-like pigment that aids in oxygen storage, allowing them to inhabit oxygen-poor environments. Larvae in many families obtain oxygen at the water's surface through short or elongate caudal respiratory siphons, which may be retractile. Others (Tipulidae, Stratiomyidae) have caudal spiracles with surrounding fringes of setae that trap air and allow larvae to float in the surface film with their spiracles exposed to air. Mosquito (Culicidae) and some phantom midge (Chaoboridae) larvae swim to the surface to obtain oxygen. Larvae in many genera have abdominal papillae for osmoregulation. Sucker disks anchor Blephariceridae and Simuliidae larvae that live in rapid currents, and prolegs, pseudopods, or creeping welts permit locomotion in most species.

Pupae in several Nematocera genera use anterior respiratory horns to obtain oxygen at the surface; others rely on cutaneous respiration. Pupae of Culicidae and Chaoboridae swim to the surface to obtain oxygen, and Dixidae larvae pupate just above the water line. Most orthorrhaphous Brachycera pupate on land, while cyclorrhaphous Brachycera and Stratiomyidae pupate in a puparium, which may be terrestrial or float at the water's surface.

Many species of aquatic Diptera in North America remain undescribed, and larvae of most described species remain unknown. Only in families of public health importance (Culicidae, Tabanidae, Simuliidae, Sciomyzidae) and Chaoboridae are larvae well enough known that reliable species keys exist. There have been many recent advances in larvae taxonomy, especially in Chironomidae, but additional research is needed. The two volume "Manual of Nearctic Diptera" by Agriculture Canada (McAlpine et al. 1981, 1987) provides generic keys for adults, and in most families also for larvae and occasionally pupae; also included is information about morphology, biology, behavior, classification, and distribution.

Generic names proposed by Meigen in 1800 and family names based on these genera were used in North America from about 1950 until 1965, when they were suppressed by the International Commission on Zoological Nomenclature (1965). Family names based on Meigen (1800) genera are included in parentheses after the recognized family name.

NEMATOCERA

BLEPHARICERIDAE - Net-winged Midges (1 genus, 1 species)

Larvae of *Blepharicera* are rare in Wisconsin, occurring only in extremely fast water of clean northern streams. They attach with ventral suckers to rocks or vegetation hanging into the stream, and feed on algae and diatoms. Larvae move forward slowly by alternately moving anterior and posterior sucker disks. Adults oviposit on rocks above the water, and larvae hatch when eggs are flooded by high water. Larvae pupate in cracks and depressions near the water's surface.

CERATOPOGONIDAE (HELEIDAE) - Biting Midges, No-see-ums (12 genera, 60 species)

The often small, very thin, and nearly transparent larvae are easily overlooked by collectors. Some species have terrestrial or semiaquatic larvae; larvae of aquatic species inhabit a variety of lentic habitats from tree holes to lakes, and also inhabit streams. *Palpomyia* larvae may be found in the sublittoral or profundal mud of lakes, but those of most *Palpomyia, Bezzia, Probezzia,* and other genera are found among emergent vegetation of lakes, ponds, marshes, and margins of streams. Larvae cannot be identified to species, and some genera cannot be separated. Most species have one or more generations per year. *Palpomyia, Bezzia,* and *Probezzia* larvae are predators, but feeding habits of other genera are poorly known. Adults of *Culicoides* bite people, and occasionally may be a nuisance. The larval key is based on Glukhova (1977), and must be considered tentative.

CHAOBORIDAE - Phantom Midges (3 genera, 8 species)

The transparent larvae occur in lentic habitats. Larvae and pupae of *Mochlonyx* are fairly common in snow-melt pools. They feed mostly on mosquito larvae, with adults emerging shortly after most spring *Aedes* mosquitoes; larvae of *Eucorethra* are rare. *Chaoborus* larvae often occur abundantly

in permanent ponds, and in sublittoral and profundal zones of lakes; they are the only common inhabitants of limnetic areas of lakes. Larvae of *Chaoborus* prey on small insects and crustacea. Most species are univoltine in Wisconsin, with emergence in late spring or early summer. The short-lived adults are attracted to lights, and may be a nuisance.

CHIRONOMIDAE (TENDIPEDIDAE) - Lake Flies, Midges (103 aquatic genera)

Larvae are abundant in almost every type of aquatic habitat. Fortunately, adults do not feed and are short-lived. Larvae are herbivores, detritivores, omnivores, or carnivores, depending on the genus. Species are univoltine to multivoltine, with adults on the wing in all but the coldest part of the winter. Biologies of a few species have been studied in detail, but generally their biology is poorly known. Most larvae cannot be identified to species, and some are difficult to identify to genus; adults and pupae are better known. Many species remain undescribed, and several genera are poorly defined, but recent generic revisions and continued efforts of several taxonomists have resulted in adequate species keys for adults and pupae, and in some genera even for larvae. Important references are, Oliver et al.'s catalog of Nearctic Chironomidae (1990), their corrections and additions (1994), and Wiederholm (1983). The latter keys larvae to genus and species groups, describes larvae of each genus, provides comments on identification, ecology, and distribution, and lists known species keys; all genera known to occur in Wisconsin are keyed and described.

CULICIDAE - Mosquitoes (9 genera, 48 species)

Larvae of one or more species breed in almost every shallow lentic habitat without fish. *Aedes* larvae are abundant in snow-melt pools, and along with much rarer *Psorophora* larvae, also occur abundantly in temporary ponds and marshes in the summer. *Anopheles* larvae are common among emergent vegetation of permanent marshes, and vegetated stream and lake margins. *Culex, Uranotaenia,* and *Culiseta* larvae are common summer inhabitants of permanent ponds and marshes, the latter also occurring in the spring. *Coquillettidia* larvae attach to cattails and similar plants from which they get air for respiration, and are difficult to collect. *Wyeomyia* larvae live only in pitcher plants, while water in tree holes, discarded tires, and containers harbor larvae of *Aedes*, and very rarely *Orthopodomyia* in the extreme south. Life cycles range from univoltine to multivoltine. Most larvae feed on microorganisms, algae, and detritus; *Psorophora* larvae are predaceous. Adults may be abundant from spring to autumn; most species of *Culex, Culiseta,* and *Anopheles* overwinter as adults. Species in other genera overwinter as eggs, but *Wyeomyia* and *Coquillettidia* overwinter as larvae, the former frozen in the ice.

DIXIDAE - Dixid Midges (2 genera, 2 species)

Larvae of *Dixa* and *Dixella* are fairly common in cattail marshes and among vegetation along streams, ponds, and lakes. They usually remain in the surface film, often bent in a U-shape, and feed on microorganisms and detritus; they pupate just above the water on vegetation. Adults are short-lived midges that do not feed. Little is known about their life cycle.

PSYCHODIDAE - Moth Flies (2 aquatic genera)

Larvae in two genera are aquatic; many species are semi-aquatic or terrestrial. Most species are probably multivoltine, with larvae of *Psychoda* breeding in lentic habitats with large amounts of organic matter, which often results from pollution. Larvae of *Pericoma* most often occur along margins of streams. Larvae and adults feed on decaying organic matter; little is known about their biology.

PTYCHOPTERIDAE (LIREOPEIDAE) - Phantom Crane Flies (2 genera, 3 species)

Larvae of *Bittacomorpha* and *Ptychoptera* live on decaying debris in shallow marshes or along edges of ponds and slow streams. They obtain oxygen at the surface through a caudal respiratory siphon. All species are aquatic as larvae and pupae, but are generally uncommon and difficult to find. Their biology is poorly known.

SIMULIIDAE - Black Flies (5 genera, 30 species)

Larvae and pupae inhabit streams of all types, using a caudal sucker to attach to vegetation, rocks, and other objects in the current. Most feed by using cephalic fans to filter plankton and organic debris from the water; they also graze on adjacent substrates. Larvae of *Cnephia, Prosimulium,* and many species of *Simulium* inhabit only cleaner streams, and are univoltine with emergence in the spring. Some species of *Simulium* are very tolerant of organic pollution, becoming abundant in partially polluted streams and emerging from spring through autumn. Larvae of *Simulium* and *Prosimulium* are often abundant; those of *Cnephia, Ectemnia,* and *Stegopterna* are uncommon. *Greniera* and *Twinnia* larvae have not been collected, but probably occur in northern Wisconsin.

TIPULIDAE - Crane Flies (14 genera, 52 species)

In this, the largest family of Diptera, most species and genera are terrestrial or semiaquatic. Most aquatic species develop in streams, where *Antocha, Dicranota, Hexatoma,* and *Tipula* larvae are common and those of *Limnophila, Limonia, Pedicia, Pilaria, Erioptera, Hesperoconopa,* and *Pseudolimnophila* are less frequently found. Larvae live in the bottom substrate, moss or algal scum on rocks, debris, or rotting wood. Larvae of *Helius, Prionocera,* and *Phalacrocera* are uncommon to rare in weedy ponds, marshes, or margins of lakes and streams. Most species probably are univoltine; some may be semivoltine. Larvae eat a wide range of food, with most species being herbivores or detritivores.

BRACHYCERA

ATHERICIDAE (formerly in RHAGIONIDAE) - Snipe Flies (1 genus, 1 species)

The predaceous larvae of *Atherix* occur commonly in gravel riffles of a variety of streams. The life cycle is one year, with pupation on land and emergence of the predaceous adults in early summer. Eggs are laid on vegetation or supports above the stream, with many females contributing to a large

communal egg mass. Larvae hatch and drop into the stream; upon completing development they pupate in moist soil of the stream bank.

DOLICHOPODIDAE - Long-legged Flies

The predaceous larvae may be aquatic, semiaquatic, or terrestrial, but are so poorly known that generic identification is not reliable. Larvae of a few genera occasionally occur in various lentic and lotic habitats.

EMPIDIDAE - Dance Flies (3 genera)

The small larvae are fairly common in many Wisconsin streams, where they prey on smaller insects and other animals. Larval taxonomy is poorly developed; generic identifications must be considered tentative. Almost nothing is known about the life history.

EPHYDRIDAE - Shore Flies

While most species are semiaquatic, some live in vegetation and debris in shallow lentic habitats where they feed on algae, diatoms, or detritus; a few species are predators. Aquatic larvae are uncommon in Wisconsin. They pupate in a puparium that floats at the water's surface. Foote (1995) reviewed the biology. Larvae are poorly known, and generic identification is not reliable.

MUSCIDAE - Muscoid Flies (3 genera)

Larvae are uncommon in streams and occasionally in shallow lentic habitats. Eggs are laid in algae, larvae develop near the surface, and pupate in a puparium at the surface. There are no keys to genera of aquatic larvae.

SCIOMYZIDAE (TETANOCERIDAE) - Marsh Flies (12 genera, 36 species)

Larvae are predators or parasitoids of snails, fingernail clams, and slugs; only those living on slugs or land snails are not aquatic. Larvae occur near the surface of lentic habitats and vegetated margins of streams. They swallow a large air bubble to keep them and their prey afloat. Eggs are laid on emergent vegetation; hatching larvae drop into the water and search for prey. Upon completing development, they pupate in a puparium either in the snail shell or floating freely at the water's surface. Because snails are intermediate hosts of liver flukes that infect cattle and schistosomes that attack humans, larvae have been extensively studied as a potential biological control.

STRATIOMYIDAE - Soldier Flies (9 genera, 25 species)

While most species are terrestrial, larvae in nine genera inhabit a variety of shallow lentic habitats. Larvae are poorly known; those of *Anoplodonta* and *Labostigmina* are not keyed, and larvae of *Hedriodiscus* cannot be separated from some *Odontomyia*. Larvae of *Odontomyia* and *Stratiomys* are common in Wisconsin; other genera are rare. Larvae hang suspended in the surface film by caudal hydrofuge hairs; they feed on detritus and algae. Their body is covered with calcium carbonate crystals, which may offer protection. Eggs are laid in masses on emergent or submerged vegetation. Larvae hatch, fall into the water where they develop and ultimately pupate in a puparium, which may float at the surface. Adults feed mostly on flowers.

SYRPHIDAE - Flower Flies (3 genera, 31 species)

Aquatic larvae live in organically enriched and often polluted water, obtaining oxygen at the surface through a retractile caudal siphon. Because of these siphons they are called "rat-tailed maggots". Larvae of *Eristalis* are quite common; they can be readily separated from larvae of *Helophilus* only when they are still living and their tracheal trunks can be easily seen. Life histories are poorly known, but most species are probably bivoltine or multivoltine. Eggs are laid in masses in the larval habitat. Pupation is in a puparium, and pupae may have respiratory horns. Adults feed on nectar from flowers.

TABANIDAE - Deer Flies and Horse Flies (4 genera, 27 species)

Some species are aquatic, but most have semiaquatic larvae. Larvae of *Chrysops* are fairly common in both lotic and shallow lentic habitats; those of *Tabanus, Atylotus,* and *Hybomitra* are uncommon in shallow ponds and marshes. Eggs are laid on emergent vegetation, the newly hatched larvae dropping into the water where they prey on smaller invertebrates. Larvae leave the water to pupate in moist soil. Adults feed on humans and other mammals in late spring and early summer. Most species are probably univoltine.

KEY TO GENERA OF AQUATIC DIPTERA LARVAE IN WISCONSIN

1. Larva apparently 7-segmented, segments 1-6 each with a prominent ventral sucker (Fig. 1) . . . . . .**BLEPHARICERIDAE, *Blepharicera***

Without 6 ventral suckers **2**

2(1). Head capsule completely sclerotized and fully visible (Figs. 11-16, 18-21); mandibles opposed, moving in a horizontal plane . . . . . .NEMATOCERA **12**

Head capsule absent, incomplete behind, or retracted at least partially into thorax **3**

3(2). Head capsule rounded, often incomplete (Figs. 34-38), more or less retracted into thorax (Fig. 33); mandibles opposed, moving horizontally . . . . . .NEMATOCERA, TIPULIDAE **41**

Head capsule lacking, or elongate and truncate if at least partially sclerotized (Figs. 2-6, 8-10, 22-23); mandibles moving vertically . . BRACHYCERA **4**

4(3). **BRACHYCERA** - Head mostly visible, truncate in shape (Figs. 2, 23-24); body dorsoventrally flattened; margin of posterior spiracular chamber usually with long, soft setae (Fig. 2) . . . . . STRATIOMYIDAE **21**

Head vestigial or mostly retracted into thorax and elongate; body nearly circular in cross section; spiracular chamber without long, soft setae **5**

5(4). Larva with partially retractile caudal respiratory tube at least half as long as body (Fig. 3) . . . . . SYRPHIDAE **39**

Larva without long respiratory tube **6**

6(5). Caudal spiracular disc with palmate hairs surrounded by 8-10 lobes, some of which may be very short (Fig. 24); body wrinkled (Fig. 4) . . . . . SCIOMYZIDAE **30**

Caudal spiracular disc without palmate hairs; if surrounded by lobes, body not wrinkled 7

7(6). Prolegs indistinct or absent; paired or elongate terminal processes lacking (Figs. 5-6) 8

Abdomen with distinct prolegs and paired or elongate terminal processes (Figs. 7-9) 9

8(7). Body tapered at both ends; a girdle of pseudopods on each segment (Fig. 5) . . . . . TABANIDAE **28**

Body terminating in a spiracular pit surrounded by pointed lobes; pseudopods only ventrally (Fig. 6) . . . . . .**DOLICHOPODIDAE** (no key)

9(7). Terminal processes ciliated, divergent, longer than prolegs (Fig. 7) . . . . . **ATHERICIDAE,** ***Atherix***

Terminal processes not ciliated, usually shorter than prolegs 10

10(9). Head with palpi and antennae visible; < 4 mm long (Fig. 8) . . . . . EMPIDIDAE **84**

Head structure lacking; often > 4 mm long **11**

11(10). Posterior prolegs as long as or longer than respiratory tubes (Fig. 9) . . . . . **MUSCIDAE** (no key)

Posterior prolegs absent or shorter than respiratory tube(s) (Fig. 10) . . . . . **EPHYDRIDAE** (no key)

12(2). **NEMATOCERA (part)** - Prolegs absent (Figs. 11, 14-15). 13

Prolegs present at one or both ends of body, or on abdominal segments (Figs. 16, 18-20) **16**

13(12). Thoracic segments fused and distinctly thicker than abdomen (Fig. 11) 14

Thorax and abdomen subequal in diameter (Figs. 14-15) 15

14(13). Antenna prehensile, with long, strong apical spines (Fig. 12) . . . . . .CHAOBORIDAE **54**

Antenna not prehensile, lacking long apical spines (Fig. 13) . . . . . .CULICIDAE **56**

15(13). Thoracic and abdominal segments each distinctly divided into 2 or 3 annuli (Fig. 14) . . . . . .PSYCHODIDAE **64**

No secondary annuli (Fig. 15) . . . . . CERATOPOGONIDAE **65**

16(12). Prolegs on abdominal segments (Figs. 16, 18) . . . **17**

Prolegs on anterior and/or posterior ends of body only (Figs. 19-20) 18

17(16). Paired ventral prolegs on abdominal segments 1-2 (Fig. 16); posterior end of body with 2 pairs of fringed processes (Fig. 17) . . . . . DIXIDAE **76**

Paired ventral prolegs on abdominal segments 1-3: posterior end of body with long respiratory tube (Fig. 18) . . . . . .PTYCHOPTERIDAE **77**

18(16). Only posterior prolegs present . . . . . .**CERATOPOGONIDAE,** ***Dasyhelea***

Anterior prolegs present (Figs. 19-20) 19

19(18). Prolegs present only on prothorax; posterior of abdomen swollen and with terminal sucker (Fig. 19) . . . . . .SIMULIIDAE **78**

Posterior prolegs almost always present; posterior of abdomen not swollen, lacking terminal sucker . **20**

20(19). Body covered with long, strong spines or bristles (Fig. 21) . . . . .**CERATOPOGONIDAE,** ***Atrichopogon***

Body at most covered with setae . . . . . CHIRONOMIDAE **91**

21(4). **STRATIOMYIDAE** - Last abdominal segment lacking coronet of plumose or pinnate setae . . . . . ***Nemotelus***

Last abdominal segment with coronet of plumose or pinnate setae at apex **22**

22(21). Antenna dorsal, not at apex of ocular lobe (Fig. 22). **23**

Antenna at apex of ocular lobe (Fig. 23) **25**

23(22). Ventral curved spines absent from posterior margin of abdominal segment 7 . . . . . ***Oxycera***

Ventral curved spines on posterior margin of abdominal segment 7 (may be concealed beneath preceding segment) **24**

24(23). Prothoracic spiracles on long stalk . . . . ***Euparyphus***

Prothoracic spiracles not on long stalk .***Caloparyphus***

25(22). Ventral curved spines on posterior margin of abdominal segment 7 (may be concealed beneath preceding segment **26**

Ventral curved spines absent from posterior margin of abdominal segment 7 . . . . . .**27**

26(25). Ventral curved spines also on posterior margin of abdominal segment 6.***Odontomyia*** or ***Hedriodiscus***

Ventral curved spines only on abdominal segment 7. . . . . ***Odontomyia***

27(25). Last abdominal segment < twice as long as basal width . . . . . .***Odontomyia***

Last abdominal segment > twice basal width . . . . . ***Stratiomys***

28(8). **TABANIDAE** - Anterior abdominal segments with 4 pseudopods and 2 dorsal welts; < 20 mm long . . . . . ***Chrysops***

Anterior abdominal segments with 6 pseudopods and 2 dorsal welts; often > 20 mm long **29**

29(28). Median lateral surfaces of anal segment with pubescent markings **or** striations absent or poorly developed dorsally and/or ventrally on abdomen . . . . . ***Tabanus*** or ***Atylotus***

Median lateral surfaces of anal segment lack pubescent markings; striations present dorsally and ventrally on all abdominal segments, **if absent,** pubescence restricted, at most, to a prothoracic annulus and anal ridges . . . . . ***Hybomitra***

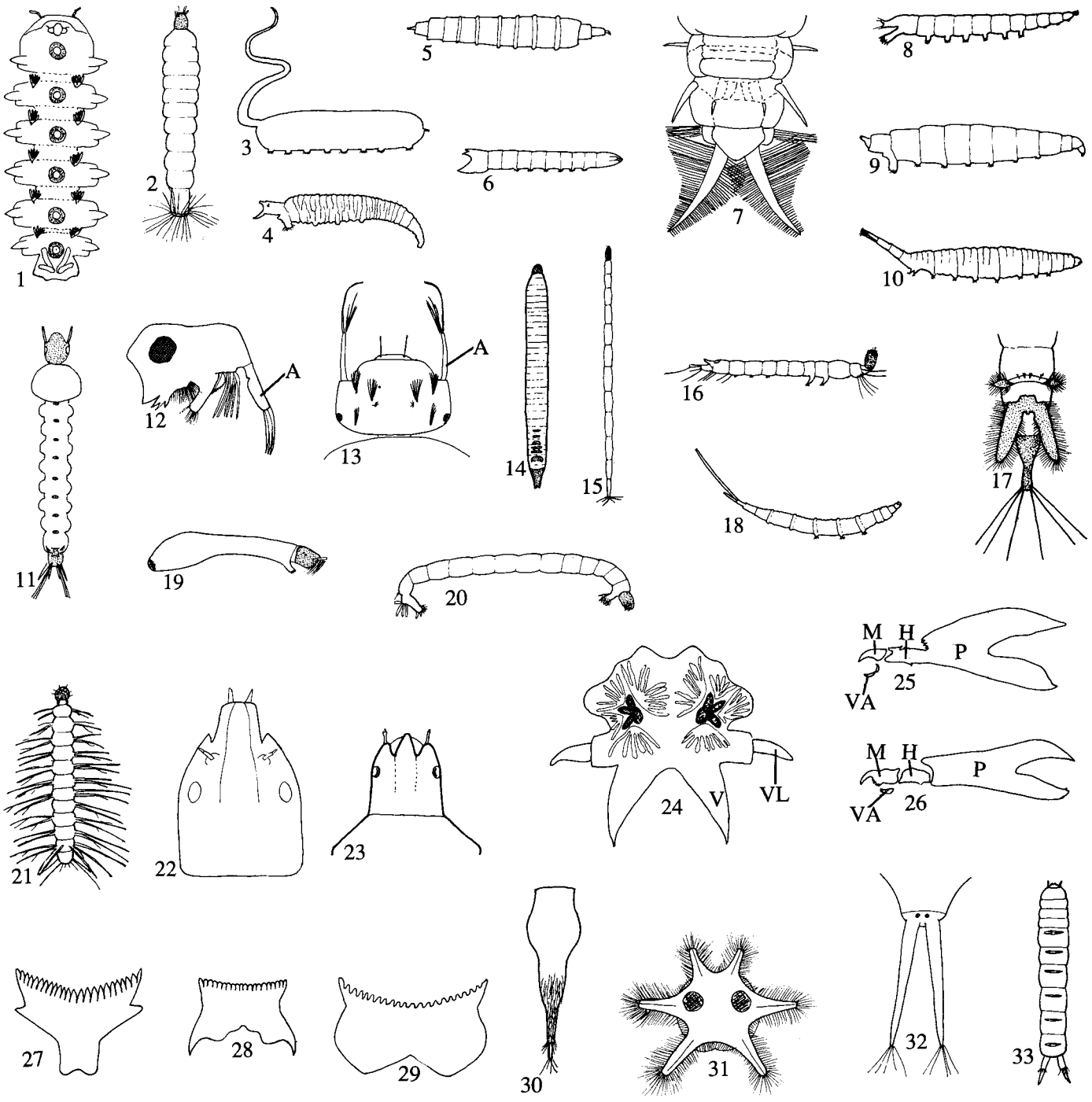
30(6). **SCIOMYZIDAE** - Patches of spinules present ventrally **31**

Patches of spinules absent **34**

31(30). Integument with thick coat of transparent spinules; palmate hairs surrounding posterior spiracles; ventral or ventrolateral lobes of spiracular disc elongate (Fig. 24) . . . . . ***Antichaeta***

Integument without thick coat of transparent spinules; posterior spiracles without palmate hairs; ventral and ventrolateral lobes of spiracular disc short . .**32**

32(31). Anterior spiracles bifid . . . . . ***Colobaea***



Figures 1-33. Diptera Larvae. 1. *Blepharicera* (ventral). 2. *Odontomyia* (dorsal). 3. *Eristalis* (lateral). 4. *Tetanocera* (lateral). 5. *Chrysops* (lateral). 6. Dolichopodidae (lateral). 7. Terminal segments *Atherix* (dorsal). 8. Empididae (lateral). 9. *Limnophora* (lateral). 10. Ephydridae (lateral). 11. *Anopheles* (dorsal). 12. Head *Chaoborus* with prehensile antenna (A). 13. Head *Coquillettidia* with antenna (A). 14. *Psychoda* (dorsal). 15. *Palpomyia* (dorsal). 16. *Dixella* (lateral). 17. Terminal segments *Dixa* (dorsal). 18. *Ptychoptera* (lateral). 19. *Simulium* (lateral). 20. *Chironomus* (lateral). 21. *Atrichopogon* (dorsal). 22-23. Head (dorsal): 22. *Euparyphus*. 23. *Odontomyia*. 24. Spiracular disk *Sepedon* with ventral (V) and ventrolateral (VL) lobes. 25-26. Head sclerites with ventral arch (VA), mouth hooks (M), hypostomial sclerite (H), and pharyngeal sclerite (P): 25. *Renocera*. 26. *Dictya*. 27-29. Ventral arch: 27. *Dictya*. 28. *Sepedon*. 29. *Elgiva*. 30. Terminal segments *Hesperoconopa*. 31-32. Spiracular disk: 31. *Prionocera*. 32. *Dicranota*. 33. *Antocha* (dorsal).

Anterior spiracles circular, not divided 33

33(32). Lobes of spiracular disc reduced, only ventral lobes distinct . . . . . *Sciomyza*

At least ventral and ventrolateral lobes distinct . . . . . *Pherbellia, Pteromicra, Atrichomelina*

34(30). Hypostomal and pharyngeal sclerites fused (Fig. 25). . . . . *Renocera*

Hypostomal and pharyngeal sclerites separate (Fig. 26) 35

35(34). Ventral arch triangular (Fig. 27); integument black; 8 lobes on spiracular disc . . . . . *Dictya*

Ventral arch bilobed (Figs. 28-29); 8 or 10 lobes on spiracular disc 36

36(35). Spiracular disc with 10 lobes (Fig. 24); ventral arch with posterolateral projections (Fig. 28) . *Sepedon*

Spiracular disc with 8 lobes; ventral arch without posterolateral projections (Fig. 29) 37

37(36). Postanal portion of segment 12 much longer than wide . . . . . *Elgiva*

Postanal portion of segment 12 about as long as wide 38

38(37). Lateral, ventrolateral, and ventral lobes of spiracular disc elongate, subequal . . . . . *Hedria*

Lateral lobes much shorter than subequal ventrolateral and ventral lobes . . . . . *Tetanocera*

39(5). **SYRPHIDAE** - Extended respiratory tube about 1/2 length of body . . . . . *Chrysogaster*

Extended respiratory tube much longer than body .40

40(39). Longitudinal tracheal trunks straight . . . . . *Eristalis*

Longitudinal tracheal trunks undulating . *Helophilus*

41(3). **NEMATOCERA, TIPULIDAE** - Body covered with very long spines; lentic . . . . . *Phalacrocera*

Body without long spines; lotic or lentic 42

42(41). Abdomen terminating in a single elongate lobe (Fig. 30); spiracles absent; lotic . . . . . *Hesperoconopa*

Abdomen terminating in two or more lobes, which usually surround a spiracular disc (Figs. 31-33, 39-42); spiracles usually visible 43

43(42). Spiracular disc surrounded by 6 or 8 lobes 44

Spiracular disc surrounded by 5 or fewer lobes . . .45

44(43). Spiracular lobes elongate, digitiform, and fringed with long setae (Fig. 31); lentic . . . . . *Prionocera*

Spiracular lobes not elongate or fringed with long setae, often bifid; lotic . . . . . *Tipula*

45(43). Spiracular disc with dorsal and lateral lobes absent or obsolete; ventral lobes elongate (Figs. 32-33); lotic 46

Spiracular disc with lateral lobes and often dorsal lobe distinct; if ventral lobes are elongate, lateral lobes are distinct (Figs. 39, 41); lotic or lentic 48

46(45). Conspicuous dorsal and ventral creeping welts; spiracles absent (Fig. 33) . . . . . *Antocha*

Dorsal welts absent; prolegs or pseudopods ventrally; spiracles conspicuous 47

47(46). Conspicuous cylindrical prolegs on abdominal segments 3-7 . . . . . *Dicranota*

Ventral raised welts or pseudopods on abdominal segments 4-7 . . . . . *Pedicia*

48(45). Blades of maxillae projecting from retracted head; head capsule 4-6 slender rods, posterior incisions deep (Figs. 34-36); lotic 49

Blades of maxillae do not project from retracted head; head capsule massive and complete with narrow posterior incisions (Fig. 37); lotic or lentic 51

49(48). Dorsal plate of head united into posterior spatula (Fig. 34); ventral spiracular lobes elongate, with very long fringe of hair (Fig. 39) . . . . . *Pilaria*

Dorsal plate of head not united into spatula (Figs. 35-36); hair fringe on ventral lobes not exceptionally long (Fig. 40) 50

50(49). Mentum a narrow, sclerotized transverse bar (Fig. 38); dorsum of head mostly membranous (Fig. 35) . . . . . *Limnophila*

Mental region not sclerotized; dorsum of head with divided plates anteriorly (Fig. 36). . . . . *Hexatoma*

51(48). Abdomen with creeping welts; lotic or lentic 52

Abdomen without creeping welts; lotic 53

52(51). Dorsal and ventral creeping welts; lotic . . . *Limonia*

Only 6 ventral welts; body covered with long, dark pubescence; lentic . . . . . *Helius*

53(51). Spiracular disc with 4 lobes (Fig. 41) . . . . . *Pseudolimnophila*

Spiracular disc with 5 lobes (Fig. 42) . . . . *Erioptera*

54(14). **CHAOBORIDAE** - Abdominal segment 8 with dorsal respiratory siphon . . . . . *Mochlonyx*

No respiratory siphon on abdominal segment 8 . . .55

55(54). Dark air sacks in thorax and abdominal segment 7 . . . . . *Chaoborus*

Dark air sacks lacking . . . . . *Eucorethra*

56(14). **CULICIDAE** - Abdominal segment 8 without respiratory siphon (Fig. 11) . . . . . *Anopheles*

Respiratory siphon on abdominal segment 8 (Figs. 44-49) 57

57(56). Siphon with pecten (Figs. 44-47) 58

Siphon without pecten (Figs. 48-49) 62

58(57). Upper and lower head hairs single, spine-like (Fig. 43) . . . . . *Uranotaenia*

Upper and lower head hairs not spine-like 59

59(58). Siphon with pair of large basoventral hair tufts (Fig. 44) . . . . . *Culiseta*

Siphon without such hair tufts (Figs. 45-47) 60

60(59). Siphon with several pairs of ventral tufts, some of which may be single long hairs (Fig. 45) . . *Culex*

Siphon with only a single pair of ventral tufts, or none (Figs. 46-47) 61

61(60). Ventral brush of anal segment with several tufts arising out of sclerotized ring (Fig. 46) . . . . . *Psorophora*

Ventral brush of anal segment with all tufts posterior to sclerotized ring (Fig. 47), or sclerotized ring incomplete ventrally . . . . . *Aedes*

62(57). Siphon triangular and very short (Fig. 48); head wider than long . . . . . *Coquillettidia*

Siphon conical and elongate; head as long as wide.63

63(62). Siphon with many single hairs (Fig. 49); in pitcher plants . . . . . *Wyeomyia*

Siphon with a single pair of highly branched tufts; in tree hole and containers ..... *Orthopodomyia*

64(15). **PSYCHODIDAE** - Twenty-six dorsal plates; paired adanal plates and single preanal plate (Fig. 50) ... . *Pericoma*

Dorsal plates absent or numbering less than 26 (Fig. 14); adanal plate single and transverse, preanal plate absent ..... *Psychoda*

65(15). **CERATOPOGONIDAE** - Head ≤ twice as long as wide, and posterior collar of uniform width ventrally (Fig. 51) **66**

Head > twice as long as wide **or** ventral collar of head with triangular of hemispherical expansion (Figs. 52-53) **71**

66(65). Head very small compared to body, about 1/3 length of anal segment (Fig. 54) ..... *Serromyia*

Head larger **67**

67(66). Antennae obviously protruding ..... *Stilobezzia*

Antennae not protruding **68**

68(67). Anal segment with long dark setae, equal to length of segment ..... *Alluaudomyia*

Anal segment with setae < 1/2 length of segment . **69**

69(68). Anal segment with stout black setae, 1/3 length of segment ..... *Monohelea*

Anal segment with short, pale setae **70**

70(69). A long sclerotized suture on ventral side of head (Fig. 51) ..... *Ceratopogon*

No long sclerotized suture on ventral side of head .. .. *Culicoides*

71(65). Mandible long, about 1/3 length of head .... *Clinohelea* or *Heteromyia*

Mandible no more than 1/6 length of head **72**

72(71). Four thick setae on anal segment 1/2-3/4 length of segment; posterior collar of head of uniform width ventrally, if somewhat elongate, head < 1.7 times as long as wide ..... *Bezzia* or *Palpomyia*

Four thick setae on anal segment about 1/3 length of segment; posterior collar of head with ventral triangular or hemispherical expansion (Figs. 52-53) **73**

73(72). Body with spots of black pigment ..... *Nilobezzia*

Body pigment brown **74**

74(73). Head < 1.8 times as long as wide, ventral collar with triangular expansion (Fig. 52) ..... *Sphaeromias*

Head > 1.8 times as long as wide, ventral collar with hemispherical expansion (Fig. 53) **75**

75(74). Head > twice as long as wide, with anterior strongly narrowed (Fig. 53) ..... *Probezzia*

Head < twice as long as wide, not strongly narrowed anteriorly ..... *Mallochohelea*

76(17). **DIXIDAE** - Dorsum of abdomen bare or nearly so . ..... *Dixella*

Dorsum of abdomen with rosettes of hair on segments 2-7 ..... *Dixa*

77(17). **PTYCHOPTERIDAE** - Body pale; prolegs weakly developed ..... *Ptychoptera*

Body rust-colored; prolegs well-developed .... *Bittacomorpha*

78(19). **SIMULIIDAE** - Labral fan absent; anal sclerite Y-shaped ..... *Twinnia*

Labral fan present; anal sclerite X-shaped, rectangular, or absent **79**

79(78). Antennomeres 1-2 colorless, 3-4 dark brown or black; mentum with laterally notched middle tooth and 3 pairs of large lateral teeth with smaller teeth between them (Fig. 55) ..... *Prosimulium*

Antennomeres 3-4 not sharply contrasting with basal segments; mentum not as above (Figs. 56, 59-60). **80**

80(79). Mentum with large middle tooth and large tooth on each side separated from the middle tooth by 3 smaller teeth (Fig. 56) ..... *Simulium*

Mentum variable, but without 3 large subequal teeth, each separated by 3 smaller teeth **81**

81(80). Abdominal segment 8 with pair of ventral, cone-shaped tubercles (Figs. 57-58) **82**

Abdominal segment 8 without cone-shaped tubercles, sometimes with transverse mid-ventral bulge ... **83**

82(81). Abdomen greatly and abruptly expanded at segment 5 (Fig. 57); anal sclerite absent ..... *Ectemnia*

Abdomen not expanded at segment 5 (Fig. 58); anal sclerite present ..... *Greniera*

83(81). Mentum with uniformly small teeth; throat cleft rounded anteriorly (Fig. 59) ..... *Cnephia*

Mentum with 3 distinct groups of teeth; throat cleft a small inverted V-shape (Fig. 60) .... *Stegopterna*

84(10). **EMPIDIDAE** - Seven pairs of abdominal prolegs. **85**

Eight pairs of abdominal prolegs **86**

85(84). Last abdominal segment with at most small dorsal and apical tubercles, each with 1-3 pairs of long setae ..... *Chelifera*

Last abdominal segment with a single, mesally-divided, setose, caudal lobe ..... *Hemerodromia*

86(84). Last abdominal segment with 2 dorsolateral lobes and a partially divided apical lobe ..... *Clinocera*

Last abdominal segment with 2 pairs of lobes ... **87**

87(86). Prolegs and caudal lobes rounded and very short ... . *Dolichocephala*

Prolegs and caudal lobes elongate **88**

88(87). Dorsolateral lobes on last segment longer than apical lobes **89**

Dorsolateral and apical lobes on last segment subequal **90**

89(88). Posterior spiracles present ..... *Roederoides*

Posterior spiracles absent ..... *Clinocera*

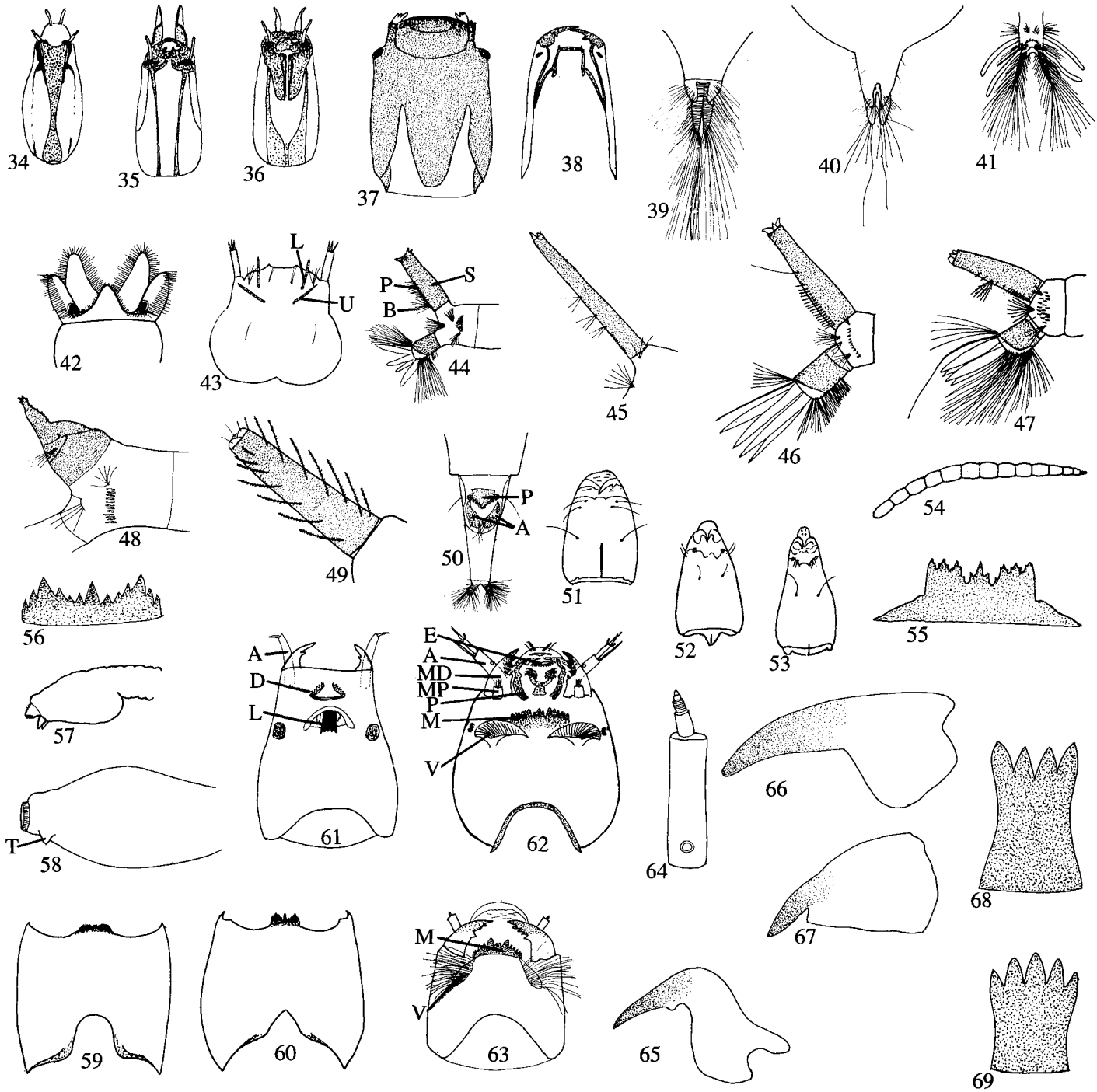
90(88). Group of 6 setae laterad of prolegs 1-7 .. *Oreogeton*

No setae laterad of prolegs 1-7 ..... *Wiedemannia*

91(20). **CHIRONOMIDAE** - Antenna retractile with basal segment usually elongate; sclerotized ligula with 4-7 teeth; mentum membranous or with dorsomental combs. (Fig. 61) ..... TANYPODINAE **96**

Antenna non-retractile; sclerotized ligula absent; mentum usually with distinct teeth (Figs. 62-63).**92**

92(91). Procercus > 5 times as long as wide; premandibles absent ..... **PODONOMINAE, *Parochlus***



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Procercus rarely > 4 times as long as wide; premandibles present 93

93(92). Striated ventromental plates present (Fig. 62) . . . . . .CHIRONOMINAE **157**

Ventromental plates, if present, never striated, but sometimes bearded (Fig. 63) 94

94(93). Antennomere 3 annulated (Fig. 64) . . . . . DIAMESINAE **118**

Antennomere 3 not annulated 95

95(94). Ventromental plates large, heavily bearded (Fig. 63) or mesally pointed (Fig. 81) . . . . . .PRODIAMESINAE **121**

Ventromental plates, if present, small, rounded, or laterally pointed, not heavily bearded (Figs. 92-96) . . . . . .ORTHOCLADINAE, **123**

96(91). **TANYPODINAE** - Ligula (Fig. 61) with 6 or 7 teeth 97

Ligula with 4 or 5 teeth 98

97(96). Ligula with 6 teeth; mandible hook-like (Fig. 65) . . . . . ***Clinotanypus***

Ligula with 7 teeth; mandible curved (Fig. 66) . . . . . ***Coelotanypus***

98(96). Dorsomental combs present (Fig. 61) 99

Dorsomental combs absent 105

99(98). Ligula with black teeth 100

Ligula with yellow or reddish teeth 101

100(99). Ligula with 5 black teeth . . . . . ***Procladius***

Ligula with 4 black teeth . . . . . ***Djalmabatista***

101(99). Ligula with 4 teeth (Fig. 68) . . . . . ***Psectrotanypus***

Ligula with 5 teeth (Fig. 69) 102

102(101). Toothed margin of ligula convex (Fig. 69); mandible with bulbous base and very minute lateral teeth (Fig. 67) . . . . . ***Tanypus***

Toothed margin of ligula straight or concave (Figs. 74-75); lateral teeth on mandible usually distinct 103

103(102). Inner corners of dorsomental combs produced (Fig. 70) . . . . . ***Brundiniella***

Inner corners of dorsomental combs rounded (Fig. 71) 104

104(103). Dorsomental comb with 4 large and 1 small teeth . . . . . ***Apsectrocladius***

Dorsomental comb with 8 teeth . . . ***Macropelopia***

105(98). Head about 3 times as long as antenna; body red; mandible with large, blunt lateral tooth and small accessory tooth . . . . . ***Natarsia***

Head seldom > twice as long as antenna; body never red; mandible variable 106

106(105). Maxillary palp with 2 or more wide basal segments (Fig. 72) . . . . . ***Ablabesmyia***

Maxillary palp with 1 wide basal segment 107

107(106). Procercus dark, ≥ 6 times as long as wide; anal papillae longer than prolegs (Fig. 73).***Pentaneura***

Procercus < 6 times as long as wide, usually pale; anal papillae not longer than prolegs 108

108(107). Middle tooth of ligula longer than first lateral teeth 109

Middle tooth of ligula smaller or subequal to first lateral teeth 110

109(108). Antennomere 2 or entire antenna brown . . . . . ***Labrundinia***

Entire antenna pale . . . . . ***Nilotanypus***

110(108). Basal antennomere 6.0-7.5 times as long as remaining segments; 3 medium-sized claws on posterior prolegs dark, 2 somewhat dark; head granulose . . . . . ***Guttipelopia***

Basal antennomere < 5.5 times as long as remaining segments; claws on posterior prolegs not as above; head not granulose 111

111(110). Toothed margin of ligula straight, teeth subequal (Fig. 74); one small claw on posterior proleg with a long tooth on inner edge . . . . . ***Zavrelimyia***

Toothed margin of ligula concave (Fig. 75); no small claw on posterior proleg with a long tooth 112

112(111). First lateral teeth of ligula not pointed outward; lateral teeth of mandibles distinct 113

First lateral teeth of ligula pointed outward (Fig. 75); lateral teeth of mandible minute and indistinct 114

113(112). Middle tooth of ligula very narrow, half width of outer teeth; claws of posterior proleg with distinct teeth, one claw dark . . . . . ***Monopelopia***

Middle tooth of ligula similar to size of other teeth; claws of posterior proleg pale and without distinct teeth . . . . . ***Larsia***

114(112). Maxillary palp with 2 apical segments 115

Maxillary palp with 3 apical segments 116

115(114). Posterior margin of head dark brown; antenna < twice length of mandible . . . . ***Thienemannimyia***

Posterior margin of head light brown; antennae ≥ twice length of mandible . . . . . ***Meropelopia***

116(114). Basal and accessory tooth of mandible vestigial; pseudoradula broad at base, strongly tapered apically . . . . . ***Rheopelopia***

Basal and accessory tooth of mandible reduced, but distinguishable; pseudoradula at most weakly tapered toward apex 117

117(116). Basal tooth of mandible about size of accessory tooth; pseudoradula broad, with about 8 rows of granules . . . . . ***Conchapelopia***

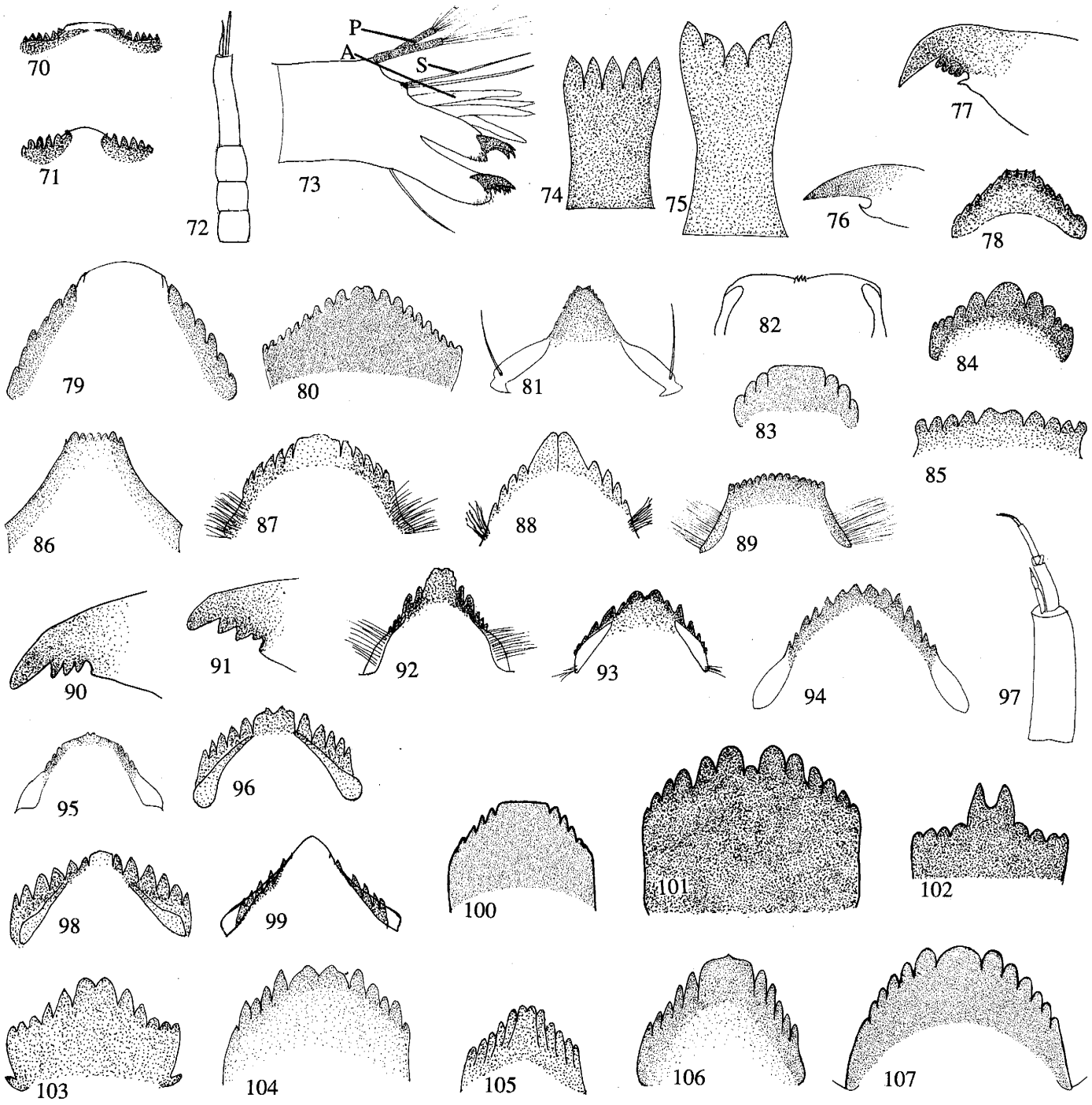
Basal tooth of mandible elongate, much larger than accessory tooth; pseudoradula narrow, with about 12 rows of granules . . . . . ***Helopelopia***

118(94). **DIAMESINAE** - Mandible with hook-shaped lateral tooth (Fig. 76); mentum without distinct teeth . . . . . ***Potthastia***

Mandible with 4 lateral teeth (Fig. 77); mentum with numerous strong teeth 119

119(118). Apical tooth of mandible distinctly longer than distance between first and fourth laterals (Fig. 77); mentum with truncate middle tooth and 5 pairs of lateral teeth (Fig. 78) . . . . . ***Pagastia***

Apical tooth of mandible shorter than distance between first and fourth laterals; mentum convex in center (Figs. 79-80) 120



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120(119). Middle of mentum with very broad pale tooth (Fig. 79) . . . . . ***Sympotthastia***
Middle of mentum dark with several teeth (Fig. 80) . . . . . ***Diamesa***

121(95). **PRODIAMESINAE** - Ventromental plate with only a few hairs (Fig. 81); middle of mentum concave with indistinct teeth (Fig. 81) . . . ***Monodiamesa***
Ventromental plate heavily bearded (Fig. 63); middle of mentum, if concave, with 2 distinct middle teeth (Fig. 63) **122**

122(121). Mentum inconspicuous with unpaired middle tooth; mandible circular and heavily bearded . . . . . ***Odontomesa***
Mentum distinct, with pair of central teeth (Fig. 63); mandible with small beard . . . . . ***Prodiamesa***

123(95). **ORTHOCLADINAE** - Antenna ≥ half as long as head, often with 1-2 dark segments **124**
Antenna < half as long as head, without dark segments **127**

124(123). Antennomere 2 and sometimes 1 or 3 darker than other segments **125**
All antennal segments similarly colored **126**

125(124). Antenna longer than head, 4-segmented, with segments 2 and often 3 dark . . . . ***Corynoneura***
Antenna slightly > half as long as head, 5-segmented, with segment 2 and sometimes 1 dark . . . . . ***Thienemanniella***

126(124). Antenna 4-segmented with apical segment very long and whip-like, several times longer than segment 3, segment 2 evenly sclerotized . . ***Lopescladius***
Antenna 5-segmented with apical segment not long and whip-like, segment 2 more sclerotized in basal half . . . . . ***Rheosmittia***

127(123). Only 2-3 small teeth visible in median concavity of mentum (Fig. 82); inhabits blue-green algae . . . . . ***Acamptocladius***
Mentum not as in Fig. 82; habitat variable . . . **128**

128(127). Procerci absent; anal prolegs reduced or absent.**129**
Procerci present; anal prolegs normal **130**

129(128). Mentum with reduced number of teeth (Fig. 83) . . . . . ***Pseudosmittia***
Mentum with 11 teeth (Fig. 84) . . . . . ***Smittia***

130(128). One seta on procercus ≥ 1/4 length of body . . **131**
No seta on procercus ≥ 1/4 length of body . . . **132**

131(130). Mandible with 3 lateral teeth; mentum with a pair of middle teeth and 4 lateral teeth (Fig. 85) . . . . . ***Pseudorthocladius***
Mandible with 2 lateral teeth; mentum with a single or slightly incised middle tooth and 4 lateral teeth . . . . . ***Parachaetocladius***

132(130). Body with numerous long, dark setae, many longer than a body segment; center of mentum truncated with several subequal teeth (Fig. 86); phoretic . . . . . ***Epoicocladius***
Body usually without long, dark setae; if such setae are present, middle of mentum is convex with only 1-2 teeth **133**

133(132). Several setae in region of ventromental plate . . **134**
Setae absent from region of ventromental plate.**139**

134(133). Ventromental plate inconspicuous (Figs. 87-88).**135**
Ventromental plate conspicuous (Figs. 89, 92-93) **136**

135(134). Mentum with 6 pairs of distinct lateral teeth and 3 broad, obscure, middle teeth that are indistinctly separated (Fig. 87) . . . . . ***Acricotopus***
Mentum with pair of large, elongate, middle teeth and 4 pairs of small lateral teeth (Fig. 88) . . . . . ***Synorthocladius***

136(134). Mentum with 4 middle teeth of nearly same size as 10 lateral teeth (Fig. 89) . . . . . ***Diplocladius***
If mentum has 14 teeth, they are unequal (Figs. 92-93) **137**

137(136). Mentum with broad middle tooth usually cleft or having protuberance in middle, and with 5 pairs of lateral teeth; lateral margin of ventromental plate straight; apical tooth of mandible elongate (Fig. 90); spur(s) at base of procercus . . . . . ***Psectrocladius***
Mentum convex with a pair of middle teeth; lateral margin of ventromental plates rounded; apical tooth of mandible not elongate (Fig. 91); spur(s) absent from base of procercus **138**

138(137). Procercus with medioposterior spur; ventromental plate large with numerous setae (Fig. 92); first lateral teeth of mentum large . . ***Rheocricotopus***
Procercus without spur; ventromental plate smaller, with few setae (Fig. 93); first lateral teeth of mentum reduced . . . . . ***Zalutschia***

139(133). Ventromental plate distinct (Figs. 94-96, 98-99).**140**
Ventromental plate indistinct (Figs. 100-108) . .**145**

140(139). Mentum with 14 teeth (Fig. 94) . . . . ***Hydrobaenus***
Mentum with 11 to 13 teeth (Figs. 95-96, 98-99)**141**

141(140). Mentum with broad middle tooth with twin mesal peaks (Fig. 95); last tooth of mandible much longer than distance between tips of laterals; phoretic . . . . . ***Nanocladius***
Mentum without twin mesal peaks (Figs. 96, 98-99); last tooth of mandible not distinctly longer than distance between laterals **142**

142(141). Mentum with a pair of middle teeth and 5 pairs of lateral teeth (Fig. 96) **143**
Mentum with a pale middle tooth and 5-6 pairs of lateral teeth (Figs. 98-99) **144**

143(142). Antenna longer than mandible, 7-segmented, with short segment 3 and vestigial apical segment (Fig. 97) . . . . . ***Heterotrissocladius***
Antenna shorter than mandible, 5-segmented . . . . . ***Chaetocladius***

144(142). Mentum with pale middle tooth and 6 pairs of darker lateral teeth, the first closely applied to middle tooth (Fig. 98) . . . . . ***Parakiefferiella***
Mentum with very convex pale middle tooth and 5 pairs of darker lateral teeth obscured in ventral view by ventromental plates (Fig. 99) . . . . . ***Stilocladius***[1]

145(139). Mentum very dark with broadly truncated middle tooth and 5 pairs of lateral teeth (Fig. 100) . . . . . ***Cardiocladius***
Mentum without broadly truncated, dark middle tooth **146**

146(145). Mentum black, with small middle tooth recessed between large first laterals (Fig. 101) . . . ***Brillia***
Mentum, if black, not as above **147**

147(146). Mentum black, with 2 very long middle teeth and 4 or 5 pairs of lateral teeth (Fig. 102) . ***Xylotopus***
Mentum not black, without 2 very long teeth . . **148**

148(147). Mentum with even number of teeth **149**
Mentum with odd number of teeth **153**

149(148). Middle teeth of mentum recessed between longer first lateral teeth . . . . . ***Metriocnemus***
Middle teeth of mentum projecting beyond first lateral teeth **150**

150(149). Mentum with distinct tooth-like lateral projection near base (Fig. 103) . . . . . ***Limnophyes***
Mentum without tooth-like lateral projection near base **151**

151(150). Middle body segments with some setae at least 1/2 as long as corresponding segment . . . . ***Tvetenia***
Middle body segments without long setae **152**

152(151). Third lateral teeth of mentum shorter than fourth laterals (Fig. 104) . . . . . ***Parametriocnemus***
Third lateral teeth of mentum as long as fourth laterals (Fig. 105) . . . . . ***Eukiefferiella***

153(148). Mentum with 11 teeth, middle tooth broad and peaked mesally (Fig. 106) **154**
If mentum has 11 teeth, middle tooth not broad and peaked mesally **155**

154(153). Head capsule testaceous to light brown; middle abdominal segments with some setae ≥ 1/2 length of segment . . . . . ***Tvetenia***
Head capsule brown; middle abdominal segments without long setae . . . . . ***Eukiefferiella***

155(153). Mentum with 11 teeth, little convexity, and a very broad middle tooth; ventromental plates above lateral edge of mentum cause it to appear thickened laterally . . . . . ***Paraphaenocladius***
Mentum with 13 or more teeth, if only 11 teeth are present, first 2 pairs of lateral teeth are small and obscure; mentum not thickened laterally . . . **156**

156(155). Mentum evenly colored and contoured, with rounded middle tooth and 6 or 9 pairs of lateral teeth (Fig. 107) . . . . . ***Orthocladius***
Mentum with the middle tooth and first two lateral teeth usually paler; several species, each with one or more of the following characteristics: mentum with only 7 or 9 teeth; outer edge of mandible crenulate (Fig. 109); inner margin of mandible with serrations (Fig. 110); second lateral teeth very closely applied to first laterals (Fig. 108); body with hair pencils on posterolateral margins of posterior abdominal segments (Fig. 111) . . . . . ***Cricotopus***

157(93). **CHIRONOMINAE** - Antenna on dorsal protuberance of head, which is always longer than broad (Fig. 112); antennomere 1 curved, ≥ 6 times as long as wide (Fig. 112) . . . . . .TANYTARSINI **158**
Antenna not on large protuberance; antennomere 1 not distinctly curved, < 4 times as long as wide . . . . . .CHIRONOMINI **164**

158(157). **TANYTARSINI** - Ventromental plates well separated, pointed at inner apices (Fig. 113) .**159**
Ventromental plates almost meeting, bluntly rounded at inner apices (Fig. 114) **160**

159(158). Inner apical spur of antennal tubercle extremely long and simple (Fig. 115): antennomere 2 as long or longer than 3-5 combined . . . . . ***Stempellinella***
Inner apical spur of antennal tubercle large and palmate (Fig. 116); antennomere 2 about half length of 3-5 combined . . . . . ***Stempellina***

160(158). Lauterborn organs large, longer than petiole (Fig. 117) **161**
Lauterborn organs small, < half as long as petiole (Fig. 118) **162**

161(160). Lauterborn organ small, > twice length of very short petiole; claws of posterior prolegs without serrate inner margins . . . . . ***Paratanytarsus***
Lauterborn organ large, 1/3 longer than petiole (Fig. 117); some claws on posterior prolegs serrate on inner margin . . . . . ***Cladotanytarsus***

162(160). Lauterborn organ about 1/3 as long as petiole; lotic . . . . . ***Rheotanytarsus***
Lauterborn organ < 1/5 as long as petiole; lotic or lentic **163**

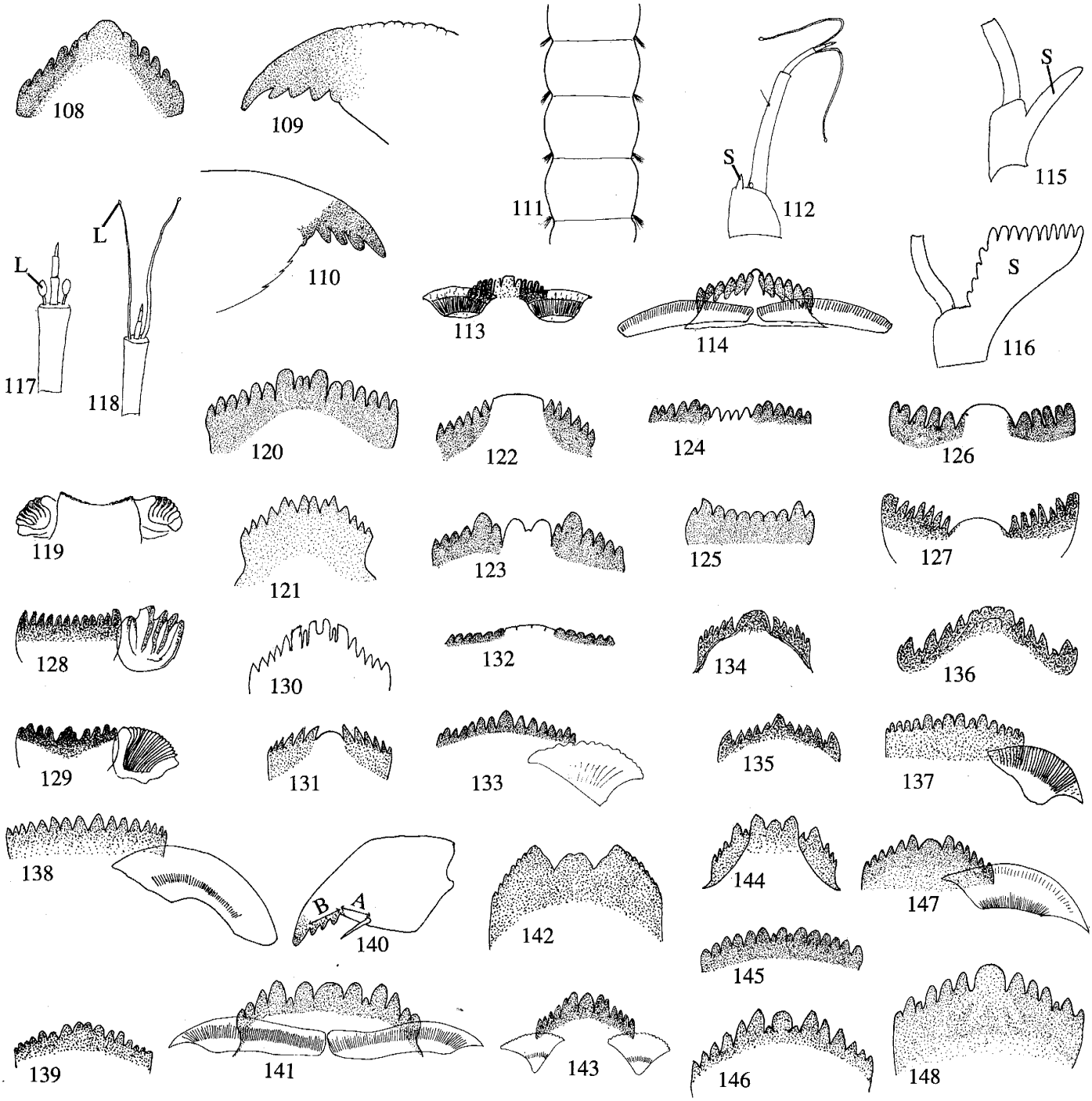
163(162). Antennal tubercle usually with an inner apical spur (Fig. 112); premandible bifid; claws on posterior prolegs usually numerous, arranged in a horse-shoe of several irregular rows . . . ***Micropsectra***
Antennal tubercle usually without a spur at apex; premandible with more than 2 teeth; claws on posterior prolegs usually few, arranged as a horse-shoe in a single row . . . . . ***Tanytarsus***

164(157). **CHIRONOMINI** - First 7 abdominal segments divided, giving appearance of 20 segmented body; mentum weakly concave with indistinct teeth laterally (Fig. 119) . . . . . ***Chernovskiia***
First 7 abdominal segments not divided; mentum, if concave, with dark lateral teeth **165**

165(164). Antenna 6-segmented, with large lauterborn organs alternating on segments 2 and 3 . . . . . **166**
Antenna usually 5- or 7-segmented, without large lauterborn organs **170**

166(165). All teeth on mentum unicolorous **167**
Middle of mentum paler than lateral teeth **168**

167(166). Mentum with small middle pair of teeth and large first laterals clearly anterior to remaining laterals (Fig. 120); mentum with 16 teeth . . . . . ***Stictochironomus***



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Mentum with 14 teeth, middle pair and second laterals long, first laterals small (Fig. 121) . . . . . ***Lauterborniella***

168(166). Mentum with single, pale, broad, middle tooth and 6 dark laterals that are progressively shorter (Fig. 122) . . . . . ***Paralauterborniella***

Mentum with at least 2 pale middle teeth **169**

169(168). Mentum with 2 pale middle teeth and often a minute tooth between them; lateral teeth dark, second laterals longest (Fig. 123) . . . . . ***Microtendipes***

Mentum with middle and first lateral teeth pale; third lateral teeth longest (Fig. 124).***Paratendipes***

170(165). Mentum concave, with 10 subequal dark teeth (Fig. 125) . . . . . ***Stenochironomus***

Mentum convex, if concave, middle is dome-shaped and pale (Figs. 126-127) **171**

171(170). Mentum strongly concave, with pale dome-shaped middle and oblique darker lateral teeth (Figs. 126-127) **172**

Mentum convex, center usually with teeth **174**

172(171). Mentum with 5 pairs of dark lateral teeth in addition to dark lateral margins of dome-shaped middle (Fig. 126) . . . . . ***Cryptochironomus***

Mentum with 7 pairs of dark lateral teeth in addition to dark lateral margins of dome-shaped middle (Fig. 127) **173**

173(172). Antenna 7-segmented . . . . ***Demicryptochironomus***

Antenna 5-segmented . . . . . ***Gillotia***

174(171). Antenna 7-segmented **175**

Antenna with 5 segments, rarely 6 . . . . . **176**

175(174). Mentum with 12 or 14 subequal teeth (Fig. 128) . . . . . ***Robackia***

Mentum with trifid middle tooth and 4 pairs of lateral teeth (Fig. 129) . . . . . ***Beckidia***

176(174). Larva < 5 mm long; mentum with 16 pale teeth (Fig. 130); mandible with 4 pale lateral teeth . . . . . ***Pagastiella***

Larva often > 5 mm long; mentum and mandible with at least some dark teeth **177**

177(176). Mentum with broad, unnotched, middle tooth, that is paler than lateral teeth (Fig. 131); mandible with long apical tooth and projecting clump of 4 lateral teeth . . . . . ***Nilothauma***

Mentum of nearly uniform color or with medially notched pale middle tooth (Fig. 132); mandible without projecting clump of 4 lateral teeth . .**178**

178(177). Mentum with broad, often notched, middle tooth, that is often paler than lateral teeth (Fig. 132); basal segment of maxillary palp > half as long as antennomere 1 . . . . . **179**

Mentum of nearly uniform color (Figs 133-136); basal segment of maxillary palp < half as long as antennomere 1 . . . . . **180**

179(178). Mandible with pointed lateral teeth: antennomere 2 much longer than 3 . . . . . ***Paracladopelma***

Mandible with flattened lateral teeth: antennomere 2 about as long as 3 . . . . . ***Harnischia***

180(178). Ventromental plate deeply scalloped anteriorly (Fig. 133); mentum with 7 pairs of subequal pointed lateral teeth and pointed or mesally notched middle tooth (Fig. 133) . . . . . ***Parachironomus***

Ventromental plate not deeply scalloped anteriorly; if scalloped, mentum with only 6 pairs of lateral teeth **181**

181(180). Mentum with 1-3 outside lateral teeth enlarged and projecting forward beyond adjacent lateral teeth (Figs. 134-136); mandible with some lateral teeth flattened apically **182**

Outside lateral teeth not enlarged and projecting; lateral teeth of mandible pointed **185**

182(181). Mentum with middle tooth single and broadly rounded (Fig. 134) **183**

Mentum with middle tooth trifid, medially notched, or double (Figs. 135-136) **184**

183(182). Antenna 6-segmented, antennomere 2 much shorter than 3, with antennal blade at apex; premandible with 3 large blades . . . . . ***Saetheria***

Antenna 5-segmented, antennomere 2 much longer than 3; premandible with 2 long blades . . . . . ***Cryptotendipes***

184(182). Mentum with middle tooth trifid (Fig. 135) . . . . . ***Microchironomus***

Mentum with middle tooth notched or double (Fig. 136) . . . . . ***Cladopelma***

185(181). Mentum with a pair of middle teeth **186**

Mentum with a single middle tooth **190**

186(185). First lateral teeth of mentum much shorter than middle and second lateral teeth (Fig. 137), or subequal to them (Fig. 138) **187**

First lateral teeth of mentum longer than second laterals and usually longer than middle teeth (Fig. 139) **188**

187(186). Ventromental plate triangular laterally with lateral corners pointed; first lateral tooth of mentum usually shorter than adjacent teeth (Fig. 137) . . . . . ***Polypedilum***

Ventromental plate nearly parallel-sided laterally, with lateral corners rounded; middle 6 teeth on mentum subequal in length (Fig. 138) . ***Asheum***[2]

188(186). Middle teeth of mentum fused for much of their length (Fig. 139); ventromental plate 3-4 times as wide as long; antennal blade not reaching to tip of antennomere 4 . . . . . ***Endochironomus***

Middle teeth almost as distinctly separated from each other as from first lateral teeth; ventromental plate at most 3 times as wide as long; antennal blade reaching past tip of antennomere 4 . . .**189**

189(188). Distance from basal notch of inner mandibular teeth to insertion of nearby seta (A) < three-fourths distance to apical notch (B) (Fig. 140) . ***Tribelos***

Distance from basal notch of inner mandibular teeth to insertion of nearby seta (A) ≥ three-fourths distance to apical notch (B) . . . . ***Phaenopsectra***

190(185). Ventromental plates rounded mesally and separated from each other by less than width of middle tooth of mentum (Fig. 141) . ***Pseudochironomus***

Ventromental plates separated by more than width of middle tooth 191

191(190). Mentum nearly black with recessed, middle tooth that may be trifid, very large first laterals, and remaining laterals inconspicuous (Fig. 142); in freshwater sponges . . . . . ***Xenochironomus***

Mentum with conspicuous lateral teeth; not in freshwater sponges **192**

192(191). Ventromental plate < 1 1/2 times as wide as long, crenulate anteriorly (Fig. 143); second lateral teeth on mentum often closely applied to first laterals (Fig. 143) . . . . . ***Dicrotendipes***

Ventromental plate ≥ twice as wide as long; second lateral teeth on mentum not closely applied to first laterals **193**

193(192). Middle tooth of mentum shorter than first lateral teeth, second lateral teeth much smaller than adjacent teeth (Fig. 144) . . . . . ***Endotribelos***[3]

Middle tooth of mentum nearly a long or longer than first laterals, second laterals never much smaller than adjacent teeth (Figs. 145-148) **194**

194(193). Body with 2 pairs of ventral tubules; mentum with trifid middle tooth and 6 pairs of lateral teeth (Fig. 145) . . . . . ***Chironomus***

Body with at most 1 pair of tubules; mentum with simple or notched middle tooth (Figs. 146-148) 195

195(194). Middle tooth of mentum deeply notched near base (Fig. 146); premandible with 6 pointed teeth . . . . . ***Kiefferulus***

Middle tooth of mentum simple or slightly notched (Fig. 147-148); premandible bifid apically . . **196**

196(195). Ventromental plate at least 3 times as wide as long; mentum with middle tooth simple, subequal to or smaller than first laterals (Fig. 147) . . . . . ***Glyptotendipes***

Ventromental plate about twice as wide as long; mentum with very large middle tooth and conspicuously reduced 4th laterals (Fig. 148), **or** with wide middle tooth, slightly notched near base . . . . . ***Einfeldia***

[1] May be a new genus; [2] May be *Polypedilum*; [3] May be *Phaenopsectra*

WISCONSIN SPECIES AND REFERENCES TO LARVAL KEYS

NEMATOCERA

BLEPHARICERIDAE

*Blepharicera - tenuipes**

CERATOPOGONIDAE** (Glukhova 1977 - translation)

*Alluaudomyia - bella, megaparamera, needhami, wirthi**

Atrichopogon - fusculus, levis*, minutus**

Bezzia - bivittata, copiosa, cockerelli, glabra, opaca, setulosa, vaicolor*

*Ceratopogon - culicoidithorax**

Clinohelea - curriei**

Culicoides - arboricola, baueri, bickleyi, biguttatus, crepuscularis, denticulatus, dickei, flukei, furensoides, guttipennis, haematopotus, nanus, obsoletus*, piliferus, pseudopiliferus, sanguisuga, sphagnumensis, spinosus, stellifer, stilobezzoides, testudinalis, travisi, variipennis, venustus, villosipennis, wisconsinensis*

Dasyhelea - grisea*, mutabilis*, opressa**

Heteromyia - fasciata**

Mallochohelea - albibasis, albihalter, flavidula, smithi*

Jenkinshelea - magnipennis**

Johannsenomyia - annulicornis*, argentata**

*Monohelea - leucopeza**

*Nilobezzia - mallochi, minor**

Palpomyia - altispina, basalis, canadensis, flaviceps*, hastata*, jonesi, lineata, novitibialis, plebeia, plebeiella, rubiginosa, rufa*, scalpellifera*, subaspera, tibialis*

Parabezzia - petiolata*, williamsi**

Probezzia - albitibia, albiventris, atriventris, infuscata, jamnbacki*, pallida, sabroskyi, seminigra, smithii, williamsi, xanthogaster*

Serromyia - ledicola, nudicolis, vockerothi**

Sphaeromias - longipennis

Stilobezzia - antennalis*, coquillettei**

CHAOBORIDAE (Cook 1956)

Chaoborus (Saether 1972, Borkent 1979) - *albatus, americanus, flavicans, punctipennis, trivittatus*

Eucorethra - underwoodi

Mochlonyx - cinctipes, velutinus

CHIRONOMIDAE (Keys listed below not in Wiederholm 1983)

Ablabesmyia (Roback 1985)

Cricotopus (Simpson et al. 1983)

Dicrotendipes (Epler 1988)

Endochironomus (Grodhous 1987)

Eukiefferiella (Bode 1983)

Guttipelopia (Bilyg 1988)

Polypedilum (Boesel 1985)

Stenochironomus (Borkent 1984)

Tribelos (Grodhous 1987)

Tvetenia (Bode 1983)

CULICIDAE (Carpenter and LaCasse 1955, Wood et al. 1979, Darsie and Ward 1981)

Aedes - abserratus, aurifer, atropalpus, campestris, canadensis, cinereus, communis, decticus, diantaeus, dorsalis, euedes, excrucians, fitchii, flavescens, grossbecki, hendersoni, implicatus, intrudens, pionips, pullatus*, punctor, riparius, spencerii, sticticus, stimulans, triseriatus, trivittatus, vexans*

Anopheles - barberi, earlei, punctipennis, quadrimaculatus, walkeri

Coquillettidia - perturbans

Culex - erraticus, pipiens, restuans, salinarius, tarsalis, territans

Culiseta - impatiens, incidens, inornata, melanura, minnesotae, morsitans*

Orthopodomyia - signifera

*Psorophora - ciliata, ferox, horrida**

Uranotaenia - sapphirina

Wyeomyia - smithii

DIXIDAE
*Dixa - modesta**
Dixella - cornuta, nova**
PSYCHODIDAE**
Pericoma - americana, marginalis*, scotiae*, signata*, slossonae**
Psychoda - alternata, lativentris*, minuta*, pusilla*, satchelli*, setigera*, trinodulosa, umbracola**
PTYCHOPTERIDAE
Bittacomorpha - clavipes
Ptychoptera - metallica, quadrifasciata**
SIMULIIDAE (Wood et al. 1963, Anderson 1960, Merritt et al. 1978)
*Cnephia - dacotensis, ornithophila**
Ectemnia - taeniatifrons
Greniera - abditoides*, denaria**
Prosimulium (Peterson 1970) - *decemarticulatum, fontanum, fuscum, gibsoni, magnum, mixtum, multidentatum, mysticum**
Simulium (+*Eusimulium*) - *aestivum*, amatinum*, aureum, baffinense*, congareenarum*, corbis, croxtoni, decorum, emarginatum*, euryadminiculum, excisum*, fibrinflatum, gouldingi, jenningsi, johannseni, impar*, innocens*, latipes, longistilum*, luggeri, meridionale, parnassum*, pictipes, pugetense, quebecense*, rivuli*, rugglesi, tuberosum, venustum, verecundum, vernum*, vittatum*
Stegopterna - emergens, mutata
Twinnia - tibblesi**
TIPULIDAE**
Antocha - obtusa, opalizans, saxicola*
Dicranota - cayuga, currani*, eucera, flaveola*, fumipennis*, iowa*, noveboracensis, petiolata**
Erioptera - armata, cana, caliptera, chlorophylla, chlorophylloides*, indianensis*, knabi*, parva*, septemtrionis, straminea*, uliginosa, venusta, vespertina, villosa**
Helius - flavipes, mainensis
*Hesperoconopa - dolichophallus**
Hexatoma - gibbosa, longicornis*, microcera*, spinosa**
Limnophila - adusta, areolata, fuscovaria, munda, poetica, rufibasis, unica
Limonia - cinctipes, globithorax, immatura, indigena, rara, simulans, solitaria, triocellata, tristigma
Pedicia - albivitta
Phalacrocera - tipulina
Pilaria - imbecilla, osborni, recondita, tenuipes
Prionocera - fuscipennis
Pseudolimnophila - inornata, luteipennis, noveboracensis, toxoneura
Tipula - abdominalis, caloptera, cayuga, collaris*, concava, dejecta*, dickinsoni, eluta, furca*, nobilis*, noveboracensis*, sayi, sulphurea, tephrocephala, tricolor, vicina*

BRACHYCERA

ATHERICIDAE (Webb 1977)
Atherix - variegata
DOLICHOPODIDAE (Aquatic species in Wisconsin unknown)
EMPIDIDAE (Only larvae of *Chelifera, Clinocera,* and *Hemerodromia* have been collected in Wisconsin)
EPHYDRIDAE (Aquatic species in Wisconsin unknown)
MUSCIDAE
Limnophora - discreta, narona**
Lispe - albitarsis, brevipes, cotidiana*, nasoni*, nudifacies, palposa*, sociabilis*
*Lispoides - aequifrons**
SCIOMYZIDAE
Antichaeta - canadensis, melanosoma
Atrichomelina - pubera
Colobaea - americana
Dictya (Valley and Berg 1977) - *borealis*, expansa, hudsonica*, pictipes*, sabroskyi*, umbroides**
Elgiva - connexa (Knudson and Berg 1964)
Hedria - mixta
Pherbellia (Bratt et al. 1969) - *albocostata*, albovaria*, argyra, beatricis*, griseola*, maculata, propages, quadrata*, seticoxa, similis, vitalis*
Pteromicra - anopla, nigrimana, similis*, sphenura**
Renocera - amanda, cyathiformis, johnsoni
Sciomyza (Foote 1959) - *aristalis*, simplex, varia**
Sepedon (Neff and Berg 1966) - *americana, armipes, borealis, neili, praemiosa, tenuicornis*
Tetanocera (Foote 1961) - *annae, clara, ferruginea, loewi, melanostigma*, mesopora, montana, nanciae, nigricosta*, oxia*, plebeja, robusta, rotundicornis*, unicolor, valida, vicina*
STRATIOMYIDAE** (McFadden 1967)
Anoplodonta - nigrirostris
Caloparyphus - tetraspilus
Euparyphus - brevicornis, stigmaticalis**
*Hedriodiscus - trivittatus, truquii, varipes**
Labostigmina - lavicornis, obscura, viridis*
Nemotelus - centralis, communis*, melanderi*, nigrinus, picinus**
Odontomyia - borealis, cincta, communis, hoodiana*, hydroleonoides, interrupta, nigerrima*, pilimana, pubescens, virgo*
Oxycera - albovittata, maculata, picta, variegata*
Stratiomys - adelpha, badia, bruneri, discalis, laticeps, lativentris*, meigenii, norma, normula, obesa*
SYRPHIDAE
*Chrysogaster - nigripes, nitida, pictipennis, pulchella, texana**
Eristalis - aeneus, anthophorinus, arbustorum, bardus, bastardii, brousii, compactus, dimidiatus, hirtus, inornatus*, latifrons, obscurus*, occidentalis*, oestraceus*, rupium*, saxorum, tenax, transversus, vinetorum*
Helophilus - bilinearis, borealis, brooksi, chrysostomus, distinctus, divisus, fasciatus, hybridus*, latifrons, laetus, lunulatus, obscurus, obsoletus, porcus, relictus, rex*, stipatus*
TABANIDAE (Pechuman et al. 1983)
Atylotus - thoracicus, woodi
Chrysops - aestuans, ater, brunneus, cincticornis, cuclux, excitans, frigidus, mitis, moechus, niger, sequax, striatus*
Hybomitra - cincta, epistates, frontalis, lurida, minuscula,*

pechumani
Tabanus - atratus, fairchildi, lineola, marginalis, nigrescens, nigripes, novaescotiae, reinwardtii, sparus, subniger, subsimilis**

**Some species may not be aquatic

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GLOSSARY

accessory tooth of mandible - in Tanypodinae a tooth proximal to basal tooth and projecting toward tip or mandible

aciculations - short, distinct scratches, grooves, or lines

acuminate - tapering to a long point

allochthonous - originating outside (of aquatic environment)

angulate - forming an angle; not rounded

annulate - ringed; surrounded by ring(s) of different color; formed in ring-like segments

annulus (annuli) - ring(s)

antennomere - an antennal segment, numbered from base to apex

apex - that part of any structure opposite base by which it is attached.

apical - pertaining to apex

apterous - without wings

arcuate - arched; bow-like

basal - at or pertaining to base or point of attachment; nearest main body

basal tooth of mandible - in Tanypodinae a tooth projecting perpendicular to mandible and distal to accessory tooth
beard - fringed with long setae or hairs
bifid - cleft, or divided into two parts; forked
bifurcate - divided partly, or forked into two
bilamellate - divided into two lamellae or plates
bivoltine - two generations a year
brachypterous - with short or abbreviated wings
bristle - stiff seta or hair, usually short and blunt
bulbous - bulb-like; swollen
carapace - hard covering
carina - elevated ridge or keel
carinate - pertaining to a carina
caudad - toward or in direction of tail end of body along median line
cercal - pertaining to cercus
cercus (cerci) - paired appendage of last abdominal segment; in Anisoptera a lateral, terminal, triangular sclerite
chelate - bearing a movable claw like that of a crab
chloride epithelia - ovoid areas of modified cuticle bordered by a thin sclerotized line
cilia - fringes; series of moderate or thin setae arranged in tufts or single lines
ciliate - fringed with a row of parallel setae or cilia
clypeus - that part of the head between the frons and labrum
coronet - a small crown or corona
costa (costae) - elevated ridge(s), rounded at its crest
creeping welt - a slightly raised, often darkened structure on Diptera larvae
crenation - a scalloped margin or rounded tooth
crenulate - with small scallops, evenly rounded and rather deeply carved
cupule - cup-shaped segment at base of club on some antennae
deflexed - bent downward
denticle - small tooth
denticulate - set with little teeth or notches
digitiform - formed or shaped like a finger
distal - near or toward free end of any appendage; part farthest from body
effaced - obliterated; rubbed out
elytron (elytra) - hardened, shell-like mesothoracic wing(s) of Coleoptera
emarginate - notched; with an obtuse, rounded, or quadrate section cut from a margin
epicranial suture - Y-shaped suture on dorsal surface of head
epipharynx - structure on inner surface of labrum
epipleuron (epipleura) - deflexed or inflexed portion(s) of elytra immediately beneath the edge
epiproct - dorsal terminal sclerite in Anisoptera
fascia - a broad transverse band
fibrilliform - in the form of many threads
filiform - thread-like; slender and of equal diameter
flagellum - whip or whip-like process
fluted - channeled or grooved
fossorial - formed for digging or burrowing
frons - front of head between arms of epicranial suture
frontal process (shelf, horn) - process or other structure on frons
frontal sutures - arms of epicranial suture
funicle - portion of antenna between elongate basal segment and club
fuscous - dark brownish-black
galea - outer lobe of maxilla
gena (genae) - cheek(s); part(s) of head on each side below eyes and above gular suture
geniculate - knee-jointed; abruptly bent at an angle
glossa (glossae) - median terminal (or subterminal) lobe(s) of labium
gula - throat sclerite, forming central part of head beneath genae
hemelytron (hemelytra) - mesothoracic wing(s) of Heteroptera
humerus - shoulder; basal exterior angle of elytra
hypopharynx - structure on upper and inner part of labium
hyporheic - occurring well beneath the surface of the substrate
hypostomal sclerites - sclerites just posterior to mouth hooks in Diptera larvae
impressed - depressed areas of markings
incised - notched or deeply cut into
infuscate - smoky gray-brown, with a blackish tinge
interocular space - space between eyes
irrorate - covered with minute dots, spots, or freckles
keel - elevated ridge or carina
lacinia (laciniae) - inner blade-like segment of maxilla(e)
lamella (lamellae) - thin plate(s) or leaf-like process(es)
lamellate - with lamellae
lanceolate - lance- or spear-shaped; oblong and tapering to end
lentic - still water
ligula - central, apical segment of labium
limnetic area - area of open water without vegetation in a lake or pond
linear - straight; elongate; in form of a straight line
littoral area - area of lake containing vegetation
littoral zone - bottom of lake containing vegetation
lotic - moving water
macropterous - with fully developed wings
mentum - distal segment of labium bearing movable parts
mesad - toward the middle
mesal - pertaining to the middle
mouth hook - vertically oriented mandible-like structure in Diptera larvae
multivoltine - more than two generations per year
muscle scar - dark or light ovoid mark contrasting with background
natatory - fitted for swimming
natatory setae - swimming hairs
obsolete - mostly or entirely absent; indistinct; not fully developed
occipital - of or pertaining to occiput or back part of head
ocellus (ocelli) - simple eye(s) consisting of a single, bead-like lens in adults, nymphs, and hemimetabolous larvae
operculate - formed as a cover
operculum - a lid or cover
ovate, ovoid - somewhat oval in shape
pala - much dilated protarsal joint in Corixidae
palmate - like palm of hand, with finger-like processes
palpomere - a segment of a palp
papilla (papillae) - soft projection(s)

paraglossa (paraglossae) - lateral terminal lobe(s) of labium
paraproct - paired, ventral, terminal, triangular sclerite in Anisoptera
parasitoid - an insect that completes it development on another insect, causing its death
pectinate - comb-like
petiole - stem or stalk at base of a structure
phoretic - attached to and carried by a larger insect
pile - thick, fine, short, erect setae, giving surface appearance of velvet
pilose - having a pile; covered with numerous short, soft setae
pinnate - having branches arranged on each side of a central axis
pleuron - entire lateral division (side) of any segment
postocular space - space between back of eyes and occipital opening
prehensile - fitted or adapted for grasping, holding, or seizing
process - a prolongation of the surface, a margin, or an appendage; any prominent part of body not otherwise definable
profundal zone - bottom of lake below thermocline (area of thermal stratification)
proleg - process or appendage serving purpose of a leg
protuberant - rising or produced above surface or general level
proximal - part of an appendage nearest body
pruinose - as if frosted or covered with fine dust
pseudopod - soft, foot-like appendage
pseudoradula - a narrow longitudinal band of granules and tubercles in rows, extending from anterior of the ligula to the anterior of the head in Tanypodinae larvae
pubescence - short, fine, down-like, erect setae
punctate - set with impressed points or punctures
rastrate - covered with longitudinal scratches
reticulate - covered with a network of lines
riffle - shallow, rapid area of stream where substrate causes disturbance of water's surface
riparian - living on bank of an aquatic habitat, terrestrial area adjacent to water
rostrum - beak; snout-like projection of head bearing mouthparts
run - area of rapid, deep water in a stream
scalloped - with edge marked with rounded hollows, without intervening angles
scape - basal segment of antenna
sclerite - piece of insect body wall bounded by sutures
sclerotized - hardened and usually darkened
scutellum - triangular piece between bases of elytra (Coleoptera) or hemelytra (Heteroptera)
semivoltine - two or more years per generation
serrate - saw-like; with notched edges like teeth of a saw
seta (setae) - slender, hair-like appendage(s); hair(s)
setose - furnished or covered with setae
spacing tubercles - humps laterally and/or dorsally on first abdominal segment of some Trichoptera larvae
spine - multicellular, thorn-like process or outgrowth of the cuticle, not separated from it by a joint
spinose - with numerous spines
spinule - very small spine
spur - spine-like appendage of cuticle, connected by a joint
stemma (stemmata) - simple eye(s) of holometabolous larvae
sternum - entire ventral part of any segment
stipes - second segment of maxilla, the segment to which movable parts are attached
stria (striae) - fine, longitudinally impressed line(s)
strigil - dark, roughened structure on dorsolateral portion of abdomen in most male Corixidae
subequal - almost or nearly equal
subimago - a winged subadult stage in Ephemeroptera
sublittoral zone - bottom of lake without vegetation and not below a thermocline (area of thermal stratification)
submentum - basal segment of labium
sulcate - with a sulcus or sulci
sulcus (sulci) - furrow(s) or groove(s)
suture - seam or impressed line indicating division of body wall
tarsomere - a tarsal segment, numbered from base to apex
tergum - dorsal surface of any body segment of an insect
testaceous - brownish-yellow
tomentum - a form of pubescence composed of matted, wooly, setae
translucent - semi-transparent; can be seen through but not clearly
trifid - cleft into three parts
triquetral - triangular in cross-section
trochantin - small, forward projecting sclerite at base of trochanter
tubercle - small bump or mound-like structure
tubule - small, elongate, tube-like structure
vernal pond or marsh - contains water only or mostly in spring
vestigial - small or degenerate
vitta(e) - broad longitudinal stripe(s)
vittate - with vittae
univoltine - one generation per year
urogomphomere - a segment of the urogomphus
urogomphus (urogomphi) - paired terminal appendage(s) on Coleoptera larvae
vertex - dorsal portion of head above frons and between compound eyes
whorl - ring of setae about a joint or center, like spokes of a wheel

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