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Mayfly Larvae OF WISCONSIN

Tom H. Klubertanz

Dolania americana larva, *Paraleptophlebia volitans* larva, *Heptagenia pulla* larva, *Pseudiron centralis* larva

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This book is dedicated to my family,
including my wife and best friend, Theresa,
and my children, Katie, John, and Luke.
No man could be more blessed.

Contents

Preface

The lakes and streams of Wisconsin provide larval habitat for over 150 species of a curious and ancient group of insects called the mayflies, the Order Ephemeroptera. Mayfly larvae commonly are found under stones, crawling on woody debris, and clinging to vegetation in our unimpaired waters. Though their shape and size can vary greatly, all mayfly larvae have a simple, primitive body plan, two or three long caudal filaments (tails), and abdominal gill filaments or plates. If they avoid predators and other hazards of their aquatic world, they emerge as adults and complete their brief terrestrial existence entirely focused on reproduction. Our largest species of mayflies burrow as larvae in silty substrates, emerging as adults in tremendous numbers that soon litter the ground with dying insects. It is during these episodes of mass emergence along large rivers that most of the public becomes aware of the presence of these important insects.

Mayflies are important insects in many ways. There is, of course, value in documenting biodiversity, regardless of the taxon. I must confess that most of my interest in mayflies is in regards to their taxonomy and natural history. Mayflies, however, are more than just innocuous, curious organisms. They are key parts of the aquatic food chain, being one of the dominant herbivorous insect groups in such habitats (Morgan 1913). Their presence or absence also tells us about the quality of aquatic habitats. Mayflies are sensitive to habitat degradation, with impaired waters having lower species diversity (Hilsenhoff 1982, 1977; Hubbard and Peters 1978). Ecologists and citizen scientists use mayflies and other aquatic insects to monitor water quality, an economic alternative to chemical analyses.

A detailed taxonomic study of the Wisconsin mayfly fauna is badly needed. The last keys for identifying all known species of mayfly larvae from any Midwest state in the United States were in Burks (1953). That publication, focused on the Illinois fauna, is very outdated because of countless taxonomic changes and a dramatic increase in the number of species known from the region. Along with Burks' monograph, access to an entire research library of monographs, papers, and book chapters would be needed to correctly identify Wisconsin's mayfly species. Few biologists have such library resources, and not all of those publications are sufficiently illustrated. Several papers and reports on Wisconsin mayflies and other aquatic insects were published from the laboratory of Dr. William Hilsenhoff, then Professor of Entomology at University of Wisconsin–Madison, from 1970 to 1995. These publications included faunal studies, keys to the Wisconsin genera, and keys to the species of several families. Unfortunately, even those publications are now dated and should be used at the species level with considerable caution.

My field work and examination of existing collections have uncovered a large number of new state and county records of Wisconsin mayflies. These records now provide a clearer picture of the distribution, conservation status, and ecological requirements of these insects in the state. Arguably, the mayfly fauna of Wisconsin now is better known than for any other Midwest state.

The specific purpose of this book, then, is to provide taxonomic keys, new distribution records, and biological information for larvae of Wisconsin mayflies. The taxonomic keys in this book will allow fairly accurate identification of mayflies from other Midwest states, especially those bordering Wisconsin. This book is intended for a wide variety of enthusiasts of the Ephemeroptera, including those with training and experience in the identification of insects and those new to the pleasures of taxonomic and faunal study. It is richly illustrated, makes consistent use of terminology, and has a complete glossary of terms.

Acknowledgments

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I am grateful for the collaborative spirit, willingness to share specimens and records, and taxonomic advice of fellow students of the Ephemeroptera, including (in alphabetical order): Steven Burian (Department of Biology, Southern Connecticut State University), Jeffrey Dimick (Wisconsin Cooperative Fishery Research Unit, Aquatic Biomonitoring Laboratory, University of Wisconsin–Stevens Point), Boris Kondratieff (Department of Bioagricultural Sciences, Colorado State University), Richard Lillie (Portage, WI), W. Patrick McCafferty (Department of Entomology, Purdue University), Arwin Provonsha (Department of Entomology, Purdue University), Kurt L. Schmude (UW–Superior), William Smith (Bureau of Natural Heritage Conservation, Wisconsin Department of Natural Resources), Robert Waltz (Indiana Office of State Chemist and Seed Commissioner and Purdue University), and Jeff Webb (University of Guelph). In addition to those listed above, I am grateful for access to specimens provided by Susan Borkin (Milwaukee Public Museum), Michael Draney (Department of Natural and Applied Sciences, UW–Green Bay), H. Gene Drecktrah (Department of Biology and Microbiology, UW–Oshkosh), and Kyle Johnson and Steven Krauth (Department of Entomology, UW–Madison).

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1 BIOLOGY AND IMPORTANCE OF WISCONSIN MAYFLIES

This first chapter examines the ecology of mayflies in Wisconsin, including their habitat use and preferences, and discusses methods of collection of larvae.

Life Cycle

The major life stages of the mayfly are the egg, larva (also known as the *nymph* or *naiad*), subimago, and imago. The eggs of mayflies are finely sculptured capsules of life that are deposited on or beneath the surface of water. All mayfly larvae are freshwater insects, usually living in flowing (lotic) rather than sluggish or stationary (lentic) waters. They have numerous features that function well in an aquatic environment, including tracheal gills for oxygen absorption and body shapes for either swimming in or avoiding water current. The mayfly larva, as with all juvenile insects, molts its exoskeleton periodically to allow for growth. After each molt, the insect briefly is soft and vulnerable until its cuticle hardens. It will have as many as thirty molts during larval development—few groups of insects have more than mayflies. The earliest instar, as the insect is called between each molt, looks little like a mature larva. As it grows, it will develop more distinctive color patterns and well-developed wingpads. The last instar, just prior to emergence, has darkened wingpads. Such "blackwing" larvae are useful indicators of when in the season a particular species will emerge as adults (Morgan 1913; Needham et al. 1935).

But the mayfly has a trick up its sleeve. In all other insects, whether or not there is a pupal stage between the larva and the adult, there is only one winged stage. As every student of backyard entomology quickly learns, once a fly, beetle, or butterfly has wings, molting is finished. Growth, for the most part, is finished as well. In the mayflies, however, it is the subimago that emerges from the old larval skin (called *exuviae*) and flies away. Some mayflies accomplish this feat right on the surface of the water whereas others have larvae that cling to vegetation or stones during the transition. The subimago has semiopaque wings with numerous fine hairs along its posterior margins. It may have different, typically more subdued, dull coloration than the imagos. After minutes, hours, or days, depending upon the species, the subimago finally molts into the imago, completing one of the rarest versions of life history in the insect world—a winged insect molting into a winged insect (Morgan 1913).

Adult mayflies are, to me, graceful and beautiful insects. Their two or three long caudal filaments, uniquely shaped wings, and delicate bodies make them easily identifiable. Adults do not feed; they rely solely upon nutrients stored during larval development. Their mouthparts and digestive tract are vestigial. Most mayflies reproduce sexually, with both males and females present in populations. Males almost always have larger eyes than females (a difference usually visible in mature larvae as well), with the greatest sexual dimorphism occurring in the Baetidae. Males also have distinctive genitalia at the posterior tip of the abdomen. Some mayflies can reproduce asexually, a process called *parthenogenesis*. In species that reproduce only in this way, such as in some *Neocloeon* (Baetidae) and *Ameletus* (Ameletidae), males do not occur. Adult female mayflies are masters of egg production, nearly filling their body cavities with eggs.

Despite their common name, flights of mayflies do not always occur in spring. Many mayflies, especially smaller species, have two generations of larvae in the summer months (Edmunds et al. 1976). Eggs deposited by females in autumn may remain dormant throughout winter or may hatch in autumn with young larvae overwintering. Species with nearly mature larvae in autumn usually emerge in very early spring and are absent in samples of larvae collected in May.

Larval Feeding Types

Mayflies have a considerable variety of feeding types (Morgan 1913; Cummins 1973; Edmunds et al. 1976; Cummins and Klug 1979). The generally recognized feeding types of larvae are collectors, scrapers, shredders, filter feeders, and invertebrate predators. The collectors feed on fine detritus and diatoms and occur in all of the most diverse mayfly families. Scrapers (grazers), such as species in *Maccaffertium* (Heptageniidae) and *Ameletus* (Ameletidae), remove living diatoms, algae, and protists attached to rocks, logs, and other surfaces. The shape and armature of their mouthparts, particularly their maxillae, are different than the typical mayfly. A limited number of mayfly larvae shred plant debris, including leaves, stems, and roots. Larvae of *Callibaetis* (Baetidae), a common genus in lentic habitats, and *Leptophlebia,* mayflies most commonly occurring in shallow, riparian backwaters, feed in this fashion. Mayflies from the ecological guild known as the filter feeders gather nutrients floating in the water, generally using dense, long rows of leg setae. This feeding type is best demonstrated in *Isonychia* (Isonychiidae). Predatory mayflies include some of our rarer genera such as *Pseudiron* (Pseudironidae), *Spinadis* (Heptageniidae), and *Dolania* (Behningiidae). These taxa usually feed extensively on midge larvae (Diptera: Chironomidae). Mature larvae of at least

some *Siphlonurus* (Siphlonuridae) are predators of midge and mosquito larvae (Edmunds et al. 1976).

Larval Body Types

The diversity in mayfly body types reflects their diversity in feeding types and habitat preferences (Morgan 1913; Cummins 1973). The two most diverse and common families of mayflies in Wisconsin differ significantly in body type. The Baetidae, with 46 species known from Wisconsin, has streamlined, minnow-shaped larvae capable of considerable athletic prowess as swimmers. They swim dolphin-like, with all movement in the vertical plane. Trying to catch one in a pan of water is not an easy task. The Heptageniidae, with 25 species known from the state, are adapted to avoiding current. They have flattened hydrodynamic heads and legs that are held laterally from the body. More likely to behave like stoneflies (Plecoptera) and cling tightly to rocks or logs, they swim more laboriously with either lateral or vertical movements. Most heptageniids are scrapers, removing living biofilm from the substrate. Most genera of mayflies fall into one of these two general descriptions.

Some taxa are best described as crawlers, rarely leaving their protective silt-covered root masses or mats of algae and venturing out into the current. These include tiny larvae of the Caenidae and Leptohyphidae, and the tank-shaped Baetiscidae. Another unusual body type occurs in burrowing species. These mayflies have soft bodies, large feathery gills, fossorial legs, and long mandibular tusks. They include some of our largest mayflies, such as adults of *Hexagenia* (Ephemeridae) that emerge from the Mississippi River in great numbers. Other families with burrowing larvae include Polymitarcyidae and Palingeniidae. All of these mayflies construct tubular burrows in soft silt, soft or hard clay, or sand. Though species of *Anthopotamus* (Potamanthidae) also have mandibular tusks, they lack most of the other features of burrowing mayflies and live in more erosional habitats.

Environmental Importance

The species of Ephemeroptera are key components of aquatic systems, located near the base of the food chain (Morgan 1913; Cummins et al. 1966), and are important food items for fish (Schwiebert 1973). They also are important processors of detritus, recycling nonliving materials and making them available for consumers.

Mayflies also are ecologically important as indicators of water quality (Hilsenhoff 1982, 1977; Hubbard and Peters 1978). The presence of a diverse and balanced assemblage of mayfly species in a river or stream is a sign of both current and past environmental health. Other insect groups, such as stoneflies, also are indicators of good water quality.

Wisconsin Habitats for Mayfly Larvae

There are 72 counties in Wisconsin (Fig. 1). The major rivers of the state are shown in Figure *2*. Most of the state's border miles are large rivers, including the Mississippi, St. Croix, and Menominee Rivers. Other medium to large rivers in the state include the Black, Chippewa, Flambeau, Fox, Rock, and Wisconsin Rivers. The last is 692 miles long and is the longest and largest inland river system in the state (Lillie and Hilsenhoff 1992), draining over 12,000 square miles of land. The free-flowing Lower Wisconsin River below the Prairie du Sac Dam contains rare macroinvertebrate communities. Sand-bottom segments of such large rivers, particularly the Wisconsin, St. Croix, and Chippewa Rivers, have the greatest number of rare and endangered mayfly taxa. These species are in the genera *Acanthametropus* (Acanthametropodidae), *Dolania* (Behningiidae), *Pseudocentroptiloides* (Baetidae), and *Spinadis* (Heptageniidae), among others. They also can be quite difficult to collect, resulting in only superficial knowledge of the biology of most of these species.

A great number of mayfly species occur in smaller streams and rivers, including the many cold-water trout streams in the northern half of the state. In such habitats, if they are undisturbed and in good health, mayfly diversity is at its greatest level. Most impressive are the mayfly communities in the Brule, Flambeau, Namekagon, and Popple Rivers and their tributaries. Mayflies are much less common and in low diversity in medium to large warm-water rivers of southern and southeastern Wisconsin, such as the intensively managed Rock and Fox Rivers. Farther west, the Sugar River in Green and Rock Counties is in better condition and supports populations of unusual mayflies such as *Homoeoneuria* (Oligoneuriidae) and *Cercobrachys* (Caenidae). Some small creeks and streams in southern Wisconsin, such as Otter Creek in Sauk County, Turtle Creek in Walworth and Rock Counties, and Jericho Creek in Waukesha County, still have good species diversity. Taxa rarely occurring in far southern Wisconsin, such as several species of *Procloeon*, *Anafroptilum*, and *Diphetor* in the Baetidae, *Dannella* (Ephemerellidae), and *Ameletus* (Ameletidae) can be found in these waters. These few sites give us a glimpse of what must have been spectacular communities of mayflies across the region prior to changes in land use and stream flow. Many of the streams in the Grant River drainage basin in southwestern Wisconsin are severely degraded, with the basin having one of the lowest levels of mayfly diversity of any in the Midwest (Randolph and McCafferty 1998). Beginning with the studies by Bill Hilsenhoff in the 1970s, extensive, statewide sampling of small to medium streams and rivers has provided us with a clear picture of the mayfly fauna of such waters.

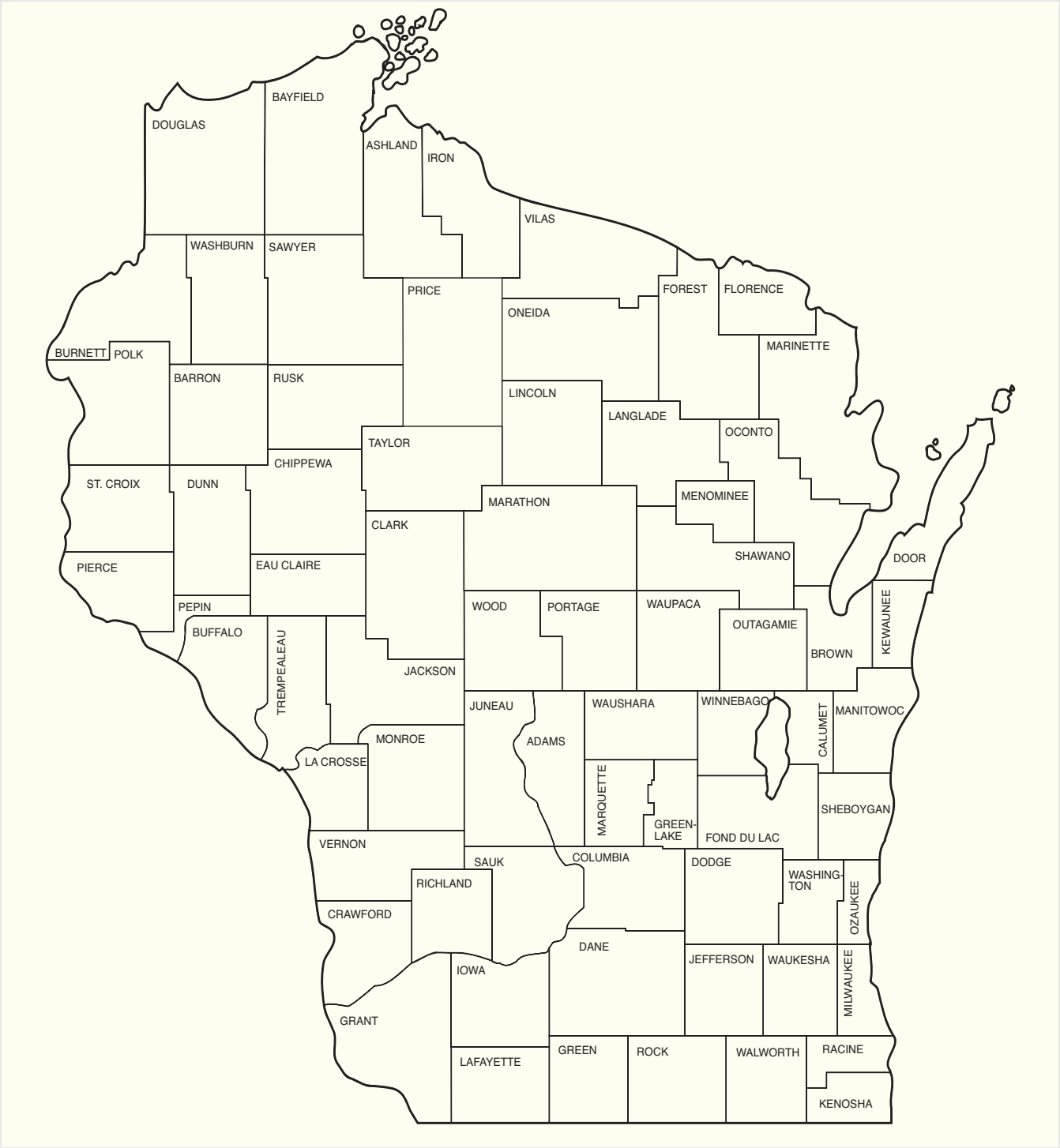


Figure 1. Wisconsin counties.

Figure 2. Major rivers of Wisconsin.

Relatively few mayflies occur in lakes and ponds. These include species less dependent upon water current and high levels of dissolved oxygen. The most common small mayflies of lentic habitats are in *Callibaetis* (Baetidae), *Caenis* (Caenidae), and *Tricorythodes* (Leptohyphidae). In northern lakes, *Stenonema* (Heptageniidae) and ephemerellids such as *Eurylophella* are typical. Also common in lentic habitats, including Lakes Michigan and Superior, are species of large burrowing mayflies in *Hexagenia* and *Ephemera* (Ephemeridae). In general, lentic habitats in Wisconsin have been sampled for mayflies less intensively than lotic habitats.

Conservation and restoration of aquatic habitats in Wisconsin are needed to sustain the state's diversity of mayflies and other macroinvertebrates. As discussed later in this book, many of Wisconsin's mayflies are uncommon to rare, consisting of only a few isolated populations. Such populations are very susceptible to habitat degradation and localized extinction. I hope that the information provided in this book encourages better stewardship of Wisconsin's aquatic resources.

Substrates

Mayflies as a group use a wide variety of substrates (Morgan 1913; Lillie and Hilsenhoff 1992). The greatest taxonomic diversity occurs on gravel- to cobble-sized rocky substrates and woody debris. Often, larvae occur beneath such structures, or in crevasses, sheltered from the current. Other species remain more exposed to the current. Vegetation is a common substrate for larvae, especially for members of the Baetidae. Mayflies in the Ephemeridae and related families burrow in soft silt and clay. Sandy substrates support several of Wisconsin's rarest species, especially those of large rivers.

Collection Methods

Mayflies can be collected using a variety of methods. Simple inspection of surfaces of logs and rocks is productive, particularly for acquiring undamaged specimens for rearing. Species inhabiting finer substrates or vegetation can be collected by disturbing the substrate, usually with the feet, while holding a D-framed aquatic net or drift net just downstream. Knowledge of microhabitat associations can improve the chances of collecting less common species. Some species are associated with calm eddies behind stones, sandbars, shallow backwaters, or current-swept vegetation. Mayflies of large rivers are most difficult to collect, requiring the use of boats and specialized equipment. Fine-meshed drift nets can be used to collect larvae and exuviae floating downstream. Larvae should always be handled gently to reduce specimen damage that can interfere with identification.

The most commonly used preservative for mayfly larvae collected in the field is 80% ethanol. This preservative should be changed to 70% ethanol in the lab for long-term storage. Alcohol is much preferred over formalin, which tends to make specimens brittle and has greater environmental impact. Formalin has the advantage, however, of being easily transported in more concentrated solutions that can be diluted in the field. Regardless of the preservative or additives, integumentary patterns on specimens eventually fade. Bleached specimens may be unidentifiable since some species are separable only by coloration. Photographs and notes taken when specimens were fresh can be quite valuable decades later.

All specimens should be properly labeled using indelible ink. Pencil should be used only for temporary labels. Each label should contain information about the precise sampling location, including the name of the body of water. It should have sufficient information to help others relocate the sample site, including detail about the nearest road access, town and range, and/or geographical positioning system (GPS) coordinates. Finally, the label should contain the sample date and name of the sampler(s). The month should always be indicated with a Roman numeral. If the sample was taken from one substrate or with one methodology, then that information also can be placed on the label.

2 ANATOMY OF MAYFLY LARVAE

This chapter focuses on the anatomical features used as characters in larval keys for mayflies, providing clarification and explanation of the relevant terminology. The content of this chapter assumes some general knowledge of insect anatomy but provides much support for those unfamiliar with the Ephemeroptera. For more detail on mayfly anatomy, see Morgan (1913), Needham et al. (1935), Burks (1953), and Edmunds and Waltz (1996). This book follows the recommendations for mayfly anatomical terminology outlined by Hubbard (1995). Specific definitions of such terms are given in the glossary. The major anatomical features of the typical mayfly larva are shown in Figure 3.

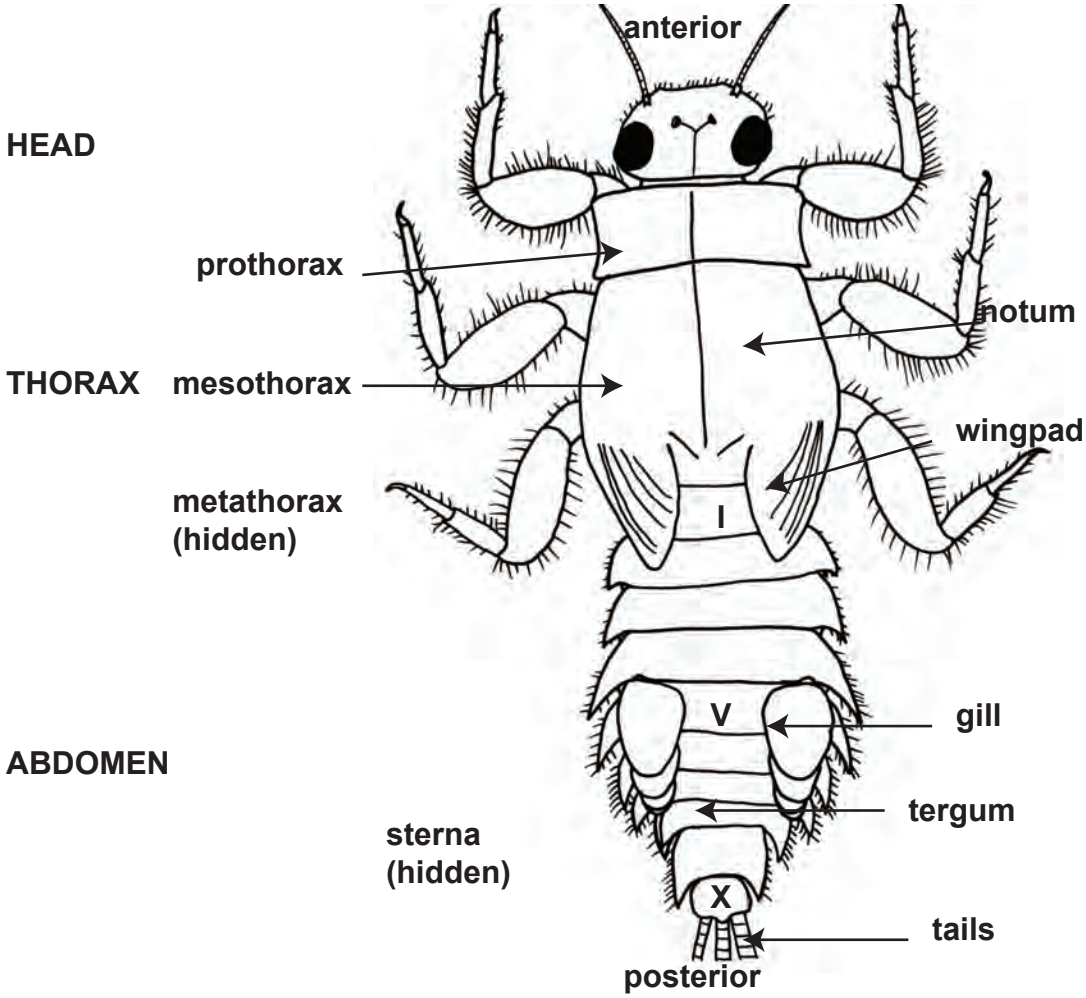


Figure 3. Major anatomical features of the larval mayfly.

Head

The dorsal surface of the head capsule has two compound eyes (Fig. 4). Though preserved mayflies almost always have black eyes, live specimens have bronze, greenish, or golden-colored eyes. Mature male larvae of most species have larger eyes than females, making it relatively easy to determine gender. Adult males of some taxa, such as the Baetidae and Leptophlebiidae, have compound eyes subdivided into two regions, with the dorsal portion more brightly colored. This structure becomes visible in males towards the end of larval development, as in Figure 88.

Between and anterior to the compound eyes are three simple eyes called *ocelli*. These consist of two lateral ocelli and one slightly anterior median ocellus. The ocelli are light sensitive but do not produce visual images. Characters related to the ocelli are rarely used in taxonomic keys.

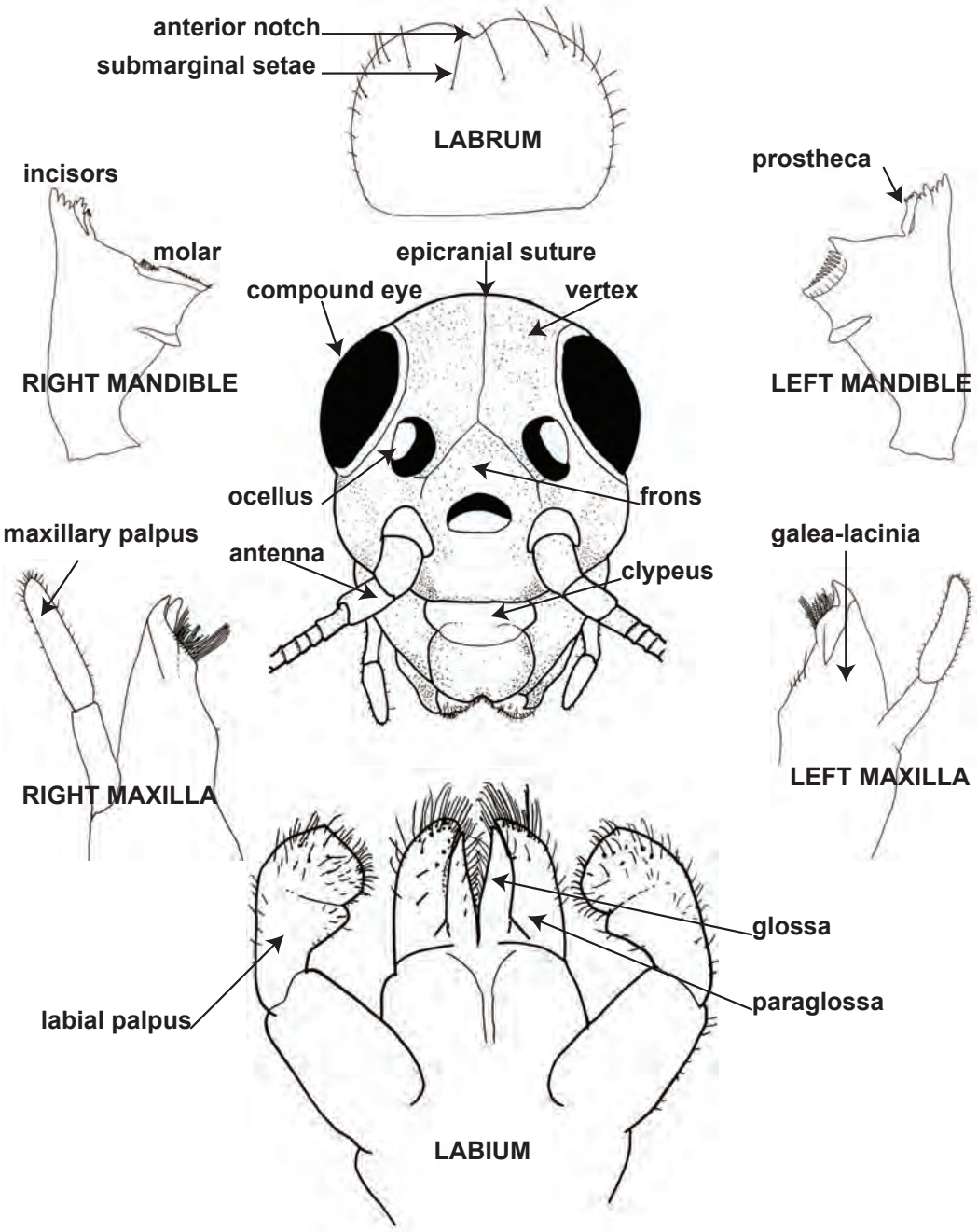


Figure 4. Head and mouthparts of the larval mayfly.

The dorsal surface of the head capsule is divided into the clypeus, frons, vertex, and occiput. The occiput is a sclerite posterior of the occipital suture, which generally is limited in mayflies and not visible in dorsal view. The region anterior to the occiput is the vertex. It consists of two sclerites connected medially along the epicranial suture and mostly located between the compound eyes. Dorsal tubercles and other structures on the vertex are used in the keys for the species of Caenidae, Ephemerellidae, and Ephemeridae. The anterior end of the occipital suture forks into two lateral epicranial sutures, which pass anterior to (as in the Baetidae, Fig. 7n) or bisect the lateral ocelli (Fig. 7a). Anterior to the lateral epicranial sutures is the frons. It is uncommonly encountered in keys. The presence of freckles on the frons is a distinctive feature of the heptageniids *Leucrocuta* and *Nixe* (Fig. 255b). At the anterior margin of the frons is a narrow sclerite called the *clypeus*. The clypeus attaches to the dorsal, lid-like labrum that covers the remaining mouthparts.

The dorsal surface of the head capsule bears one pair of antennae. Each antenna is divided into a basal scape, a middle pedicel, and a long, filamentous flagellum. The flagellum is subdivided into numerous segments. Antennal structure occasionally is used in keys. The presence or absence of whorls of long setae on the antennae is used to separate *Litobrancha* from *Hexagenia* in the Ephemeridae, and to determine species of *Cercobrachys* in the Caenidae. Preparation of slide mounts of antennae is recommended in the Baetidae for the identification of *Labiobaetis* and for differentiation of *Baetis brunneicolor* McDunnough and *B. tricaudatus* Dodds.

The major mouthparts of mayfly larvae, from dorsal to ventral, are the labrum, mandibles, maxillae, and labium (Fig. 4). The hypopharynx is located between the mandibles but is not used in the keys. The labrum is the dorsal covering of the mouthparts. It articulates with the clypeus of the head capsule. All taxonomically important labral setae are on the dorsal surface, including marginal and submarginal setae, and slide mounts should be made accordingly. Both the location and the microstructure of these setae can be taxonomically important, especially in the Baetidae. The anterior edge of the labrum usually has a medial notch, the shape of which is used occasionally in the keys.

Beneath the labrum is a pair of mandibles (Fig. 4). In most species, the mandibles are similar to those of many chewing insects, with both posterior molar and anterior (apical) incisor regions. The molar region is flat topped and heavily sclerotized. It generally is not visible unless the mandible is dissected. The incisors are more conical and may have associated setae. Between these two regions may be a loosely articulated sclerite called the *prostheca*, which usually has an elongate, roughly rectangular shape. Dissection of mandibles commonly is required in the keys. Note that in most taxa, the right and left mandibles are structurally different. Dorsal and ventral views of the same mandible can appear quite different as well, requiring care when preparing slide mounts. The mandibles of some mayfly larvae are produced into tusks, as in the burrowing families Ephemeridae (Fig. 7b), Palingeniidae, and Polymitarcyidae, as well as in the striking larvae of Potamanthidae (Fig. 7a). The shape of the tusks and the distribution of spines on their surface commonly are used in the keys for those families.

Ventral to the mandibles are the paired maxillae. Each maxilla consists of a medial, relatively flat galea-lacinia that is armed distally with various spines and setae, and a maxillary palpus consisting of up to four segments. In contrast to the mandibles, the left and right maxillae are similar. Slide mounts of maxillae commonly are required in the keys, such as for identifying the species of *Maccaffertium*, *Stenacron*, and *Procloeon.* The ventral view is most useful, unless otherwise indicated. In *Ameletus*, the setae at the distal end of the galea-lacinia are curved and pectinate, forming a plankton rake (Fig. 8p). The shape of the maxillary palpi is the key feature for separating *Labiobaetis* from other baetids. Articulation of the palpal segments may be indistinct, for example causing difficulty in identifying the species of *Anafroptilum, Neocloeon,* and *Procloeon* (Baetidae). In a few taxa, such as certain members of the Ephemerellidae and Leptohyphidae, the palpi are reduced or absent.

The ventral-most mouthpart is the labium. It is composed of two pair of lobes, the glossae and paraglossae, and the fingerlike labial palpi. The glossae are medial to the paraglossae. Structural features of the glossae and paraglossae are uncommonly used in keys. In the Baetidae, they are extremely useful in separating the species of *Pseudocentroptiloides*. The labial palpi, composed of two or three segments, are commonly used in keys. The third segment, if present, may be indicated by only a weakly formed crease across the palpus. The shape of the third segment of the labial palpus is one of the most frequently used characters in the keys for the Baetidae. In the Leptophlebiidae, the number of specific setae on the dorsal surface of this segment is used to separate *Leptophlebia cupida* (Say) and *L. nebulosa* (Walker). The shape of setae on the first segment of the labial palpi is used in the Caenidae to separate *Sparbarus* from other genera.

The ventral view of the labium is most useful in slide mounts, as it more likely will give a clear view of the shape of the palpi. Slide mounts should be prepared in that orientation unless indicated otherwise in the keys.

Thorax

The three segments of the thorax are, from anterior to posterior, the pro-, meso-, and metathorax (Fig. 3). These three prefixes commonly are used to refer to particular sclerites or leg parts on the thorax (e.g., *meta*tarsus, *pro*notum). Thoracic coloration occasionally is used in the keys, but not as often as in adult keys. Each thoracic segment has dorsal sclerites forming the notum. The pronotum simply has two sclerites fused along the midline. Coloration of the pronotum is used, for example, in separating the species of *Baetis* (Baetidae) and in field recognition of *Stenacron* (Heptageniidae). Structural features of the pronotum are used in the keys for species of *Serratella* (Ephemerellidae) and *Caenis* (Caenidae). Behind the pronotum is the mesonotum. In the Baetiscidae, the mesonotum is expanded to form a domed carapace over the thorax (Fig. 7f). The distribution of spines on the carapace is used in the key for the species of *Baetisca*. The mesonotum and metanotum essentially are fused in mayfly larvae and not easily visible as separate segments in dorsal view. Metanotal characters rarely are used in the keys, except in regard to the wingpads.

The ventral surfaces of the thoracic segments are called *sterna*, a term also used for the ventral surfaces of the abdominal segments. Surprisingly, the thoracic sterna are uncommonly used in keys. In the Caenidae, the distribution of median tubercles on the thoracic sterna is used to separate the genera and species of brachycercines—those species in the family with ocellar tubercles on the head.

The posterior margin of the mesonotum always bears a pair of wingpads. Wingpads increase in relative size with each successive molt. Highly folded subimagal wing membranes are visible inside the wingpads of last instars, with the wingpads becoming nearly black just before emergence. Mayflies with such wingpads, therefore, are called "blackwing" larvae. Records of blackwing larvae provide useful information regarding phenology. The metanotal wingpads always are much smaller and beneath the mesonotal pads. Metathoracic wingpads, and therefore the adult hind wings, are absent in several independent lineages of the Baetidae, such as in some *Acentrella, Neocloeon*, and *Procloeon*.

Legs

The keys in this book use the prefixes *pro-*, *meso-*, and *meta-* to refer to particular legs or segments on those legs. Mayflies have the typical major regions of the insect leg, from base to tip: coxa, trochanter, femur, tibia, and tarsus (Fig. 5). The coxa is the proximal segment that articulates with the thorax. Though *Ametropus* (Ametropodidae) is not yet known from Wisconsin, species in that genus have each coxa with an unusual spinous pad (Fig. 8b). Rarely, such as in some

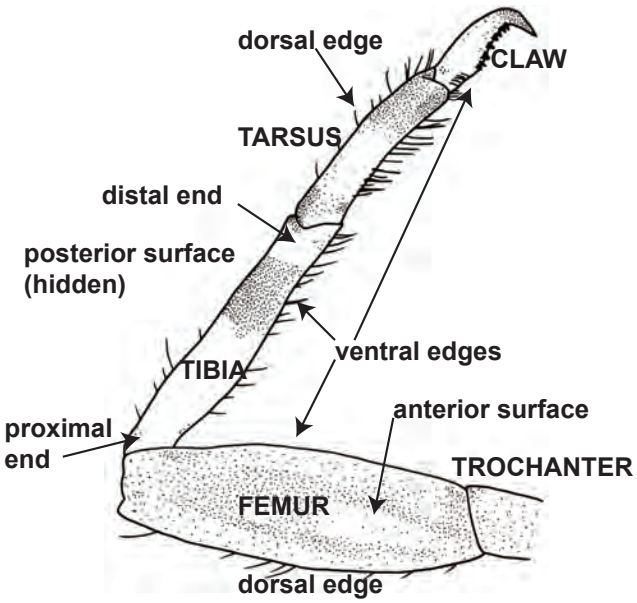


Figure 5. Leg of the larval mayfly.

Heterocloeon and *Camelobaetidius* (Baetidae), the coxae bear gill-like osmobranchiae (Fig. 20l). The trochanter is fairly generalized and not used in Wisconsin keys. The largest segment of the insect leg is the femur. Many different aspects of femoral structure and coloration are used in the taxonomic keys. In *Drunella* (Ephemerellidae), the profemur is larger than the other femora, with a row of large spines. The tibia generally is more slender, except in the fossorial legs of the Ephemeridae and other burrowing mayflies (Fig. 7d). In the Isonychiidae and Oligoneuriidae, the tibiae have long setae used for collecting food (Fig. 8e). The tarsus is unsegmented and almost always has a single claw. In the Metretopodidae, the protarsal claw is bifid. The claws of mayfly larvae most often have one row of tooth-like denticles, but two rows occur in some taxa such as *Heterocloeon* (Baetidae). Slide mounts of tarsi commonly are required in keys, with appropriate orientation of the tarsus on the slide being important.

Throughout this text, the dorsal, ventral, anterior, and posterior surfaces of legs refer to those indicated in Figure 5, following Hubbard (1995). This nomenclature refers to the surfaces of the primitive insect leg, not the surfaces of the leg typically maintained by the insect in its natural posture. As such, the laterally projecting and flattened legs of the heptageniid mayflies have the anterior surface facing upward and the posterior surface against the substrate.

Abdomen

The mayfly abdomen consists of dorsal sclerites called *terga* (singl. *tergum*) and ventral sclerites called *sterna* (singl. *sternum*) (Fig. 3). There are ten terga and nine sterna visible on the mayfly larva. Particular sclerites are referred to by Roman numerals in this text. As expected, abdominal characters often are used in keys. In many older keys, tergal coloration often was used to differentiate species. Such characters fade in alcohol, however, and are avoided whenever possible in the keys, or are combined with structural characters. Abdominal coloration is extremely helpful in making preliminary identifications of larvae in the field or in sorting fresh specimens, but should be used only by experienced individuals familiar with all of the species in the region. Identifications based solely upon comparison with photographs, such as those provided in this book, will have an unacceptable error rate.

Each of the first seven abdominal segments can bear a pair of external respiratory gills. The structure and distribution of these gills are frequently used in keys. Unfortunately, specimens with missing gills are common and can be frustratingly difficult to identify, particularly in the Leptophlebiidae. As with the abdominal segments, the gills are referred to by Roman numerals. Almost all species have the gills directed dorsally, but ventrally oriented gills are present in larvae of *Rhithrogena* (Heptageniidae) and *Dolania* (Behningiidae). There are several terms referring to gill structure. Lamellate gills are flattened and plate-like. Many mayflies with lamellate gills also have filamentous or tuft-like gills in addition to the lamellae. Some mayflies have multiple gill lamellae, though these usually are formed from dorsal or ventral folds or flaps of a single lamella. Examples of such gills occur in species of *Callibaetis* and *Procloeon* (Baetidae), *Siphloplecton* (Metretopodidae), *Siphlonurus* (Siphlonuridae), and *Leptophlebia* (Leptophlebiidae). Entirely filamentous gills are less common but occur in *Paraleptophlebia* (Leptophlebiidae). Operculate gills, as in the Caenidae and Leptohyphidae, are expanded to serve as protective gill covers over more posterior gills. The gills of larvae in the Baetiscidae are beneath the thoracic carapace and not normally visible from dorsal view.

Most mayflies have three caudal filaments, or "tails," a well-known field mark used by beginning students of aquatic insects. Stoneflies, in contrast, always have two caudal filaments. The three tails in mayflies consist of two lateral caudal filaments (modified cerci) and one median caudal filament. Length, setation, and banding of the caudal filaments are used in the keys. In most species, the median caudal filament is shorter than the other two. In a few mayflies, such as species of *Epeorus* (Heptageniidae) and the baetids *Acentrella*, *Heterocloeon*, *Iswaeon*, and *Plauditus*, the median caudal filament is greatly reduced or vestigial (as in Fig. 20f). These two-tailed mayflies are the exception to the rule.

3 TAXONOMY, DIVERSITY, AND CONSERVATION OF WISCONSIN MAYFLIES

Previous Studies of Wisconsin Mayflies

Forty-one publications have contributed new Wisconsin state records of mayflies (Table 1). The earliest, documented mayfly record from the state is of the ubiquitous heptageniid *Stenacron interpunctatum* (Say) by Wodsedalek (1912). Muttkowski (1918) added three species, including the only historical record for *Leucrocuta maculipennis* (Walsh) from Wisconsin. Randolph and McCafferty (1998), however, considered this identification dubious. By 1970, the number of species known from Wisconsin had grown to seventeen, with no single publication adding more than three species (Traver 1935; Spieth 1941; Hamilton 1959; Britt 1962; Leonard and Leonard 1962; Allen and Edmunds 1963b; Allen and Edmunds 1965; Peterka 1969). Of these records, that of *Pentagenia vittigera* (Walsh) (Ephemeridae) by Hamilton (1959) was most notable, as records of this species remain scarce. In the 1970s, UW–Madison's Bill Hilsenhoff began a long series of contributions with the landmark survey of species from the Pine and Popple River systems in Florence and Forest Counties (Hilsenhoff et al. 1972). That publication was the source of 32 of our current state records, bringing the total at that time to 49 species—but just 31% of today's known diversity. The 1970s continued as the most prolific decade for new state records, with seven more species added from 1974 and 1975 (Edmunds and Jensen 1974; Lewis 1974a; Selgeby 1974; Flowers and Hilsenhoff 1975; McCafferty 1975). Edmunds and Jensen (1974) added *Spinadis simplex* (Walsh) (Heptageniidae), which today

Table 1. Chronological list of literature contributions to the known mayfly diversity of Wisconsin.

Author	Species
Wodsedalek (1912)	*Stenacron interpunctatum* (Say)
Muttkowski (1918)	*Caenis diminuta* Walker, *Leucrocuta maculipennis* (Walsh), *Siphlonurus alternatus* (Say)
Traver (1935)	*Callibaetis ferrugineus* (Walsh), *Eurylophella lutulenta* (Clemens)
Spieth (1941)	*Hexagenia limbata* (Serville)
Hamilton (1959)	*Hexagenia bilineata* (Say), *Pentagenia vittigera* (Walsh)
Britt (1962)	*Ephemera simulans* Walker, *Ephoron album* (Say)
Leonard and Leonard (1962)	*Procloeon rufostrigatum* (McDunnough)
Allen and Edmunds (1963b)	*Eurylophella funeralis* (McDunnough), *E. temporalis* (McDunnough)
Allen and Edmunds (1965)	*Ephemerella invaria* (Walker), *E. subvaria* McDunnough
Peterka (1969)	*Baetis tricaudatus* Dodds
Hilsenhoff et al. (1972)	*Acentrella parvula* (McDunnough), *A. turbida* (McDunnough), *Acerpenna pygmaea* (Hagen), *Anafroptilum album* (McDunnough), *Attenella attenuata* (McDunnough), *Baetis brunneicolor* McDunnough, *B. intercalaris* McDunnough, *B. pluto* McDunnough, *Baetisca obesa* (Say), *Dannella simplex* (McDunnough), *Drunella cornuta* (Morgan), *Ephemerella needhami* McDunnough, *Ephoron leukon* Williamson, *Eurylophella bicolor* (Clemens), *Heterocloeon curiosum* (McDunnough), *Labiobaetis frondalis* (McDunnough), *Maccaffertium mediopunctatum arwini* (Bednarik & McCafferty), *M. modestum* (Banks), *M. pulchellum* (Walsh), *M. vicarium* (Walker), *Neocloeon alamance* Traver, *Paraleptophlebia debilis* (Walker), *P. mollis* (Eaton), *Plauditus cingulatus* (McDunnough), *P. dubius* (Walsh), *P. punctiventris* (McDunnough), *Procloeon bellum* (McDunnough) [removed from the state list herein], *Rhithrogena manifesta* Eaton, *Serratella serrata* (Morgan), *Siphloplecton basale* (Walker), *Stenonema femoratum* (Say), *Teloganopsis deficiens* (Morgan)
Edmunds and Jensen (1974)	*Spinadis simplex* (Walsh)
Lewis (1974a)	*Maccaffertium exiguum* (Traver), *M. terminatum terminatum* (Walsh)
Selgeby (1974)	*Heptagenia pulla* (Clemens)
Flowers and Hilsenhoff (1975)	*Maccaffertium mexicanum integrum* (McDunnough)
McCafferty (1975)	*Hexagenia atrocaudata* McDunnough, *H. rigida* McDunnough

(continued)

Table 1. *(continued)*

Author	Species
Shapas and Hilsenhoff (1976)	*Epeorus vitreus* (Walker), *Ephemerella aurivillii* (Bengtsson), *E. catawba* Traver, *Heptagenia elegantula* (Eaton), *Labiobaetis propinquus* (Walsh), *Leucrocuta hebe* (McDunnough), *Maccaffertium luteum* (Clemens), *Nixe lucidipennis* (Clemens), *Rhithrogena impersonata* (McDunnough), *R. jejuna* Eaton, *Siphlonurus quebecensis* (Provancher)
Bergman and Hilsenhoff (1978a)	*Acerpenna macdunnoughi* (Ide), *Diphetor hageni* (Eaton)
Flowers and Hilsenhoff (1978)	*Arthroplea bipunctata* (McDunnough), *Heptagenia flavescens* (Walsh)
Morihara and McCafferty (1979b)	*Labiobaetis longipalpus* (Morihara & McCafferty)
Peckarsky (1980)	*Baetis flavistriga* McDunnough
Pescador and Berner (1981)	*Baetisca laurentina* McDunnough
Hilsenhoff (1984)	*Baetisca lacustris* McDunnough
Kondratieff and Voshell (1984)	*Isonychia sayi* Burks
Lillie et al. (1987)	*Acanthametropus pecatonica* (Burks)
Jacobs (1990)	*Choroterpes basalis* (Banks), *Dolania americana* Edmunds & Traver, *Habrophlebiodes americana* (Banks), *Leptophlebia cupida* (Say)
Provonsha (1990)	*Caenis amica* Hagen, *C. hilaris* (Say), *C. latipennis* Banks, *C. punctata* McDunnough
Bae and McCafferty (1991)	*Anthopotamus myops* (Walsh), *A. verticis* (Say)
Lillie (1992)	*Homoeoneuria ammophila* (Spieth), *Macdunnoa persimplex* (McDunnough), *Metretopus borealis* (Eaton), *Pseudiron centralis* McDunnough
Lillie and Hilsenhoff (1992)	*Caenis tardata* McDunnough, *C. youngi* Roemhild, *Isonychia bicolor* (Walker), *Paracloeodes minutus* (Daggy), *Siphloplecton interlineatum* (Walsh), *Sparbarus nasutus* (Soldan), *Susperatus prudens* (McDunnough), *Tricorythodes explicatus* (Eaton)
Lillie (1995)	*Labiobaetis dardanus* (McDunnough), *Parameletus* sp. A (as *P. chelifer* Bengtsson)
Hilsenhoff (1996)	*Ameletus lineatus* Traver, *Leptophlebia nebulosa* (Walker)
Randolph and McCafferty (1998)	*Caenis anceps* Traver, *Callibaetis fluctuans* (Walsh), *Ephemerella dorothea* Needham, *E. excrucians* Walsh, *Eurylophella aestiva* (McDunnough), *Heterocloeon amplum* (Traver), *Isonychia sicca* (Walsh), *Nixe inconspicua* (McDunnough), *Paraleptophlebia guttata* (McDunnough), *Rhithrogena undulata* (Banks), *Sparbarus lacustris* (Needham)
Klubertanz and Hess (2001)	*Dannella lita* (Burks), *Procloeon viridoculare* (Berner)
McCafferty and Jacobus (2001)	*Plauditus cestus* (Provonsha & McCafferty)
McCafferty et al. (2004)	*Anafroptilum conturbatum* (McDunnough), *A. victoriae* (McDunnough), *Callibaetis pallidus* Banks, *C. skokianus* Needham, *Neocloeon triangulifer* (McDunnough), *Procloeon pennulatum* (Eaton), *P. simplex* (McDunnough), *Pseudocentroptiloides usa* Waltz & McCafferty
McCafferty et al. (2005)	*Iswaeon anoka* (Daggy)
Sun and McCafferty (2008)	*Brachycercus harrisella* Curtis, *B. ojibwe* Sun & McCafferty, *Cercobrachys etowah* Soldan, *C. fox* Sun & McCafferty, *C. lilliei* Sun & McCafferty, *C. winnebago* Sun & McCafferty, *Sparbarus maculatus* (Berner)
McCafferty (2009)	*Paraleptophlebia praepedita* (Eaton)
McCafferty (2011)	*Isonychia rufa* McDunnough, *Tricorythodes albilineatus* Berner, *T. allectus* (Needham), *T. robacki* (Allen), *T. stygiatus* McDunnough
Schmude et al. (2012)	*Neoephemera bicolor* McDunnough

is one of only two state-endangered mayflies in Wisconsin. Shapas and Hilsenhoff (1976) added eleven species and made significant contributions to our understanding of mayfly biology in Wisconsin. The remainder of the decade produced five additional state records (Bergman and Hilsenhoff 1978a; Flowers and Hilsenhoff 1978; Morihara and McCafferty 1979b). Five species were documented from the state for the first time in the 1980s (Peckarsky 1980; Pescador and Berner 1981; Hilsenhoff 1984; Kondratieff and Voshell 1984; Lillie et al. 1987).

Table 2. New Wisconsin records of mayflies reported in this publication.

Family	Species
Ameletidae	*Ameletus subnotatus* Eaton
Baetidae	*Anafroptilum bifurcatum* (McDunnough), *A. minor* (McDunnough), *Callibaetis pictus* (Eaton), *Cloeon dipterum* (Linnaeus), *Fallceon quilleri* (Dodds), *Labiobaetis ephippiatus* (Traver), *Procloeon fragile* (McDunnough), *P. rivulare* (Traver), *P. rubropictum* (McDunnough), *Pseudocentroptiloides morihari* Wiersema & McCafferty
Ephemerellidae	*Drunella cornutella* (McDunnough)
Ephemeridae	*Litobrancha recurvata* (Morgan)
Heptageniidae	*Leucrocuta aphrodite* (McDunnough)
Leptophlebiidae	*Paraleptophlebia adoptiva* (McDunnough), *P. ontario* (McDunnough)
Siphlonuridae	*Siphlonurus phyllis* McDunnough, *S. rapidus* McDunnough

During this period was the discovery of *Acanthametropus pecatonica* in the Wisconsin River by Lillie et al. (1987). Today, this species is on the Wisconsin Endangered Species List. The tremendous mayfly diversity in Wisconsin was being realized, with 77 species on record by 1990.

Thirty-seven new state records were documented in the 1990s in a long list of publications (Jacobs 1990; Provonsha 1990; Bae and McCafferty 1991; Lillie 1992; Lillie and Hilsenhoff 1992; Lillie 1995; Hilsenhoff 1996; Randolph and McCafferty 1998). During this time, records of several rare and unusual mayflies were added, including the discovery of *Dolania americana* in the St. Croix River by Jacobs (1990). Lillie (1992) added four rare species to the Wisconsin state list: *Macdunnoa persimplex*, *Homoeoneuria ammophila*, *Pseudiron centralis*, and *Metretopus borealis.* Taxonomic revisions not specifically targeting Wisconsin mayflies, such as that of *Caenis* by Provonsha (1990) and of ephemeroid families by Bae and McCafferty (1991), not only added Wisconsin records, but allowed reliable identification of many larvae in existing collections. The last publication of the 1990s adding to the Wisconsin list was the comprehensive survey of Midwest mayflies by Randolph and McCafferty (1998), which added eleven species and summarized all previous state and county records.

The next decade added nineteen species, as currently recognized, to the list of Wisconsin species (Klubertanz and Hess 2001; McCafferty and Jacobus 2001; McCafferty et al. 2004; McCafferty et al. 2005; Sun and McCafferty 2008; McCafferty 2009). Difficult to identify baetids from *Callibaetis*, *Anafroptilum*, *Procloeon*, and *Pseudocentroptiloides* and other genera were added by Klubertanz and Hess (2001) and McCafferty et al. (2004). The record of *Procloeon rubropictum* in Klubertanz and Hess (2001) is corrected to *Neocloeon triangulifer* in this book, and is replaced by numerous other specimens. In their revision of the brachycercine Caenidae, Sun and McCafferty (2008) added seven species to the Wisconsin list, described several new species, and designated a Wisconsin specimen as the holotype of *Cercobrachys lilliei*.

The current decade already has added several species to the state list. McCafferty (2011) added five species, including the remarkable records of *Tricorythodes albilineatus* and the enigmatic *T. robacki*. Finally, in the most recent Wisconsin publication, Schmude et al. (2012) added *Neoephemera bicolor* to the state's faunal list, bringing the total to 140 species.

This book documents eighteen new state records (Table 2) discovered during field work and extensive examination of existing collections, including the reassignment of the state record for *Procloeon rubropictum*. It also removes *Procloeon bellum* from the state records based upon the uncertain taxonomic status of that species. With these records, Wisconsin's known mayfly diversity is 157 species. A complete checklist of these species is given in taxonomic order before the glossary at the end of this book.

With 157 species already documented for Wisconsin, how many undiscovered state records remain? *Fallceon quilleri* (Baetidae) was not known from Wisconsin until this book was nearly completed, when my colleague Jeffrey Dimick at the University of Wisconsin–Stevens Point found it in the southwest corner of the state. I believe that many *Fallceon*-like additions to Wisconsin's known mayfly fauna will be made in the coming decades. Based upon faunal lists of other Midwest states, I estimate that at least 39 additional species are possible or likely in the state (Table 3). Surprisingly, discovery of all of these species would be nearly a 25% increase in the known mayfly diversity for Wisconsin. Most of these species have records in eastern Iowa (as was the case for *F. quilleri*), northern Illinois, Minnesota, the

Table 3. Mayfly species possible to likely in Wisconsin, but not yet recorded from the state.

Family	Species	Nearest records
Ameletidae	*Ameletus ludens* Needham	IN
Ametropodidae	*Ametropus neavei* McDunnough	UP-MI
Baetidae	*Apobaetis etowah* (Traver)	MI
	Baetis bundyae Lehmkuhl	MN
	Callibaetis floridanus Banks	IA, IN
	Camelobaetidius waltzi McCafferty	IA, IL, IN
	Plauditus elliotti (Daggy)	MN
	P. gloveri McCafferty & Waltz	IN
	P. veteris (McDunnough)	IL
	P. virilis (McDunnough)	IN
	Procloeon ingens (McDunnough)	UP-MI
	P. mendax (Walsh)	UP-MI
	P. quaesitum (McDunnough)	IN
Caenidae	*Amercaenis ridens* (McDunnough)	IA
Ephemerellidae	*Attenella margarita* (Needham)	UP-MI
	Dentatella coxalis (McDunnough)	MI
	Drunella lata (Morgan)	MI
	D. walkeri (Eaton)	IN, MI
	Eurylophella macdunnoughi Funk	MI
	E. minimella (McDunnough)	MI, MN
	E. prudentalis (McDunnough)	KY
	E. versimilis (McDunnough)	UP-MI, MN
	Serratella frisoni (McDunnough)	IL
	S. serratoides (McDunnough)	IN, UP-MI
Ephemeridae	*Ephemera varia* Eaton	IN, MI, MN
Heptageniidae	*Epeorus namatus* (Burks)	IN
	Leucrocuta juno (McDunnough)	IA, IL
	Nixe perfida (McDunnough)	IL
	N. rusticalis (McDunnough)	IA
	Raptoheptagenia cruentata (Walsh)	IL, MN
	Stenacron candidum (Traver)	IN, MN
	S. gildersleevei (Traver)	IL
	S. minnetonka (Daggy)	IL, MN
Isonychiidae	*Isonychia arida* (Say)	IL
Leptophlebiidae	*Leptophlebia intermedia* (Traver)	IL
	Paraleptophlebia volitans (McDunnough)	UP-MI, MN
Polymitarcyidae	*Tortopus primus* (McDunnough)	IL
Siphlonuridae	*Siphlonurus typicus* (Eaton)	IN, MN

Upper Peninsula of Michigan, and/or northwestern Indiana. In addition, a few other species on this list are not known from neighboring states but have geographic ranges that logically should include Wisconsin. Wisconsin records are lacking for several species identifiable only as adults, especially in the Leptohyphidae and Heptageniidae. Relatively little study of reared and adult material has been done in the state. There is, therefore, plenty of taxonomic and faunal work still needed in Wisconsin.

The mayfly fauna of each of Wisconsin's neighboring states is fairly well understood, though none has as many known species as Wisconsin. All of the Midwest states east of the Mississippi River, including Wisconsin, Illinois, and Michigan, were surveyed by Randolph and McCafferty (1998). Illinois was surveyed by Burks (1953), which, prior to Randolph and McCafferty (1998), was the most significant study of Midwest mayflies. At that time, Burks recognized 126 species in Illinois. Currently, with the rate of taxonomic lumping exceeding the rate of new species discoveries, the published Illinois fauna is down to about 115 species. Leonard and Leonard (1962) surveyed stream mayflies in Michigan. With all other published records, the Michigan fauna currently stands at

Table 4. Species known from Wisconsin but without published records from bordering states.

Family	Species
Ameletidae	*Ameletus subnotatus*
Baetidae	*Anafroptilum conturbatum*; *A. minor* *Procloeon pennulatum*; *P. rivulare* *Pseudocentroptiloides morihari*
Behningiidae	*Dolania americana*
Caenidae	*Brachycercus ojibwe* *Cercobrachys etowah*; *C. lilliei* *Sparbarus maculatus*
Ephemerellidae	*Ephemerella catawba* [in question; see species account]
Siphlonuridae	*Parameletus* sp. A

approximately 122 species. The first statewide survey of Iowa mayflies was Klubertanz (1995), with subsequent publications by McCafferty and Hubbard (1998), McCafferty et al. (2003a), and McCafferty et al. (2007). Iowa currently has published records of about 109 species, including three species reported in Meierhoff and Prill (1982) that were not included in the subsequent summaries of the literature (*Baetis phoebus* McDunnough, *Ephemerella aurivillii*, and *Stenacron minnetonka*). The least known mayfly fauna of states bordering Wisconsin is that of Minnesota, with only about 81 species with published records. Lager et al. (1982) examined the faunal diversity of northeastern Minnesota, but no statewide survey of Minnesota mayflies has been published. Therefore, the 157 Wisconsin species far exceeds the known faunal diversity of any of its bordering states. Thirteen of these species are not known from any of the bordering states (Table 4). Most of these have been detected because of intensive sampling by the Wisconsin Department of Natural Resources and biologists from various campuses of the University of Wisconsin through faculty research and programs such as the Natural Heritage Conservation Bureau's Biotic Inventory Program. The baetids on this list are difficult to identify, and most of the caenids have been identifiable only recently.

Statewide Patterns in Species Richness

Figure 6 shows the number of mayfly species known from each of Wisconsin's 72 counties. Burnett County in northwestern Wisconsin has the greatest known mayfly richness in the state (86 species), supported by the diverse fauna of the St. Croix River. Large numbers of species are known from other northern counties, including Rusk, Florence, and Marinette Counties. In southern Wisconsin, Sauk, Rock, and Richland Counties have the greatest known mayfly richness. In all seven of these cases, including my home of mostly agricultural Rock County, intensive sampling has allowed better detection of uncommon and rare species. In southeastern Wisconsin, four counties have fewer than ten known species. Though some species may remain undetected in these counties due to sampling effort, their known richness is much lower than other counties with comparable coverage.

Conservation Status of Wisconsin Mayflies

The previous section showed that Wisconsin has a remarkable diversity of mayflies. This diversity is known as well as it is only because of decades of intensive sampling throughout the state. Some of Wisconsin's species occur in nearly every river and stream in the state and clearly are of little conservation concern. But many species are represented in collections by only a few specimens or from very few sites. Are such species more vulnerable to extirpation?

Table 5 lists 87 of the least common species in Wisconsin based upon the following criteria: 1) listed as Endangered or Threatened, 2) listed as a Species of Special Concern, or 3) known from fewer than five counties in the state, an arbitrary cutoff. These 87 species represent over 55% of the state's known mayfly diversity. Most of the ten species considered rare by Lillie (1995) are included using these criteria. *Cercobrachys* sp. (Caenidae) larvae could not be reliably identified to species at that time, but are now separated into four species in Table 5.

Two of the species in Table 5 are listed as Endangered by the State of Wisconsin. *Acanthametropus pecatonica* (Acanthametropodidae) is the more common of the two, known from a handful of sites with sandy substrates in western Wisconsin. *Spinadis simplex* (Heptageniidae) is known only from the Wisconsin River in Richland County. These two species are large, very distinctive, and present no identification challenges. They clearly

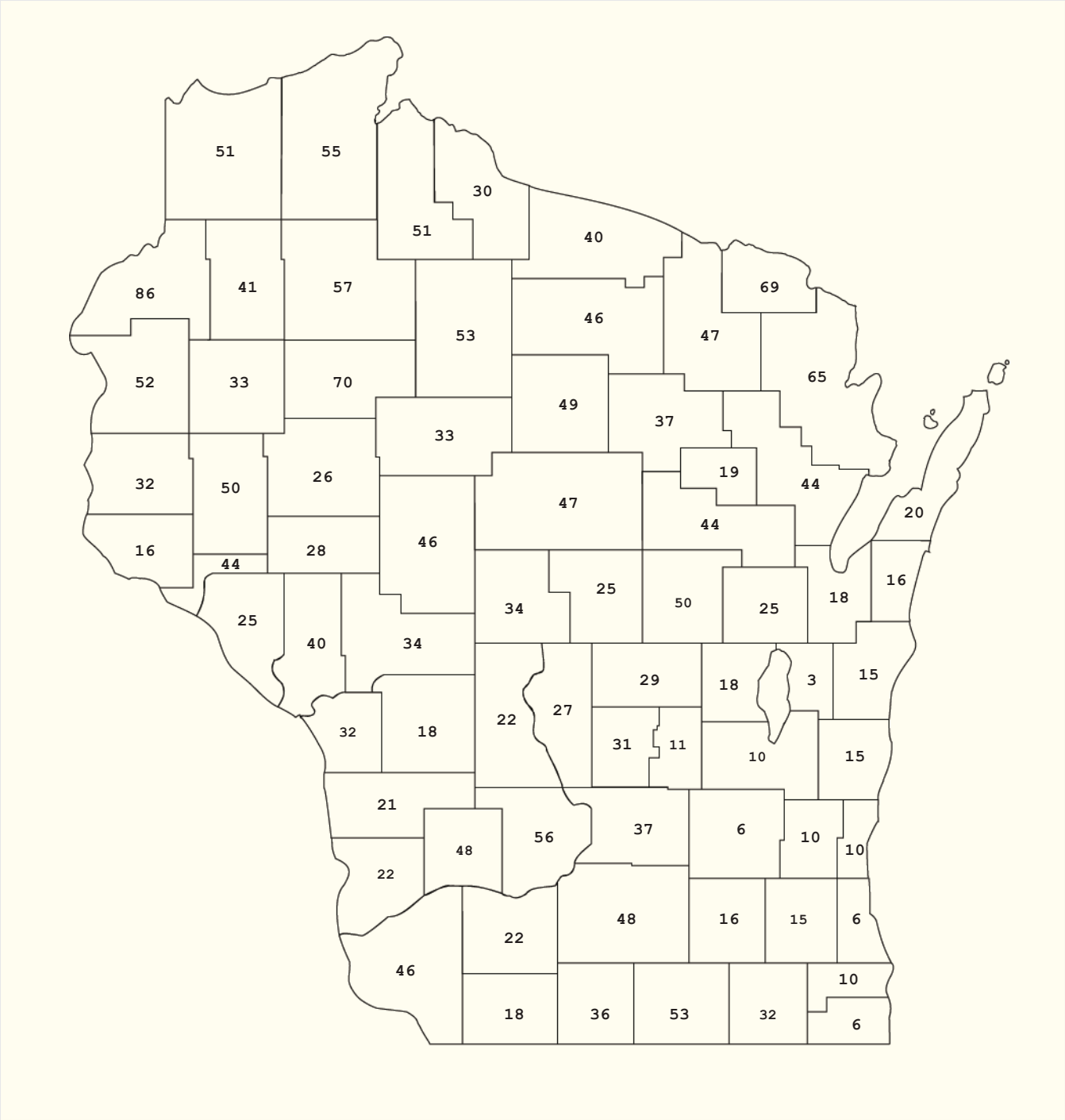


Figure 6. Known mayfly species richness in each of 72 Wisconsin counties.

are rare and in peril. No mayfly species is listed in Wisconsin as Threatened.

In addition to the two endangered species, many other mayfly species have populations or distributions resulting in elevated conservation status. Sixty of the 87 species from Table 5 (over 38% of fauna) are listed under the informal, unprotected status of Species of Special Concern by the Wisconsin Department of Natural Resources (Anonymous 2014b). *Procloeon bellum* (Baetidae) also is listed as a Species of Special Concern, but is not included in Table 5 because of taxonomic uncertainty. Some of these 60 species are widely distributed in the state. Thirty-seven of them are found in five or more counties,

including *Procloeon viridoculare*, which is now known from 25 counties. The remaining 21 Species of Special Concern are known from fewer than five counties. Biological information for all of the Species of Special Concern is needed, however, to better understand the vulnerabilities of their populations, regardless of their current distribution in the state.

One of the most challenging exercises is to separate those species that are rarely encountered or identified from the ones that truly are rare. Of course, the number of counties where a species is known is not as meaningful as information about the number, sizes, and genetic viability of populations. Unfortunately, anything close to such detailed population-level information exists for only a couple of mayfly species. In many cases, labels on specimens in collections indicate only the county and date of collection. County records are the best data available.

Of the 87 species listed in Table 5, 48 (30% of fauna) are known from fewer than five counties in Wisconsin regardless of their conservation status. Over half (25) of these uncommonly documented or encountered species have no elevated conservation status. Twenty species (13% of fauna) are known from only one county in Wisconsin. Fourteen of those 20 most rarely documented species have no conservation status. How many species in these various categories are biologically rare, rather than just apparently rare because of lack of data?

Most streams and rivers in Wisconsin have been thoroughly sampled. Decades of collections by faculty and students of the 26 University of Wisconsin campuses, the Wisconsin Department of Natural Resources, the Environmental Protection Agency, and others are sufficient to not only give an excellent representation of the fauna, but to even provide information about faunal changes over time. Lentic biomes in Wisconsin have been less frequently sampled, though few species occupy such habitats. A few species are difficult to sample because they live in deep water, in shifting substrates, or in high current. The two psammophilous species of *Pseudocentroptiloides* (Baetidae) come to mind, and those mayflies also are difficult to collect because of their small size and are challenging to identify. Such species are disproportionately underrepresented in the dataset.

Not all species of Wisconsin mayflies can be reliably identified as larvae. In this book, 19 species known from Wisconsin (12% of fauna) are characterized as problematic or very difficult to identify. At best, these species only can be identified by a qualified expert with access to verified, reared material. The criteria for other levels of difficulty are explained later in this chapter. Eleven of these 19 species presenting the greatest taxonomic challenges are known from fewer than five counties and are included with the 87 species in Table 5. Biologically, they are not necessarily rare even though five of them are listed as Species of Special Concern. A survey of adult mayflies in the state, through rearing and terrestrial collections, is badly needed to determine the status of each. Two of these 19 species, *Baetis flavistriga* (Baetidae) and *Stenacron interpunctatum* (Heptageniidae), are on the other end of the spectrum. They are known from nearly every county, yet cannot be reliably separated from currently recognized congeners as larvae.

Are there additional species that should receive elevated conservation status because they are rare, not just because they present taxonomic challenges? There are 19 species in Table 5 that are reliably identifiable, are known from five or fewer counties, and do not have elevated conservation status. These species likely are biologically rare and should be the subjects of targeted assessment and possible conservation measures. Thirteen of them have their first Wisconsin records included in this book, the result of intensive sampling and examination of existing collections for overlooked species.

Format of Species Accounts

Each species account in this publication provides a wide range of taxonomic and biological information. Most of the categories of information are self-explanatory. The taxonomic history of each species was obtained from the Mayfly Central (Anonymous 2014a) and Ephemeroptera of the World (Kluge 2014) websites, which contain the most complete and up-to-date information about North American mayflies. Frequent reference to these websites is advised to remain informed about taxonomic changes. Any previously published, formal larval descriptions are listed in my species accounts, as well as any reliable photographs or illustrations of the larval habitus (general overall appearance). For nearly all species, photographs of the larval habitus are provided in this book. Unfaded and undamaged specimens were not available for all species, so the reader is cautioned against making identifications solely based upon appearance in the photographs. Many species are variably patterned or cannot be reliably identified without careful examination of morphology. To improve the depth of focus of photographs, serial images were combined using public domain CombineZM software (A. Hadley, 2008). The "Determination" section in each species account provides information regarding the ease or

Table 5. Rare and rarely reported Wisconsin mayflies.

Family	Species	Larval identification	Counties	Status*
Acanthametropodidae	*Acanthametropus pecatonica*		4	END, R
Ameletidae	*Ameletus lineatus*	Very difficult	1	SSC
	A. subnotatus		1	
Arthropleidae	*Arthroplea bipunctata*		7	SSC
Baetidae	*Anafroptilum album*		9	SSC
	A. bifurcatum		1	
	A. conturbatum		1	SSC
	A. minor		3	
	A. victoriae		4	SSC
	Baetis pluto		1	
	Callibaetis pallidus	Problematic	3	SSC
	C. pictus		2	
	C. skokianus	Problematic	2	SSC
	Cloeon dipterum		1	
	Diphetor hageni		3	SSC
	Fallceon quilleri		1	
	Labiobaetis dardanus		6	SSC
	L. longipalpus		7	SSC
	Neocloeon alamance		2	
	N. triangulifer		9	SSC
	Paracloeodes minutus		9	SSC
	Plauditus cestus		5	SSC
	P. cingulatus		6	SSC
	Procloeon fragile		3	
	P. pennulatum		5	SSC
	P. rivulare	Very difficult	1	SSC
	P. rubropictum		14	SSC
	P. rufostrigatum		19	SSC
	P. simplex		7	SSC
	P. viridoculare		25	SSC
	Pseudocentroptiloides usa		10	SSC
	P. morihari		4	
Baetiscidae	*Baetisca obesa*		18	SSC
Behningiidae	*Dolania americana*		1	SSC
Caenidae	*Brachycercus ojibwe*		18	SSC
	Caenis anceps		15	SSC
	C. diminuta		14	SSC
	C. hilaris		11	SSC
	C. punctata		9	SSC
	C. tardata		9	SSC
	C. youngi		6	SSC

(continued)

Table 5. *(continued)*

Family	Species	Larval identification	Counties	Status*
Caenidae *(cont.)*	*Cercobrachys etowah*		4	
	C. fox		5	SSC
	C. lilliei		6	SSC
	C. winnebago		2	SSC
	Sparbarus lacustris		9	SSC
	S. maculatus		3	SSC
	S. nasutus		7	SSC
	Susperatus prudens		12	SSC
Ephemerellidae	*Dannella lita*		6	SSC
	Drunella cornuta		3	SSC
	D. cornutella		1	
	Ephemerella catawba (in question; see species account)	Very difficult	2	
	E. excrucians		5	SSC
	Eurylophella aestiva		3	SSC
	Serratella serrata		5	SSC
Ephemeridae	*Hexagenia atrocaudata*		10	SSC
	H. rigida		4	SSC
	Litobrancha recurvata		4	
Heptageniidae	*Heptagenia pulla*		5	SSC
	Leucrocuta aphrodite		1	
	L. maculipennis	Problematic	1	SSC
	Maccaffertium luteum		18	SSC
	M. pulchellum		13	SSC
	Macdunnoa persimplex		3	R, SSC
	Nixe inconspicua		2	SSC
	Rhithrogena impersonata		5	SSC
	R. jejuna		15	SSC
	R. manifesta		13	SSC
	R. undulata		2	SSC
	Spinadis simplex		1	END, R
Leptohyphidae	*Tricorythodes albilineatus*	Very difficult	1	
	T. allectus	Problematic	2	
	T. explicatus	Very difficult	2	
	T. robacki		1	
	T. stygiatus	Problematic	3	
Leptophlebiidae	*Habrophlebiodes americana*		1	
	Paraleptophlebia guttata		1	
	P. ontario		1	
Metretopodidae	*Metretopus borealis*		3	R, SSC
Neoephemeridae	*Neoephemera bicolor*		1	SSC
Oligoneuriidae	*Homoeoneuria ammophila*		3	R, SSC
Palingeniidae	*Pentagenia vittigera*		6	R, SSC

(continued)

Table 5. *(continued)*

Family	Species	Larval identification	Counties	Status*
Pseudironidae	*Pseudiron centralis*		11	R, SSC
Siphlonuridae	*Parameletus* sp. A		2	R, SSC
	Siphlonurus phyllis		1	
	S. rapidus	Problematic	4	

*END—State Endangered, Wisconsin Department of Natural Resources; R—previously considered rare by Lillie (1995); SSC—State Species of Special Concern, Wisconsin Department of Natural Resources Natural Heritage Working List, June 2014.

difficulty of identification of the taxon within the known or possible Wisconsin fauna. The information contained in this section may not be appropriate in other regions, where different combinations of taxa occur. With this information, though, the user can reduce the odds of misidentification of specimens from Wisconsin and neighboring states. The following categories are used in this text to describe the ease or difficulty of identification:

Easy: Can be quickly identified in the field with a hand lens based upon large structures or coloration. Not easily confused with any other taxon, even for immature larvae.

Moderately Easy: Can be identified by examination under low to medium magnification with a dissecting microscope. Not easily confused with any other taxon, even for immature larvae.

Fairly Easy: Can be identified by examination under medium to high power with a dissecting microscope. Similarity with one or more other taxa may be confusing to those not familiar with the taxon, especially when examining immature larvae.

Slightly Difficult: Identification becomes easier with practice, but the taxon is easily misidentified without proper use of keys, availability of intact or mature larvae, preparation of slide mounts, or analysis of multiple characters. Generally, features not in the key, such as body coloration, can be used within a given sample to quickly and roughly sort such taxa.

Moderately Difficult: Identification remains challenging or time consuming even with practice, as slide mounts are required or there are highly similar taxa.

Difficult: Can be reliably identified with experience, but requires careful examination of slide mounts or a subtle combination of characters. Misidentification is always a possibility, even for experienced taxonomists.

Very Difficult: Identification generally reliable only by a qualified expert, usually through comparison with verified (reared) reference material or a series of specimens.

Problematic: Reliable identification not possible based solely upon larvae.

Abbreviations Used in Species Accounts and Sample Data

Anatomical and Locale Abbreviations: A (adult); Ave. (Avenue); Brk. (Brook); Co. (County); coll. (collected); Crk. (Creek); E. (East); emer. (emerged); Ex (exuviae); F (female); ft. (feet); Hwy. (Highway); L (larva); Lk. (Lake); Ln. (Lane); M (male); m (meters); mi. (miles); N. (North); Pk. (Park); R. (River); Rd. (Road); S (Subimago); S. (South); Sec. (Section); St. (State); Str. (Street); Twp. (Township); UW (University of Wisconsin); W. (West); Wildl. (Wildlife); yds. (yards).

Museum and collections where specimens are deposited are indicated in parentheses at the end of each record. Abbreviations of museums and collections used in the text are: **MPM** (Milwaukee Public Museum, Milwaukee, WI); **PERC** (Purdue Entomological Research Collection, Department of Entomology, Purdue University, West Lafayette, IN); **THK** (Tom H. Klubertanz, Department of Biological Sciences, University of Wisconsin–Rock County, Janesville, WI); **UW** (William Hilsenhoff collection, Wisconsin State Insect Collection, Department of Entomology, University of Wisconsin–Madison, Madison, WI); **UWGB** (Michael Draney, University of Wisconsin–Green Bay, Green Bay, WI); **UWO** (H. Gene Drecktrah, Department of Biology, University of Wisconsin–Oshkosh, Oshkosh, WI); **UWS** (Kurt L. Schmude, University of Wisconsin–Superior, Superior, WI); **UWSP** (Jeffrey Dimick, Wisconsin Cooperative Fishery Research Unit, Aquatic Biomonitoring Laboratory, University of Wisconsin–Stevens Point, Stevens Point, WI); **WiDNR** (Wisconsin Department of Natural Resources, Madison, Wisconsin).

Key to the Families of Wisconsin Mayfly Larvae

1. Mandibular tusks present, visible in dorsal view (Fig. 7a–c) **2**

Mandibular tusks absent **5**

2. Prothoracic legs normal, cylindrical; mandibular tusks as in Fig. 7a . . . . . **POTAMANTHIDAE: *Anthopotamus***

Prothoracic legs fossorial (Fig. 7d); mandibular tusks not as above **3**

3. Mandibular tusks curved upward (Fig. 7b) **4**

Mandibular tusks not curved upward (Fig. 7c) . . . . . **POLYMITARCYIDAE**

4. Mandibular tusk with robust spines on dorsolateral margin (Fig. 7e) . . . . . **PALINGENIIDAE: *Pentagenia vittigera***

Mandibular tusk smooth, without dorsolateral spines (Fig. 7b) . . . . . **EPHEMERIDAE**

5. Thorax expanded into dome-shaped carapace (Fig. 7f) . . . . . **BAETISCIDAE: *Baetisca***

Thorax not expanded into carapace **6**

6. Head and prothorax with dorsal pad of long spines (Fig. 7g); gills ventral . . . . . **BEHNINGIIDAE: *Dolania americana***

Head and prothorax without dorsal pad of long spines; gills variable **7**

7. Gill II forming a complete or partial plate-like operculum, covering more posterior gills (Fig. 7h–i) **8**

Gill II, if present, not forming a complete or partial operculum; more posterior gills sometimes operculate **10**

8. Operculate gill II roughly triangular, with corners varying from angular to broadly rounded (Fig. 7h); gill I absent . . . . . **LEPTOHYPHIDAE: *Tricorythodes***

Operculate gill II roughly quadrate (Fig. 7i); gill I a slender filament **9**

9. Mesonotum with rounded lobe on anterolateral corner (Fig. 7j); operculate gills fused medially; rare . . . . . **NEOEPHEMERIDAE: *Neoephemera bicolor***

Mesonotum without lobe on anterolateral corner (Fig. 7k); operculate gills not fused medially; common . . . . . **CAENIDAE**

10. Gill II present; terga rarely with paired tubercles **11**

Gill II absent; terga often with paired, submedian tubercles or clusters of spicules (Fig. 7l) . . . . . **EPHEMERELLIDAE**

11. Body and head dorsoventrally flattened (Fig. 7m) **12**

Head not dorsoventrally flattened (Fig. 7n); body usually cylindrical **14**

12. Claws elongate; tarsi bowed (Fig. 7o) . . . . . **PSEUDIRONIDAE: *Pseudiron centralis***

Claws short; tarsi not bowed (Fig. 7p) **13**

13. Maxillary palpi very long and pectinate, visible from above (Fig. 8a) . . . . . **ARTHROPLEIDAE: *Arthroplea bipunctata***

Maxillary palpi variable, but rarely visible from above . . . . . **HEPTAGENIIDAE**

14. Protarsal claw much shorter than other claws, either simple or bifid (Fig. 8b–c); meso- and metatarsal claws simple and about as long as their respective tibiae (Fig. 8d) **15**

All claws similar in structure and length; meso- and metatarsal claws of variable length **16**

15. Protarsal claws simple (Fig. 8b); procoxa with a spinous pad; not known from Wisconsin . . . . . **AMETROPODIDAE: *Ametropus neavei***

Protarsal claws bifid (Fig. 8c); procoxa without spinous pad . . . . . **METRETOPODIDAE**

16. Prothoracic leg with a dense row of long, ventral setae, setae longer than protarsus (Fig. 8e) **17**

Prothoracic leg without a dense row of ventral setae, or such setae shorter than protarsus **18**

17. Gills I–VII plate-like and rounded, with delicate, branched basal tufts (Fig. 8f); gill I not projecting between metacoxae. . . . . **ISONYCHIIDAE: *Isonychia***

Gills II–VII narrow with posterior fringes (Fig. 8g); gill I elongate and projecting between metacoxae . . . . . **OLIGONEURIIDAE: *Homoeoneuria ammophila***

18. Gills forked, tufted, as slender filaments, or plate-like with terminal filaments (Figs. 8h, 334e) . . . . . **LEPTOPHLEBIIDAE**

Gills plate-like and without terminal filaments (Fig. 8i). **19**

19. Lateral ocelli located posterior to anterolateral branches of epicranial suture (Fig. 7n); each femur with a down-curved dorsal lobe at apex, visible in anterior view (Fig. 8j); labrum usually with a deep medial notch (Fig. 8k); antennae usually more than twice as long as width of head capsule . . . . . **BAETIDAE**

Lateral ocelli located anterior to or bisected by anterolateral branches of epicranial suture (Fig. 8l); each femur with a truncate or rounded dorsal lobe at apex (Fig. 8m); labrum with medial notch of various depths (Fig. 8n); antennae usually less than twice as long as width of head capsule **20**

20. Tarsi bowed; metatarsal claw as long as metatarsus (Fig. 8o) **ACANTHAMETROPODIDAE: *Acanthametropus pecatonica***

Tarsi not bowed; metatarsal claw shorter than metatarsus. **21**

21. Maxillary crown with a dense row of pectinate spines (Fig. 8p); each gill with a lateral sclerotized band . . . . . **AMELETIDAE: *Ameletus***

Maxillary crown with a dense row of simple spines (Fig. 8q); gills without lateral sclerotized bands . . . . . **SIPHLONURIDAE**

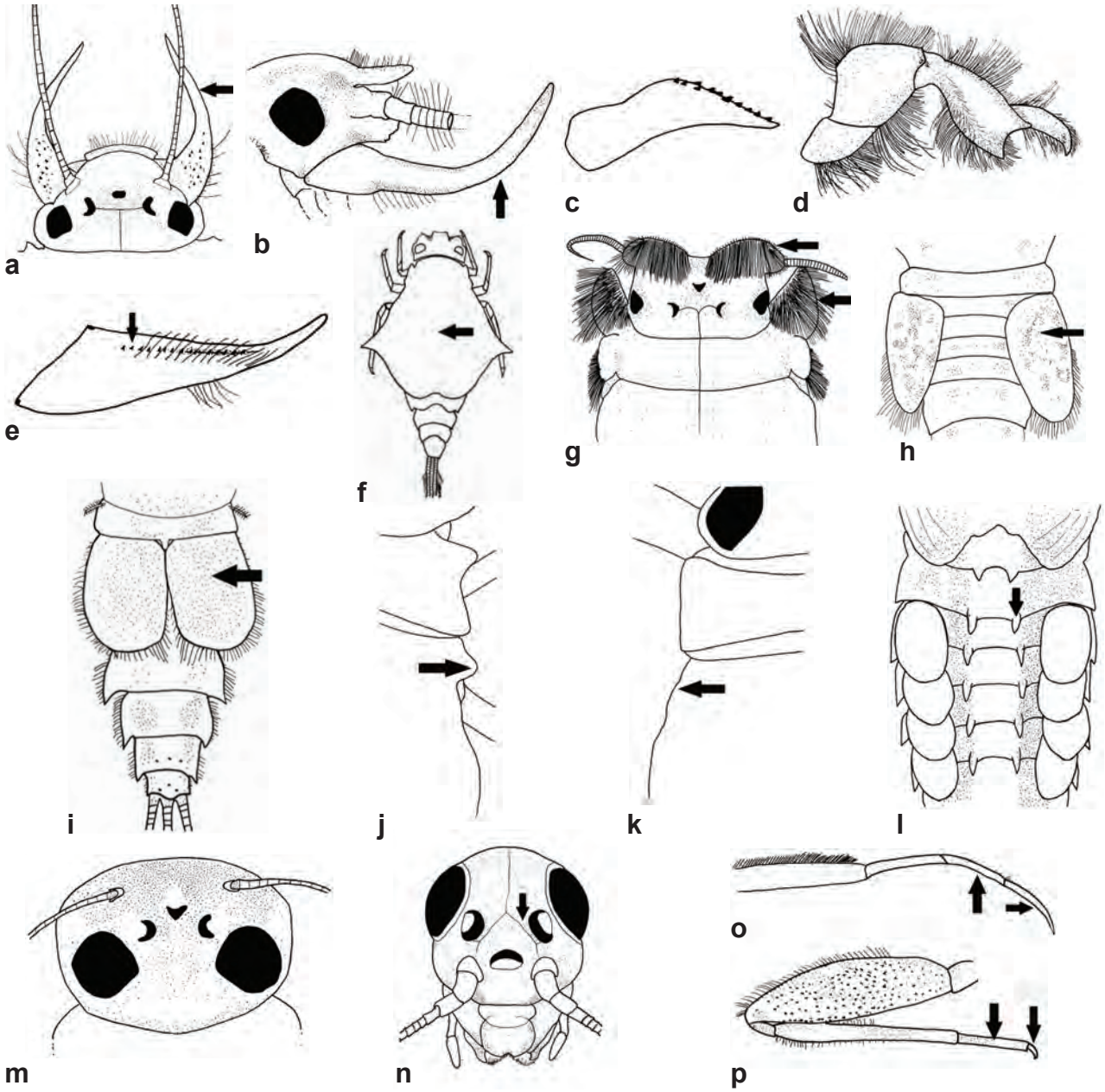


Figure 7. Mayfly families. **a,** *Anthopotamus myops* (Potamanthidae), head (dorsal); **b,** *Hexagenia limbata* (Ephemeridae), head (lateral); **c,** *Ephoron album* (Polymitarcyidae), mandible (lateral); **d,** *Hexagenia limbata* (Ephemeridae), front leg (lateral); **e,** *Pentagenia vittigera* (Palingeniidae), mandible (lateral); **f,** *Baetisca lacustris* (Baetiscidae), larva (dorsal); **g,** *Dolania americana* (Behningiidae), head and pronotum; **h,** *Tricorythodes* sp. (Leptohyphidae), terga; **i,** *Caenis latipennis* (Caenidae), terga; **j,** *Neoephemera bicolor* (Neoephemeridae), mesonotum; **k**, *C. latipennis* (Caenidae), mesonotum; **l,** *Ephemerella needhami* (Ephemerellidae), terga; **m,** *Heptagenia elegantula* (Heptageniidae), head (dorsal); **n,** *Baetis intercalaris* (Baetidae), head (anterior); **o,** *Pseudiron centralis* (Pseudironidae), front tarsus; **p,** *Stenacron interpunctatum* (Heptageniidae), middle leg (anterior).

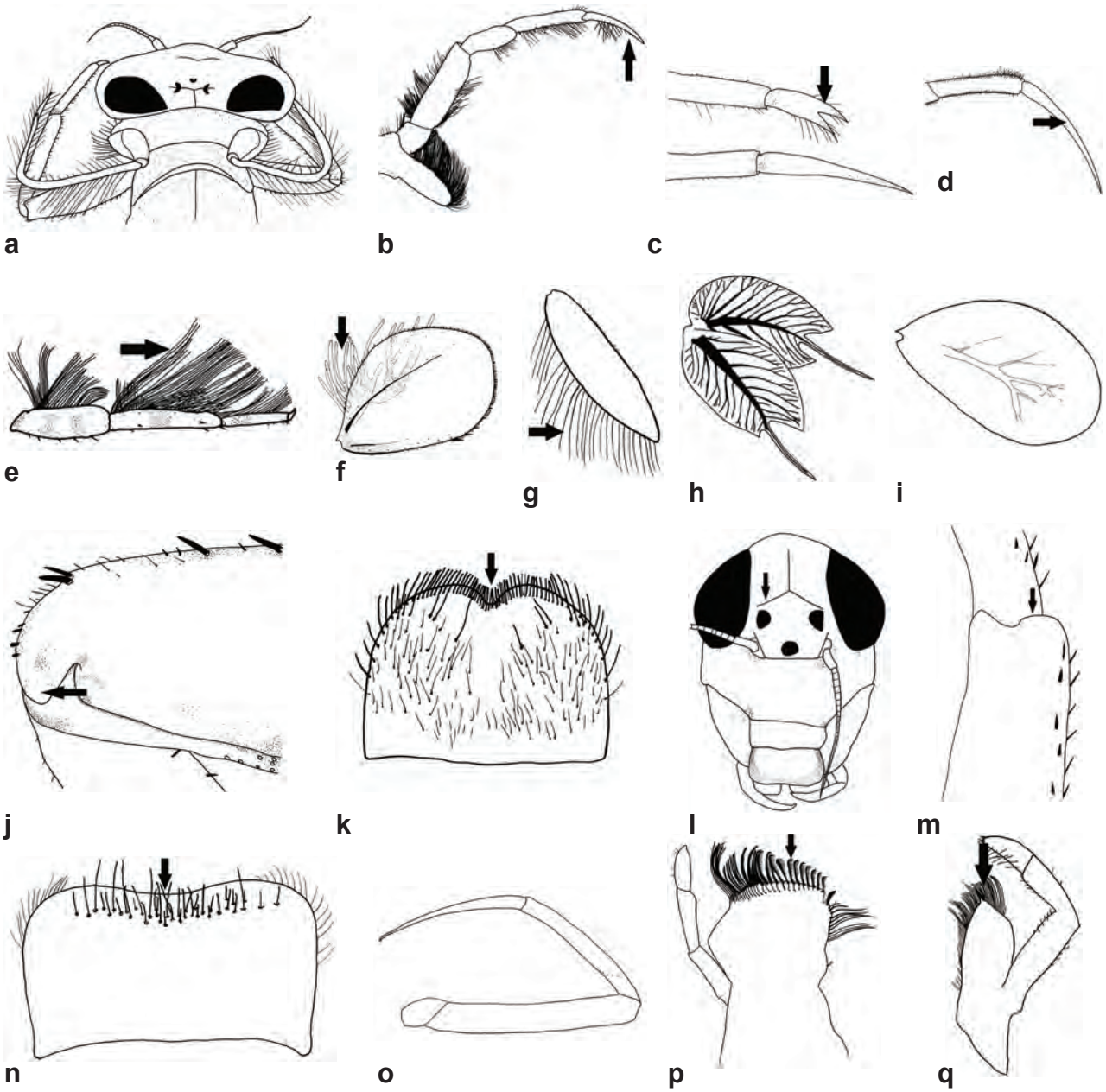


Figure 8. Mayfly families. a, *Arthroplea bipunctata* (Arthropleidae), head and pronotum; **b,** *Ametropus neavei* (Ametropodidae), front leg (posterior); **c,** *Siphloplecton interlineatum* (Metretopodidae), front and middle tarsi; **d,** *A. neavei* (Ametropodidae), middle tarsus; **e,** *Isonychia rufa* (Isonychiidae), front leg (anterior); **f,** *I. rufa* (Isonychiidae), gill V; **g,** *Homoeoneuria ammophila* (Oligoneuriidae), gill V; **h,** *Leptophlebia* sp. (Leptophlebiidae), gill V; **i,** *Baetis intercalaris* (Baetidae), gill V; **j,** *Labiobaetis propinquus* (Baetidae), front femur (anterior); **k,** *L. propinquus* (Baetidae), labrum (dorsal); **l,** *Siphlonurus* sp. (Siphlonuridae), head (anterior); **m,** *Siphlonurus* sp. (Siphlonuridae), right front femur (anterior); **n,** *Siphlonurus* sp. (Siphlonuridae), labrum (dorsal); **o,** *Acanthametropus pecatonica* (Acanthametropodidae), hind leg; **p,** *Ameletus lineatus* (Ameletidae), maxilla (ventral); **q,** *Siphlonurus* sp. (Siphlonuridae), maxilla.

4 ACANTHAMETROPODIDAE

The Acanthametropodidae in North America contains only the eastern and very rare *Acanthametropus pecatonica* and the western *Analetris eximia* Edmunds. Both were placed in the Siphlonuridae until McCafferty (1991). *Analetris* is not represented in Wisconsin.

Acanthametropus

Comments: Only two species of *Acanthametropus* are recognized. *Acanthametropus nikolskyi* Tshernova is known from the eastern Palearctic (Kluge 2014). The other species, *A. pecatonica*, is restricted to North America.

Determination: Identification of *Acanthametropus* larvae is **Easy**. The genus is the only one in the family represented in Wisconsin.

Acanthametropus pecatonica (Burks), 1953 (Fig. 9 and 10)

Taxonomic History: *Acanthametropus pecatonica* (Burks), 1953 (curr. comb., Edmunds and Allen 1957); *Metreturus pecatonica* Burks, 1953 (orig.).

Larval Description: Burks (1953), as *M. pecatonica*.

Larval Habitus: Lillie (1995).

Determination: Identification of *A. pecatonica* larvae is **Easy**. It is an unmistakable species, being large and distinctive.

Previous Wisconsin Records: Lillie et al. (1987); Lillie (1992, 1995).

Status: *Acanthametropus pecatonica* is one of the rarest species of mayflies in Wisconsin and is listed as endangered on the Wisconsin Endangered and Threatened Species List. Burks (1953) described the species from specimens taken from the Sugar and Pecatonica Rivers in extreme northern Illinois. The species was first discovered in Wisconsin in 1986 from one site on the Wisconsin River (Lillie et al. 1987), and has since been found in the Chippewa River in Pepin County (Lillie 1992), the Black River in La Crosse and Trempealeau Counties (Lillie 1995), and most recently the Wisconsin River in 2010 (William Smith, Wisconsin Department of Natural Resources, personal communication). Lillie (1995) believed only the Wisconsin and the Black Rivers could have viable populations in the state. Any populations of *A. pecatonica* in other river systems, such as the Rock and Chippewa Rivers, likely have been extirpated because of habitat loss (Randolph and McCafferty 1998). It is also likely that little habitat suitable for this psammophilous species remains in northern Illinois.

Biological Information: Larvae of *A. pecatonica* occur in wide, relatively shallow rivers (Edmunds et al. 1976), where they are associated with sand substrates, occasionally with minor silt or rock components (Edmunds et al. 1976; Lillie and Hilsenhoff 1992; Lillie 1995).

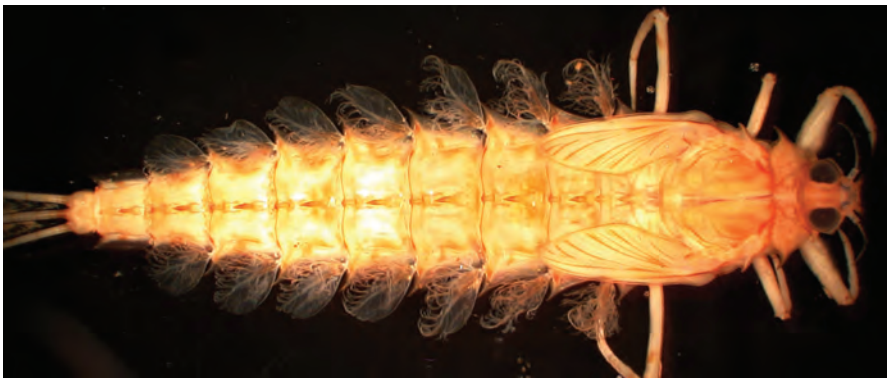


Figure 9. *Acanthametropus pecatonica,* larva.

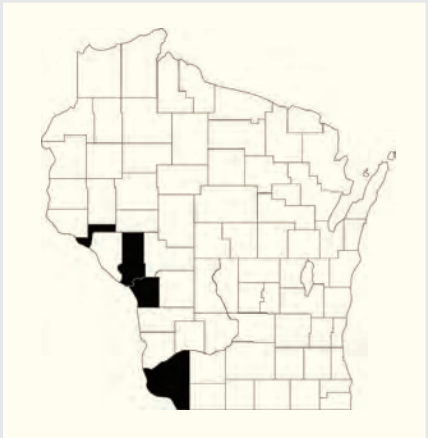


Figure 10. Wisconsin records of *Acanthametropus pecatonica.*

5 AMELETIDAE

The Ameletidae in North America is represented only by the genus *Ameletus*, with just two species known from Wisconsin. The Family Ameletidae, which is Holarctic in distribution, was removed from the Siphlonuridae by McCafferty (1991).

Ameletus

Comments: Of the 34 recognized species of *Ameletus* in the United States, only three occur in or near Wisconsin. None of them is well represented in Wisconsin collections, and the first record of *A. subnotatus* from the state is reported herein. An additional four species of *Ameletus* occur in eastern or southeastern states but are not expected in Wisconsin. The genus has its greatest species diversity in the Northwest and Southwest regions of the United States. Two species from the Midwest (*A. ludens* and *A. lineatus*) are strictly parthenogenetic (Zloty 1996).

Determination: Identification of *Ameletus* larvae is **Fairly Easy** at the generic level but **Very Difficult** for species within the genus. The Ameletidae are most easily confused with members of the Baetidae, to which *Ameletus* larvae will key in several older keys. Wang and McCafferty (1996) published new diagnostic characters for the Baetidae, which aid in separation of the two families.

Larval Keys: Traver (1932b, 1935); Burks (1953); Zloty and Pritchard (1997).

Key to the Species of *Ameletus*

1. Abdominal sterna together forming one or more dark longitudinal stripes (Fig. 11c); each gill with a sclerotized band located near margin (Fig. 11a); posterior margins of sterna VI–VIII without microspines; caudal filaments white basally, followed by a dark band containing alternating wide dark and narrow light rings more distally; parthenogenetic species without males **2**

Abdominal sterna lacking dark, longitudinal markings; each gill, especially on middle abdominal segments, with a sclerotized band located well away from margin (Fig. 11b); sterna VI–VIII with numerous microspines along posterior margins, but such microspines absent near midline; caudal filaments dark basally, with white rings approximately every three segments; sexually reproducing species with males present in populations . . . . . ***A. subnotatus***

2. Sterna IV–IX each typically with dark markings consisting of wide sublateral, longitudinal bands extending laterally to pleural folds, with a distinct medial triangle forming a discontinuous medial longitudinal band, and with all markings in sterna VII–IX tending to coalesce into a generalized darkened area; reared adults required for confirmation of species identification; not known from Wisconsin . . . . . ***A. ludens***

Sterna IV–IX each typically with dark markings limited to narrower sublateral, longitudinal stripes that do not extend laterally to pleural folds, with less distinct medial markings, and with all markings tending to coalesce only on posterior margin of sternum IX (Fig. 11c); reared adults required for confirmation of species identification . . . . . ***A. lineatus***

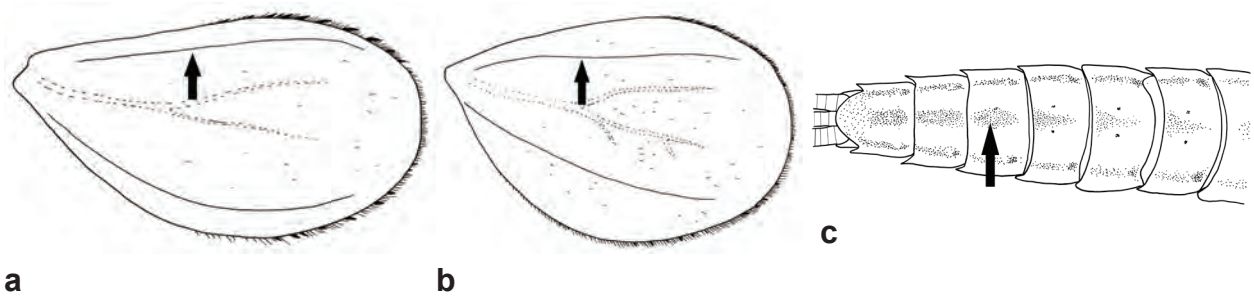


Figure 11. *Ameletus* (Ameletidae). **a,** *A. lineatus,* gill V; **b,** *A. subnotatus,* gill V; **c,** *A. lineatus,* sterna III–IX.

Ameletus lineatus Traver, 1932 (Figs. 12 and 13)

Larval Descriptions: Traver (1932b, 1935); Burks (1953).

Determination: Identification of *A. lineatus* larvae is **Very Difficult**. Abdominal markings on larvae are highly variable. Rearing is essential, therefore, for positive identification (Burian and Gibbs 1991). Burian and Gibbs (1991) also suggested, citing unpublished data by D. Funk, that *A. ludens* and *A. lineatus* are the same species, with *A. lineatus* being a clonal variant.

Previous Wisconsin Records: Hilsenhoff (1996); Lillie and Isenring (1996).

Status: *Ameletus lineatus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Larvae are known only from a variety of small creeks in Sauk County. Blackwing *Ameletus* larvae were collected in Ashland County in 2013 by Kurt L. Schmude (2L, Tafelski Crk., Old 13 Road, 1 mi. SW. of Mellen, VI-12-2013). These larvae have extensive dark markings on abdominal sterna, and thus potentially are *A. ludens,* but do at the least represent a previously unknown population of *Ameletus* in the state.

Biological Information: Difficulties in identification may be limiting our understanding of the distribution and abundance of *A. lineatus* (Randolph and McCafferty 1998). Larvae of this species prefer small streams and creeks. Lillie and Isenring (1996) found them in first- and second-order creeks in the Baraboo Hills of Sauk County, particularly in the southwestern portion of that landscape. There is one unpublished and unverified record of *A. lineatus* from the Wisconsin River in Juneau County (WiDNR), which would be highly unusual given its known habitat preference. In Pennsylvania, Grant and Masteller (1984) found larvae of *A. lineatus* in a first-order tributary. Similarly, Burian and Gibbs (1991) found larvae in well-shaded, riparian brooks in Maine. Burks (1953) in Illinois reported larvae from vegetation along the banks of swift, cool streams. More recently, Ferro and Sites (2007) reported larvae of *A. lineatus* from Missouri in a variety of habitats, including riffle, leaf pack, and low-current areas where organic matter accumulates. Burian and Gibbs (1991) found larvae in various levels of stream current, including shallow pools and gentle riffles, where larvae were clinging to vegetation and stones. The species was considered by Hilsenhoff (1982) as an indicator of excellent water quality in Wisconsin.

Figure 12. *Ameletus lineatus,* larva.

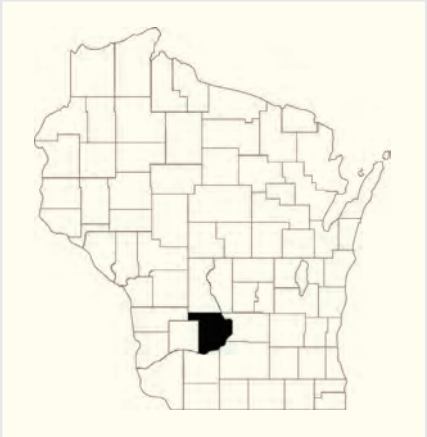


Figure 13. Wisconsin records of *Ameletus lineatus.*

Ameletus ludens Needham, 1905

Larval Descriptions: Traver (1935); Burks (1953).

Larval Habitus: Needham (1905); Morgan (1913); Traver (1935); Burks (1953); Edmunds et al. (1976).

Determination: Identification of *A. ludens* larvae is **Very Difficult**. Abdominal markings on larvae are highly variable. Rearing is essential, therefore, for positive identification (Burian and Gibbs 1991). Burian and Gibbs (1991) also suggested, citing unpublished data by D. Funk, that *A. ludens* and *A. lineatus* are the same species, with *A. lineatus* being a clonal variant.

Previous Wisconsin Records: None. Nearest records of *A. ludens* are from northwestern Indiana (Randolph and McCafferty 1998).

Biological Information: Less biological information has been published regarding *A. ludens* than *A. lineatus*. Larvae of *A. ludens* are known from second- and third-order streams (Burian and Gibbs 1991) with clear water and fast current (Hubbard and Peters 1978).

Ameletus subnotatus Eaton, 1885 (*Figs. 14 and 15*)

Larval Description and Habitus: Zloty and Pritchard (1997).

Determination: Identification of *A. subnotatus* larvae is **Fairly Easy**. Sternal markings on larvae lack the continuous longitudinal stripes of other species known from Wisconsin. Characters in the key also help separate *A. subnotatus* from other eastern species not expected in Wisconsin.

Previous Wisconsin Records: None, with the first Wisconsin and the first eastern U.S. records given below. Nearest records were from southern Manitoba and central Ontario (Zloty 1996).

New Wisconsin Records: FLORENCE: 3L, Hendricks Crk., XI-6-1979 (UW); 1L, Popple R., X-17-1972 (UW); 1L (blackwing), Woods Crk., V-3-1970 (UW).

Biological Information: *Ameletus subnotatus* is a species of larger rivers (fifth to seventh order) than other species in the genus (Zloty and Pritchard 1997), though the new Wisconsin records from Florence County are from Hendricks and Woods Creeks (first to third order) as well as the larger Popple River (fourth to fifth order).

Figure 14. *Ameletus subnotatus,* larva.

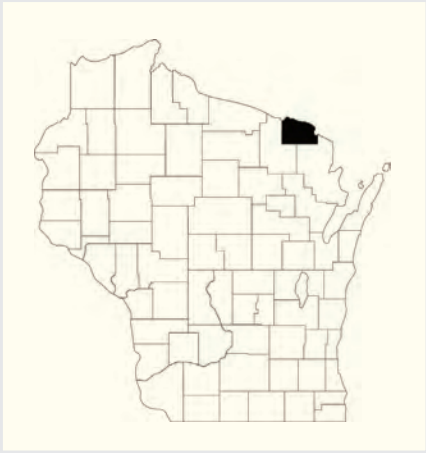


Figure 15. Wisconsin records of *Ameletus subnotatus.*

6 AMETROPODIDAE

The Ametropodidae is represented globally by only one genus, *Ametropus*. These mayflies previously were included with an odd assortment of genera, including the current concepts of *Acanthametropus*, *Pseudiron*, and *Siphloplecton*, as the Ametropidae.

Ametropus

Comments: Of the two recognized North American species of *Ametropus*, only *A. neavei* is known to occur near Wisconsin. *Ametropus ammophilus* is a western species not expected in the state.

Determination: Identification of *Ametropus* larvae is **Easy** for the genus and, at least in Wisconsin, **Easy** for the species within the genus.

Larval Key: Allen and Edmunds (1976).

Ametropus neavei McDunnough, 1928 (Fig. 16)

Taxonomic History: *Ametropus albrighti* Traver, 1935 (syn.).

Larval Description and Habitus: Allen and Edmunds (1976), as *A. albrighti* and *A. neavei*; Edmunds et al. (1976), as *A. albrighti*.

Determination: Identification of *A. neavei* larvae is **Easy**. The species is the only representative of the family likely in Wisconsin. The larvae are large and impressive.

Previous Wisconsin Records: None. Nearest records of *A. neavei* are from the East Branch of the Ontonagon River in the Upper Peninsula of Michigan (Steven and Hilsenhoff 1979). The species is, therefore, expected in Wisconsin.

Biological Information: *Ametropus neavei* is a poorly known species that apparently favors areas of relatively strong current in large rivers, where larvae can bury in firm and slightly silty sand (Edmunds et al. 1976).

Figure 16. *Ametropus neavei,* larva.

7 ARTHROPLEIDAE

The Family Arthropleidae is found in Europe, Asia, and North America (Kluge 2014), with only one species recognized from North America. The species in the family have, at various times, been included in the Heptageniidae. Wang and McCafferty (1995), however, provided phylogenetic evidence to place them in their own family. As with the three other families beginning with the letter "A", the Arthropleidae is scarcely represented and not often encountered in Wisconsin.

Arthroplea

Determination: Identification of *Arthroplea* larvae in Wisconsin is **Easy**, both for the genus and for the species within the genus. In addition to the one species in North America, there is one Palearctic species in the genus (Kluge 2014).

Arthroplea bipunctata (McDunnough), 1924 (Figs. 17 and 18)

Taxonomic History: *Arthroplea bipunctata* (McDunnough), 1924 (curr. comb., Ide 1930a); *Cinygma bipunctata* McDunnough, 1924 (orig.).

Determination: Identification of *A. bipunctata* larvae is **Easy**. They are easily distinguished from members of the Heptageniidae and Pseudironidae, with extremely long maxillary palpi (Fig. 8a).

Larval Descriptions: Ide (1930b), as *Cinygma bipunctata*; Burks (1953); Edmunds et al. (1976).

Larval Habitus: Ide (1930b).

Previous Wisconsin Records: Flowers and Hilsenhoff (1978); Randolph and McCafferty (1998).

New County Record: CLARK: Rock Crk., V-11-1979 (UW).

Status: *Arthroplea bipunctata* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Larvae are locally common in north-central Wisconsin.

Biological Information: Larvae of *A. bipunctata* are known from a wide variety of aquatic habitats with clear water, including temporary pools and ponds, floodwater pools, slow, meandering streams, and even bogs (Flowers and Hilsenhoff 1975, 1978; Hubbard and Peters 1978; Burian and Gibbs 1991; Randolph and McCafferty 1998). Larvae generally are collected in association with emergent vegetation (Burian and Gibbs 1991), including sedges (Flowers and Hilsenhoff 1975; Edmunds et al. 1976) and beneath floating mats of vegetation in bogs (Edmunds et al. 1976).

Larvae of *A. bipunctata* have a varied diet, feeding on algae, detritus, chironomid larvae, and animal remains (Flowers and Hilsenhoff 1978; Hilsenhoff 1995). During feeding, the larvae use rapid, sweeping movements of their exceedingly long maxillary palpi to sweep water and food towards their other mouthparts (Edmunds et al. 1976; Flowers and Hilsenhoff 1978).

Figure 17. *Arthroplea bipunctata,* larva.

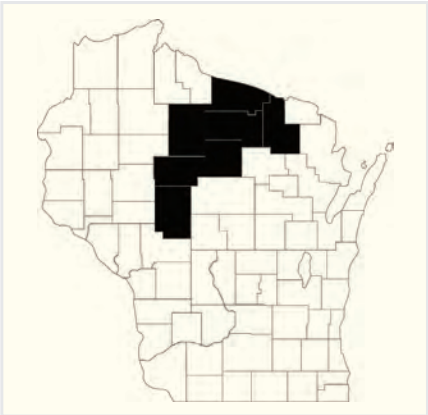


Figure 18. Wisconsin records of *Arthroplea bipunctata.*

8 BAETIDAE

The Baetidae is a diverse family of mayflies, both in North America as well as globally (Anonymous 2014a; Kluge 2014). There have been numerous nomenclatural and other taxonomic changes in the group since the baetid keys of Burks (1953), Bergman and Hilsenhoff (1978a), Morihara and McCafferty (1979b), and Hilsenhoff (1982). With the new state records presented in this book, Wisconsin's known baetid fauna now includes sixteen genera and 46 species. The beatids, commonly called *small minnow mayflies*, generally have small and agile larvae. As with most mayflies, they are more diverse in lotic habitats, though some such as *Callibaetis* are common in lentic systems.

Key to the Genera of Baetidae

1. Claws spatulate (Fig. 19a); not known from Wisconsin . . . . . ***Camelobaetidius***
Claws simple **2**

2. Caudal filaments with thin, dark bands on every three to five segments (Fig. 19b); labial palpi truncate (Fig. 19c); gill tracheae usually palmate and asymmetrical **3**

Caudal filaments rarely with thin, dark bands as above (when such bands are faintly present as in some *Callibaetis*, then labial palpi rounded); labial palpi and gills variable, but usually not as above **7**

3. Antennae longer than half of body length (Fig. 70); gills I–VI bilamellate with large dorsal flaps (Fig. 19d); labial palpus with distinctly pointed projection at anterior corner of apex (Fig. 19e); metathoracic wingpads absent; maxillary palpus three-segmented with terminal segment subequal in length to second segment (Fig. 19f); rare . . . . . ***Cloeon dipterum***

Antennae shorter than half of body length; gills I–VI with or without dorsal flaps, but not as wide as above; labial palpus lacking pointed projection at anterior corner of apex (Fig. 19c); metathoracic wingpads present or absent; maxillary palpus two- or three-segmented, with third segment, if present, of variable length; fairly common in unpolluted streams and rivers **4**

4. Glossa distinctly shorter than paraglossa, with apex broadly rounded or truncate (Fig. 19i); labrum relatively elongate, with apicolateral corners appearing acutely angled because of a broad V-shaped notch that is nearly as wide as labrum (additional narrower, deeper notch sometimes present right at midline, especially towards ventral surface) (Fig. 19h); claws subequal to or longer than respective tarsi (Fig. 19g); labial palpus truncate and greatly widened at tip. . . . . ***Pseudocentroptiloides***

Glossa subequal in length to paraglossa, with apex lanceolate (Fig. 19c); labrum relatively short, with apicolateral margins evenly rounded, and with only a narrow, U-shaped medial notch (Fig. 19j); claws varying widely in length, but usually shorter than respective tarsi; labial palpus truncate but only slightly widened at tip **5**

5. Maxillary palpus two-segmented and metathorax lacking wingpads, or maxillary palpus three-segmented with terminal segment much shorter than second segment (Fig. 19k) and metathorax with wingpads (examination of slide-mounted maxillae recommended); tergum IX never with medial tooth-like projection along posterior margin; all gills simple or one or more gills (especially gill I) with a dorsal flap; caudal filaments with lateral bristles to apices; mandibular incisors fused at a variable distance from base; at least some (especially posterior) abdominal segments with robust lateral spines (Fig. 19l). . . . . ***Procloeon***

Maxillary palpus three-segmented (examination of slide-mounted maxillae recommended), with third segment at least two-thirds length of second (Fig. 19m), although sometimes obscure or poorly articulated from second segment; metathoracic wingpads present or absent; tergum IX sometimes with medial tooth-like projection along posterior margin (Fig. 19n); gills always simple, never with dorsal flap; caudal filaments without lateral bristles to apices;

mandibular incisors of both mandibles fused to each at a distance equal to or less than half way up from their bases; abdominal segments variable with minute, small, or robust lateral spines on at least posterior segments **6**

6. Metathoracic wingpads small but present (or if absent, then lateral margins of abdominal terga with very minute spines that are restricted to posterior segments) . . . . . ***Anafroptilum***

Metathoracic wingpads absent; abdominal terga with moderately robust lateral spines (similar in length to those in Fig. 19l) . . . . . ***Neocloeon***

7. Lamella of each gill with one or more recurved flaps, appearing multilamellate (Fig. 19o). . . . . ***Callibaetis***

Gills composed of simple lamellae, without recurved flaps **8**

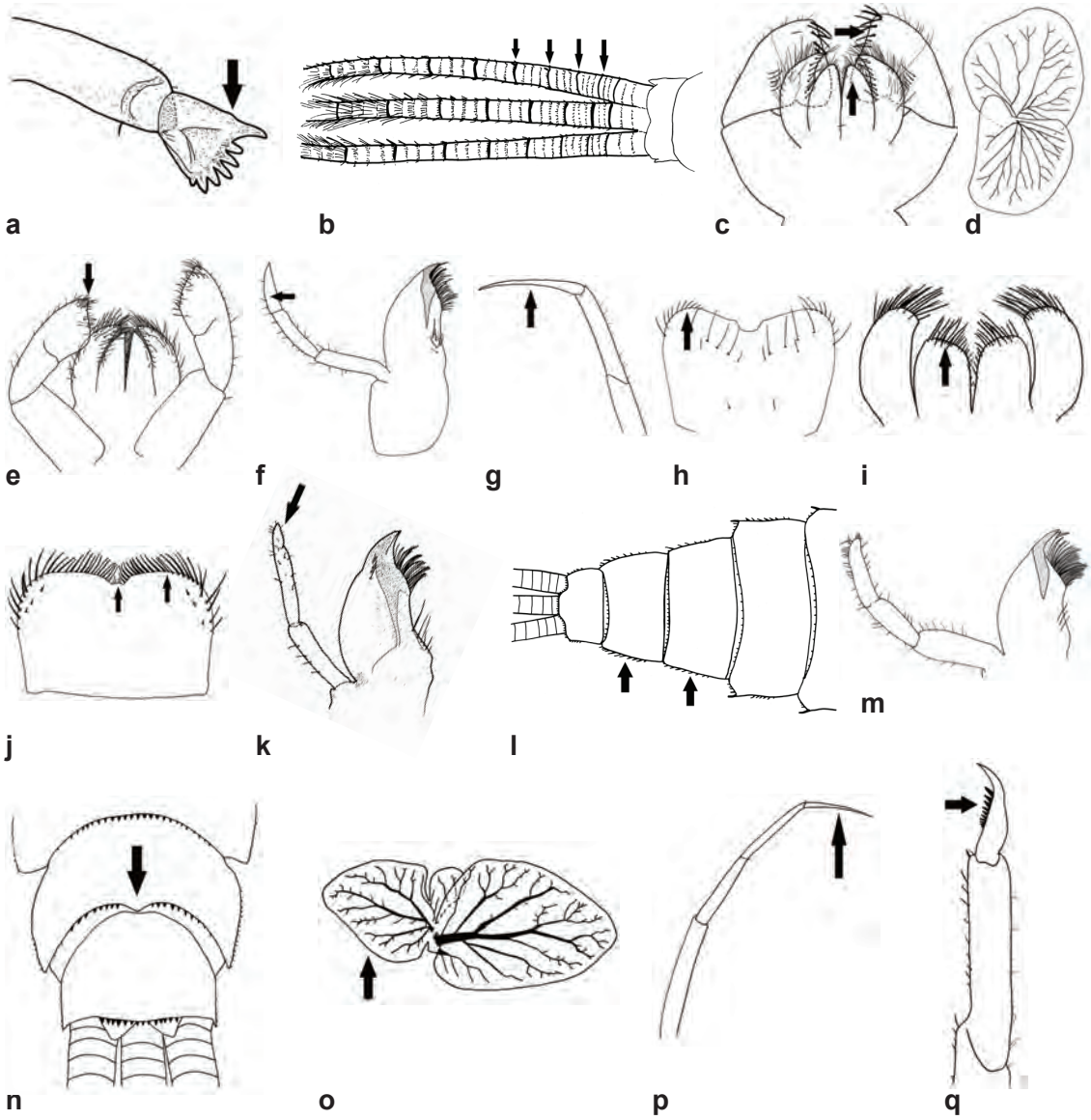


Figure 19. Baetidae. **a,** *Camelobaetidius waltzi,* front tarsus; **b,** *Procloeon viridoculare,* tails; **c,** *P. viridoculare,* labium (dorsal); **d,** *Cloeon dipterum,* gill III; **e,** *C. dipterum,* labium (ventral); **f,** *C. dipterum,* maxilla (right, ventral); **g,** *Pseudocentroptiloides morihari,* hind tarsus; **h,** *P. morihari,* labrum; **i,** *P. morihari,* glossae and paraglossae (ventral); **j,** *Procloeon viridoculare,* labrum (dorsal); **k,** *P. pennulatum,* maxilla (ventral); **l,** *P. viridoculare,* terga VI–X; **m,** *Anafroptilum bifurcatum,* maxilla (ventral); **n,** *A. bifurcatum,* terga VIII–X; **o,** *Callibaetis fluctuans,* gill V (unfolded); **p,** *Apobaetis etowah,* front leg; **q,** *Baetis intercalaris,* front tarsus.

8. Claws nearly as long as their respective tarsi (Fig. 19p); not known from Wisconsin . . . . . ***Apobaetis etowah***

Claws one half or less the length of their respective tarsi (Figs. 19q, 20a) **9**

9. Claws half as long as their respective tarsi and weakly denticulate at base (Fig. 20a); labial palpus with a large, rounded, medial lobe and a pointed distal end of terminal segment (Fig. 20c); body length of mature larvae approximately 3 mm; abdominal sterna usually marked between segments as in Fig. 20b . . . . . ***Paracloeodes minutus***

Claws usually one third or less the length of their respective tarsi and with well-developed denticles (Fig. 19q); labial palpus variable, with terminal segment with or without rounded medial lobe and with distal end rounded or truncate, but not pointed; body length of mature larvae usually larger than 3 mm; abdominal sterna variously marked, but never as above **10**

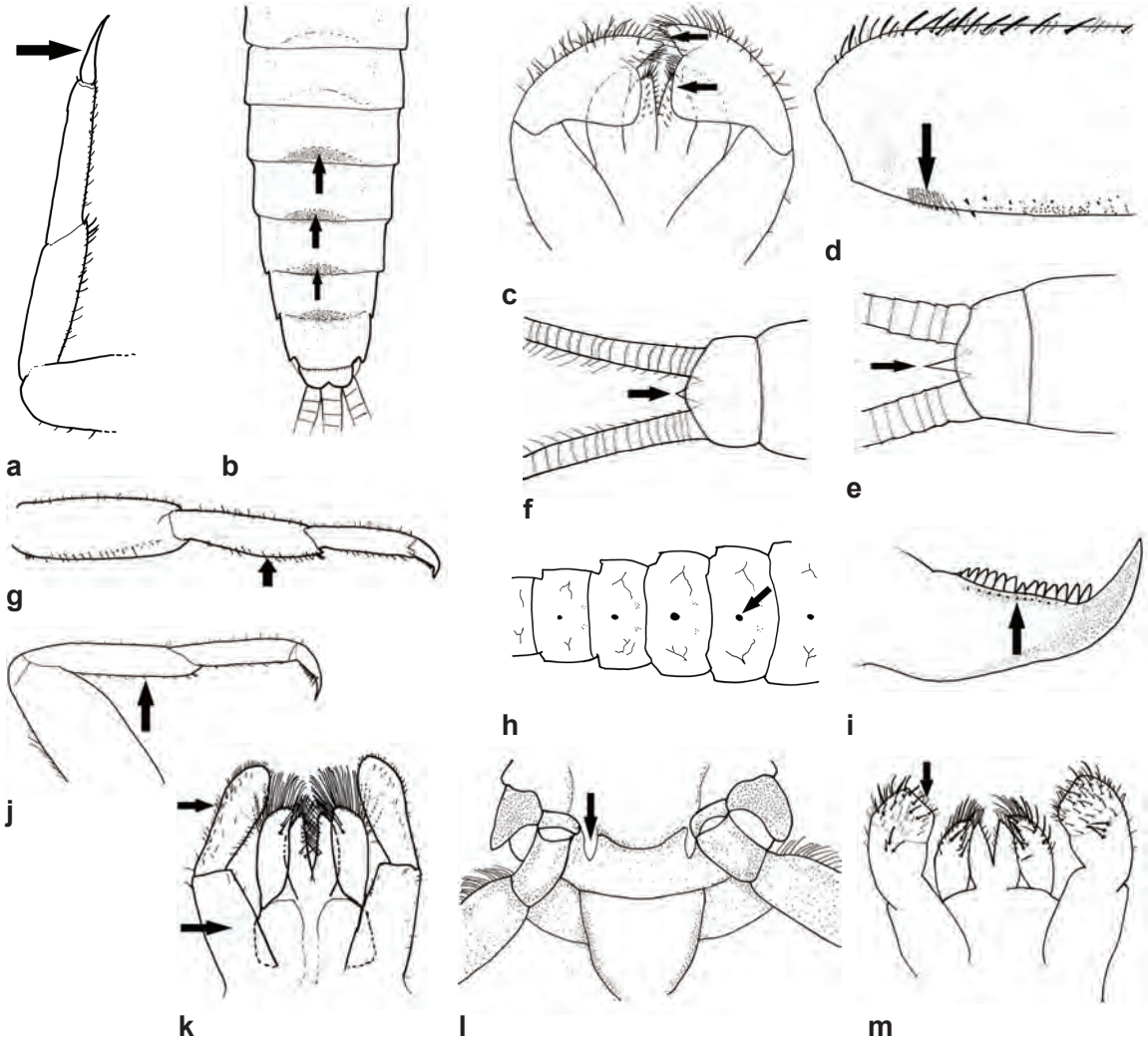


Figure 20. Baetidae. **a,** *Paracloeodes minutus,* front leg; **b,** *P. minutus,* abdominal sterna; **c,** *P. minutus,* labium (ventral); **d,** *Baetis intercalaris,* front femur (anterior); **e,** *Plauditus punctiventris,* tails (dorsal); **f,** *Acentrella parvula,* tails (dorsal); **g,** *Iswaeon anoka,* front leg; **h,** *I. anoka,* abdominal sterna; **i,** *I. anoka,* front claw; **j,** *P. punctiventris,* front leg; **k,** *Heterocloeon curiosum,* labium (ventral); **l,** *H. curiosum,* prosternum (osmobranchia indicated); **m,** *P. punctiventris,* labium (ventral).

10. Profemur with a dense patch of short setae (villopore) present just posterior of ventral surface near base of femur (Fig. 20d), best visible using compound microscopy; median caudal filament of variable length, sometimes shorter than mid-dorsal length of tergum X **11**

Profemur without a villopore; median caudal filament always longer than combined mid-dorsal length of terga VIII–X . . **16**

11. Median caudal filament greatly reduced or absent, subequal to or shorter than mid-dorsal length of tergum X (Fig. 20e, f) . . . **12**

Median caudal filament well developed, usually at least half as long as lateral filaments. **15**

12. Each tibia robust and distinctly widest at midlength (Fig. 20g); each abdominal sternum often with a central dark spot (Fig. 20h); each claw with a primary row of denticles roughly equal in length, and a secondary and weakly denticulate ridge visible under high magnification (Fig. 20i) . . . . . ***Iswaeon anoka***

Each tibia relatively slender with sides roughly parallel (Fig. 20j); abdominal sterna unmarked or with markings not as above; denticulation of claws not as above **13**

13. Labial palpus narrow, with second segment nearly parallel sided and third segment elongate (Fig. 20k); each claw with primary denticulate ridge and a secondary ridge either with or without denticles visible at high magnification; procoxa with or without gill-like osmobranchiae (Fig. 20l). . . . . ***Heterocloeon***

Labial palpus relatively compact, curved medially, and with third segment short and rounded to various degrees (Fig. 20m); claws lacking secondary ridges; procoxa never with osmobranchiae **14**

14. Median caudal filament reduced to one or two segments and much shorter than length of tergum X (Fig. 20f); each femur with long hair-like setae on dorsal margin . . . . . ***Acentrella***

Median caudal filament subequal in length to tergum X (Fig. 20e); each femur with short hair-like or spine-like setae on dorsal margin. . . . . ***Plauditus***

15. Distal, ventral margin of antennal scape with a rounded lobe and notch visible under high magnification (Fig. 21a); maxillary palpus distinctly narrowed proximal of apex (Fig. 21b) . . . . . ***Labiobaetis***

Distal, ventral margin of antennal scape entire, without expanded lobe or notch; maxillary palpus without narrowing proximal of apex . . . . . ***Baetis***

16. Gill VII slender, asymmetrical, and with an acute apex (Fig. 21c) or only slightly narrower than gill VI (Fig. 21d); second segment of labial palpus with second segment forward-projecting thumb-like process (Fig. 21e) . . . . . ***Acerpenna***

Gill VII ovate and apically rounded; labial palpus with second segment not as above; uncommon **17**

17. Gill I and socket for gill attachment absent; right mandible with bifid prostheca and without patch of setae between prostheca and molar region (Fig. 21f); uncommon . . . . . ***Diphetor hageni***

Gill I present; right mandible with unforked prostheca and with patch of setae between prostheca and molar region (Fig. 21g); rare . . . . . ***Fallceon quilleri***

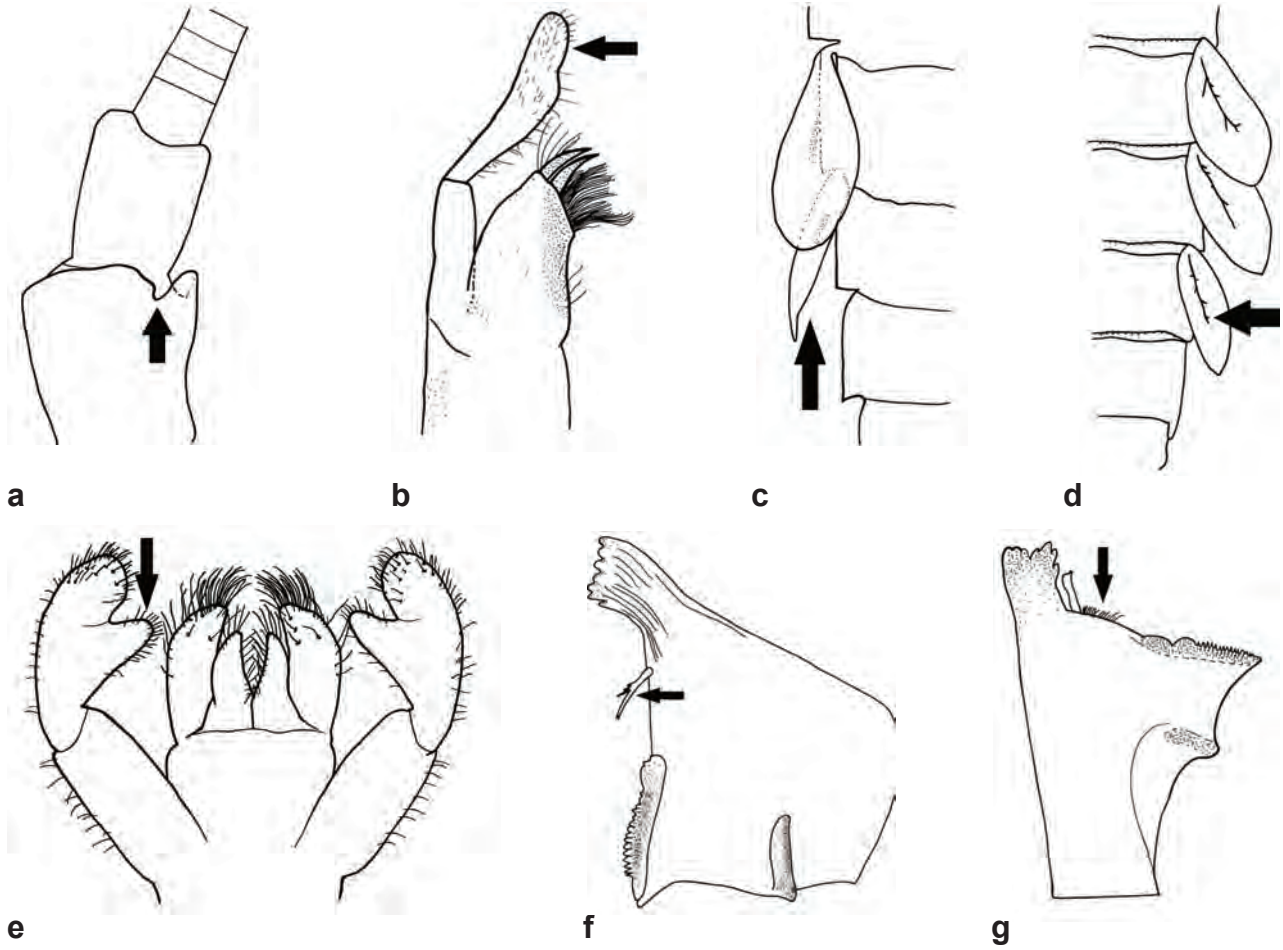


Figure 21. Baetidae. **a,** *Labiobaetis propinquus,* antennal scape (ventral); **b,** *L. longipalpus,* maxilla; **c,** *Acerpenna pygmaea,* gills VI–VII; **d,** *A. macdunnoughi,* gills V–VII; **e,** *A. pygmaea,* labium (ventral); **f,** *Diphetor hageni,* right mandible; **g,** *Fallceon quilleri,* right mandible.

Acentrella

Comments: Currently, eight species of *Acentrella* are recognized from North America. Of those, only two are known from Wisconsin. *Acentrella insignificans* (McDunnough), known from both west and east of the state, is the most likely species in Wisconsin not included in the key. It has well-developed *metathoracic* wingpads but otherwise is similar to *A. turbida*. Both species in the key below have been placed in several other genera in the past.

Determination: Identification of *Acentrella* larvae is **Fairly Easy** at the generic level, but **Moderately Easy** for Wisconsin species within the genus.

Larval Keys: Burks (1953) and Hilsenhoff (1982), both as *Pseudocloeon*; McCafferty et al. (1994); Jacobus & McCafferty (2006).

Key to the Species of *Acentrella*

1. Each femur, tibia, and tarsus with a dense row of long, fine, dorsal setae (Fig. 22a); caudal filaments unbanded. . . . . ***A. parvula***

Tibiae and tarsi lacking long, fine, dorsal setae (Fig. 22b); caudal filaments with many alternating light and dark bands along entire length (fading considerably in alcohol) (Fig. 22c) . . . . . ***A. turbida***

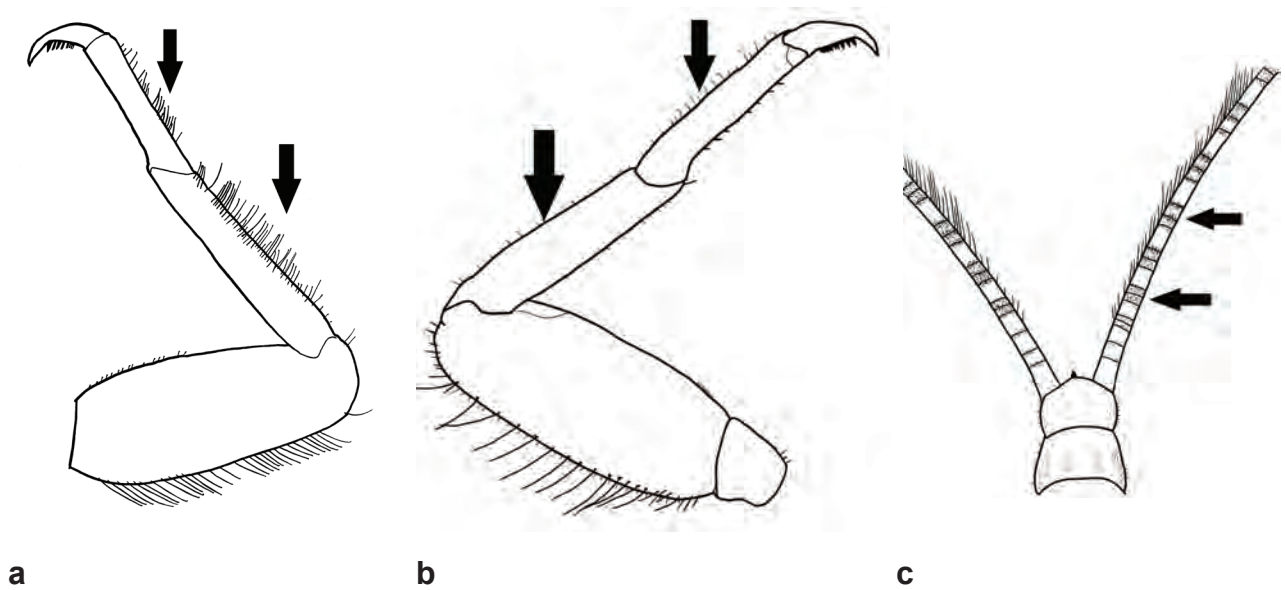


Figure 22. *Acentrella* (Baetidae). **a,** *A. turbida,* front leg; **b,** *A. parvula,* front leg; **c,** *A. parvula,* tails.

Acentrella parvula (McDunnough), 1932 (Figs. 23 and 24)

Taxonomic history: *Acentrella parvula* (McDunnough), 1932 (curr. comb., Wiersema 2000); *Baetis armillatus* McCafferty and Waltz 1990 (syn.); *Plauditus armillatus* (McCafferty and Waltz), 1990 (syn. comb.); *Plauditus parvulus* (McDunnough), 1932 (comb.); *Pseudocloeon parvulum* McDunnough, 1932 (orig.).

Larval Description: Burks (1953), as *Pseudocloeon parvulum*.

Determination: Identification of *A. parvula* larvae is **Easy**. The presence of alternating dark and light bands on the caudal filaments (Fig. 22c) is a distinctive field mark, as no other two-tailed baetid is so patterned. Specimens in alcohol generally retain tail coloration for at least a decade.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Pseudocloeon parvulum*; Shapas and Hilsenhoff (1976), as *P. parvulum*; Randolph and McCafferty (1998), as *Baetis armillatus*.

New County Records: JACKSON: 1L, Black R., Haugstad Rd., 44.2546°N 90.86549°W, V-28-1997, W. A. Smith (WiDNR); **ONEIDA:** 5L, Wisconsin R., Riverview Rd., 45.75251°N 89.55511°W, VI-7-1994, K. L. Schmude (UWS); **PRICE:** 1L, S. Fork Flambeau R., Hwy. 13, T39NR1E S18, VI-24-1998, R. A. Lillie (WiDNR); **RUSK:** 1L, N. Fork Chippewa R., Bruce, T34NR7W S5, Summer 1998 (WiDNR). Randolph and McCafferty (1998) indicated a record from Washburn County on a map, but did not give data.

Biological Information: Larvae of *A. parvula* are common in many streams across Wisconsin. Burian and Gibbs (1991) reported larvae mostly from erosional reaches of second- to third-order streams in Maine, though the species occurs in a variety of stream sizes in Wisconsin. Larvae of *A. parvula* generally are absent from heavily silted or polluted waters. I have most commonly found larvae associated with woody debris, though Berner and Pescador (1988) found them associated with submerged vegetation in Florida.

Figure 23. *Acentrella parvula,* larva.

Figure 24. Wisconsin records of *Acentrella parvula.*

Acentrella turbida (McDunnough), 1924 (Figs. 25 and 26)

Taxonomic History: *Acentrella carolina* (Banks), 1924 (syn.); *Acentrella turbida* (McDunnough), 1924 (curr. comb., Waltz and McCafferty 1987b); *Cloeon carolina* Banks, 1924 (syn.); *Pseudocloeon carolina* (Banks), 1924 (syn.); *Pseudocloeon turbidum* McDunnough, 1924 (orig.).

Larval Descriptions: Ide (1930a), as *Pseudocloeon carolina*; McCafferty et al. (1994).

Larval Habitus: Ide (1930a), as *Pseudocloeon carolina*; McCafferty et al. (1994).

Determination: Identification of *A. turbida* larvae is **Moderately Easy**. Larvae lack readily visible tergal patterns, though fresh specimens usually have dark, paired, submedian spots on abdominal terga. It is the only two-tailed baetid in Wisconsin with long, fine setae on the tibiae and tarsi (Fig. 22a). An oblique view of the leg margins is necessary to see this character. The absence of alternating pale and dark bands on the caudal filaments should not be the sole basis of identification of faded or recently molted specimens of *A. turbida*. The use of tergal coloration alone to identify this species should be avoided.

Previous Wisconsin Records: Hilsenhoff et al. (1972) and Shapas and Hilsenhoff (1976), as *Pseudocloeon carolina*; Randolph and McCafferty (1998).

New County Records: ASHLAND: 2L, Brunsweiler R., Forest Rd. 189, V-26-2006, G. Drecktrah (UWO); **BAYFIELD:** 1L, Marengo R., VI-5-1969 (UW); 1L, Marengo R., Forest Rd. 198, X-10-1992, G. Drecktrah (UWO); **BARRON:** 1L, Brill R., 29th Ave, 1.5 mi. N. of Brill, 45°37'28" N 91°40'38" W, VII-15-2011, THK (THK); **CLARK:** 1L, S. Fork Eau Claire R., VI-3-1969 (UW); **DUNN:** 1L, Chippewa R., 220th St. Landing, VII-9-2013, K. L. Schmude (UWS); **IRON:** 2L, Montreal R., VI-5-1969 (UW); **JACKSON:** 16L, Halls Crk., VI-18-1968 (UW); **LANGLADE:** 1L, W. Branch Eau Claire R., VII-18-1968 (UW); 5L, Wolf R., VI-6-1969 (UW); **LINCOLN:** 3L, Devil Crk., XI-11-1965 (UW); 1L, N. Branch Pine R., VI-5-1969 (UW); 2L, Pine R., XI-11-1965 (UW); 1L, Prairie R., VII-28-1965 (UW); 4L, Wood R., VI-5-1969 (UW); **MARATHON:** 6L, County Line Crk., XI-12-1965 (UW); 6L, Little Trappe R., XI-12-1965 (UW); 4L, Silver Crk., XI-12-1965 (UW); 1L, Trappe R., XI-12-1965 (UW); 1L, Wisconsin R., VI-7-1966 (UW); **MARINETTE:** 5L in two vials, Menominee R., Co. Rd. Z, T36NR22E S20, VI-25-1996 (WiDNR); 5L in two vials, Peshtigo R., V-28-1969 and VI-6-1977 (UW); 6L in three vials, Pike R. VI-27-1996 (WiDNR); 1L, Pike R., VI-30-1998, R. A. Lillie (WiDNR); 2L, S. Fork Jump R., V-23-1969 (UW); **ONEIDA:** 4L, Wisconsin R., River Rd., 45.79607°N 89.53928°W VI-6-1994, R. L. Otto (WiDNR); 2L, Wolf R., Meister-Stockley Rd., 45.53194°N 89.11214°W, VI-9-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **PIERCE:** 2L, Big R., IX-6-1968 (UW); **POLK:** 1L, Trade R., V-22-1969 (UW); **PORTAGE:** 1L, Waupaca R., V-14-1969 (UW); **PRICE:** 2L, Butternut Crk., V-23-1969 (UW); 6L, Jump R., VI-15-1965 (UW); 2L, Mondeaux Crk., VII-26-1965 (UW); **RICHLAND:** 2L, Pine R., VIII-23-1965 (UW); **ROCK:** Turtle Crk., Lather's Rd., 1 mi. WSW. of Shopiere, VIII-27-1999, THK and C. Hess (THK); **RUSK:** 1L, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998 (WiDNR); 1L, Clear Crk., X-24-1968 (UW); **SAWYER:** 1L, Chippewa R., Town Line Rd., T37NR7W S35, Summer 1998 (WiDNR); **SHAWANO:** 1L, N. Branch Embarrass R., VII-3-1968 (UW); **ST. CROIX:** 1L, Apple R., V-20-1969 (UW); 1L, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); 1L, Eau Galle R., Co. Rd. N, 3 mi. S. of Woodville, 44°54'18"N 92°15'53"W, VII-12-2011, THK (THK); 2L, Willow R., Co. Rd. E, ½ mi. NW. of Dry Dam Lk., 45°2'10"N 92°38'20"W, VII-12-2011, THK (THK); **VERNON:** 2L, Reads Crk., IX-10-1968 (UW); 2L, W. Fork Kickapoo R., X-30-1968 (UW); **WAUPACA:** 5L, Little Wolf R., VI-6-1969 (UW); 1L, Waupaca R., VI-6-1969 (UW); **WOOD:** 4L, Yellow R., VI-5-1968 (UW).

Status: Most of the new county records of *A. turbida* given above are from larvae in the University of Wisconsin–Madison collection incorrectly identified and previously published as *Heterocloeon curiosum* in Randolph and McCafferty (1998). With these new records, *A. turbida* is much more common and widespread in Wisconsin than previously believed.

Biological Information: Larvae of *A. turbida* are associated with riffles and rapids with gravel and/or rocky substrates (Burian and Gibbs 1991; McCafferty et al. 1994). Generally, the larvae prefer cool, clean water (Burian and Gibbs 1991; McCafferty et al. 2003a). Adults occur as late as 10 August (Rock Co.).

Figure 25. *Acentrella turbida,* larva.

Figure 26. Wisconsin records of *Acentrella turbida.*

Acerpenna

Comments: Two of the three species of *Acerpenna* occurring in North America are known from Wisconsin. These are relatively large larvae with distinctive labial palpi.

Determination: Identification of *Acerpenna* larvae is **Fairly Easy** at the generic level, and **Moderately to Fairly Easy** for identification of the species within the genus.

Larval Keys: Burks (1953), Bergman and Hilsenhoff (1978a), Morihara and McCafferty (1979b), and Hilsenhoff (1982), all as *Baetis.*

Key to the Species of *Acerpenna*

1. Gill VII slender, much narrower than preceding gills, and with asymmetrical margins (Fig. 21c) . . . . . ***A. pygmaea***

Gill VII only slightly narrower than preceding gills, with symmetrical margins (Fig. 21d) . . . . . ***A. macdunnoughi***

Acerpenna macdunnoughi (Ide), 1937 (Figs. 27 and 28)

Taxonomic History: *Acerpenna macdunnoughi* (Ide), 1937 (curr. comb., Waltz and McCafferty 1987a); *Baetis macdunnoughi* Ide, 1937 (orig.).

Larval Descriptions and Habitus: Bergman and Hilsenhoff (1978a) and Morihara and McCafferty (1979b), both as *Baetis macdunnoughi*.

Determination: Identification of *A. macdunnoughi* larvae is **Fairly Easy**. The greatest difficulty is getting the correct generic placement, as Gill VII (Fig. 21d) is not as dramatically different from Gill VI as it is in *A. pygmaea* (Fig. 21c). The abdominal tergal pattern can be suggestive of *Labiobaetis longipalpus*.

Previous Wisconsin Records: Bergman and Hilsenhoff (1978a), as *Baetis macdunnoughi*; DuBois (1993); Lillie and Isenring (1996); Randolph and McCafferty (1998).

New County Records: CHIPPEWA: 1L, unnamed crk., Deer Fly Trail, 45.23368°N 91.2893°W, V-14-2002, K. L. Schmude and C. Brennan (UWS); **DOOR:** 2L, Hibbard Crk., Co. Rd. A, 44.98556°N 87.19224°W, V-19-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **RUSK:** 1L, Pigeon Crk., Co. Rd. F, site "Chipr 5492", 45.602493°N 91.520564°W, Summer 2012, K. L. Schmude (THK); **SAWYER:** 1L, Flambeau R., Hervas, T37NR4W S35, VI-19-1997, R. A. Lillie (WiDNR); **SHAWANO:** 1L, Comet Crk., Much Rd., 44.70801°N 89.17643°W, V-26-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **WAUPACA:** 2L, S. Fork Whitcomb Crk., W. Mill Rd., 44.60455°N 89.08196°W, VI-7-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS).

Biological Information: Larvae of *A. macdunnoughi* are more common in Wisconsin than *A. pygmaea* (Randolph and McCafferty 1998), but still are considered uncommon in the state (Bergman and Hilsenhoff 1978a). New and previously published (DuBois 1993; Lillie and Isenring 1996) sample locations of sufficient detail show a wide range of first- to fifth-order streams for this species in Wisconsin. Larvae are associated with moderate to swift current (Burian and Gibbs 1991), with rocky substrates of gravel and rubble, and on emergent plants (Bergman and Hilsenhoff 1978a; Burian and Mack 1990; Burian and Gibbs 1991). Bergman and Hilsenhoff (1978c) found only parthenogenetic populations in Wisconsin, though males are known from other states, including Illinois and Indiana (McCafferty and Morihara 1979). Of the small number of specimens I have examined from Wisconsin, all were females.

Figure 27. *Acerpenna macdunnoughi,* larva.

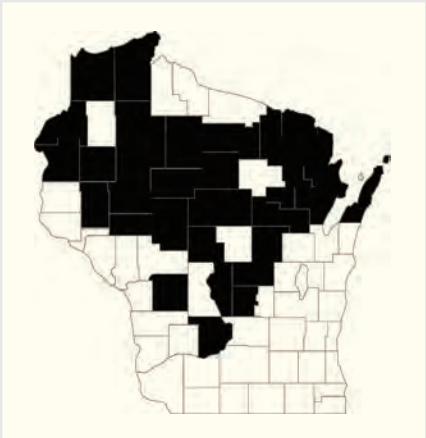


Figure 28. Wisconsin records of *Acerpenna macdunnoughi.*

Acerpenna pygmaea (Hagen), 1861 (Figs. 29 and 30)

Taxonomic History: *Acerpenna* sp. 1 McCafferty and Davis, 1992 (syn.); *Acerpenna harti* (McDunnough), 1924 (syn.); *Acerpenna pygmaea* (Hagen), 1861 (curr. comb., Waltz and McCafferty 1987a); *Baetis harti* McDunnough, 1924 (syn.); *Baetis pygmaeus* (Hagen), 1861 (comb.); *Baetis spiethi* Berner, 1940 (syn.); *Cloe pygmaea* Hagen, 1861 (orig.).

Larval Descriptions: Needham and Betten (1901), as *Baetis pygmea* (spell.); Ide (1930a), as *B. pygmaeus;* Leonard and Leonard (1962), Bergman and Hilsenhoff (1978a), and Morihara and McCafferty (1979b), all as *B. pygmaeus*.

Larval Habitus: Bergman and Hilsenhoff (1978a), Morihara and McCafferty (1979b), and Berner and Pescador (1988), all as *Baetis pygmaeus*.

Determination: Identification of *A. pygmaea* larvae is **Moderately Easy**. The asymmetrical, narrowed shape of Gill VII is distinctive (Fig. 21c). Males have more contrasting terga than females.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Baetis pygmaeus*; Shapas and Hilsenhoff (1976), as *B. pygmaeus*; Randolph and McCafferty (1998).

New County Records: DOOR: 3L, Keyes Crk., Pickeral Rd., 44.816227°N 87.579387°W, Summer 2012, K. L. Schmude (UWS); **MARINETTE:** 1L, Little Peshtigo R., Co. Rd. W, 8.8 mi. SE. of Crivitz, 45°7'15"N 87°53'33"W, X-22-2011, THK (THK); **RUSK:** 18L in three vials (including blackwing), N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998, R. A. Lillie (WiDNR). Randolph and McCafferty (1998) indicated records from Portage and Green Lake Counties on a map but did not give data.

Biological Information: Larvae of *A. pygmaea* are relatively less common in Wisconsin than *A. macdunnoughi* (Randolph and McCafferty 1998). They are known from a wide variety of lotic habitats and substrate types, including both large and small rivers (Berner 1950; Liechti 1980; Berner and Pescador 1988; Burian and Gibbs 1991). Based upon available records with sufficiently detailed sample locations, larvae of *A. pygmaea* are relatively more widespread and common in larger streams and rivers (third- to fifth-order) of Wisconsin than *A. macdunnoughi*. Larvae are fairly commonly encountered, for example, in the North Fork Chippewa, Little Peshtigo, and South Fork Flambeau Rivers.

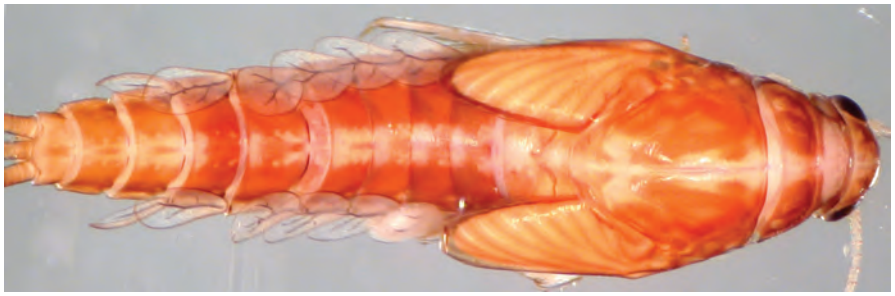


Figure 29. *Acerpenna pygmaea,* larva.

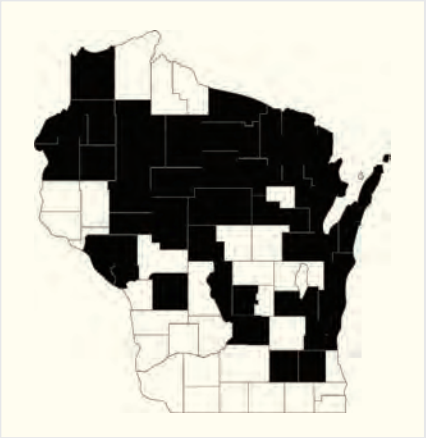


Figure 30. Wisconsin records of *Acerpenna pygmaea.*

Anafroptilum

Comments: There are eight species of *Anafroptilum* recognized from North America. Several were previously placed in *Procloeon*, and there has always been great difficulty in separating the two genera. Two species, *Neocloeon alamance* and *N. triangulifer*, recently were removed from the group (Jacobus and Wiersema 2014). Five species of *Anafroptilum* are known from Wisconsin. The genus needs revision and subsequent keys developed using structural characters. In addition, there likely are several undescribed species (Jacobus and Wiersema 2014). The key below was developed after much appreciated assistance by Dr. Steven Burian at Southern Connecticut State University regarding several of the species in the genus. Most species in the genus are more easily collected in shoreline vegetation, rather than during standard sampling of riffles and runs in the stream channel.

Determination: Identification of *Anafroptilum* larvae in Wisconsin is **Slightly Difficult** for the genus, and **Slightly Difficult to Problematic** for species within the genus. Some species of *Anafroptilum* have a weakly articulated third segment of the maxillary palpi, making generic identification difficult.

Larval Keys: Traver (1935), as *Centroptilum*; Hilsenhoff (1982), as *Cloeon*.

Key to the Species of *Anafroptilum*

1. Tergum IX with a medial tooth-like projection along posterior margin (Fig. 31a) **2**

Tergum IX rarely with a medial tooth-like projection **5**

2. Abdominal segments VII–IX each with more than seven lateral spines (and often as many as 15–20) and V and VI with minute lateral spines (Fig. 31a); sternum IX usually darker than surrounding segments; mesothoracic wingpads pale, and thorax paler in general than abdomen (Fig. 34); each femur with a pair of oval maculae at four-fifths of length on anterior surface visible in lateral view (Fig. 31b) . . . . . ***A. bifurcatum***

Abdominal segment VII, and usually VIII and IX, with fewer than seven lateral spines and lateral spines absent from V and VI (Fig. 31c); other characters variable and not in the above combination **3**

3. Abdominal segment IX with more than eight lateral spines distributed over nearly the entire length of the segment; abdominal segment VIII with more than five lateral spines usually restricted to the posterior three-quarters of segment; not known from Wisconsin . . . . . ***A. semirufum***

Abdominal segment IX with fewer than eight lateral spines, with these spines usually restricted to posterior half or two-thirds of segment; abdominal segment VIII with five or fewer distinct lateral spines restricted to posterior half of segment (Fig. 31e) **4**

4. Terga VI and IX much darker than other terga and distinctly darker than tergum V (Fig. 31d); abdominal segment IX with lateral spines scattered over posterior half to two-thirds of segment . . . . . ***A. victoriae***

Terga more uniformly colored, with V, VI, and IX all only slightly to moderately darker than other terga; abdominal segment IX with lateral spines restricted to only posterior third or quarter of segment . . . . . ***A. conturbatum***

5. Hind wingpads present; body without numerous freckle-like spots (Fig. 32); posterior margin of mesonotum without paired protuberances along midline; sterna II–VIII without paired, transverse, submedian dark lines along both posterior and adjacent anterior margins of segments . . . . . ***A. album***

Hind wingpads absent; body covered with numerous small, freckle-like spots (Figs. 31f and 38); posterior margin of mesonotum with paired protuberances along midline between wingpads; sterna II–VIII of mature larvae with paired, submedian, dark lines along both posterior and adjacent anterior margins of segments (Fig. 31f). . . . . .***A. minor***

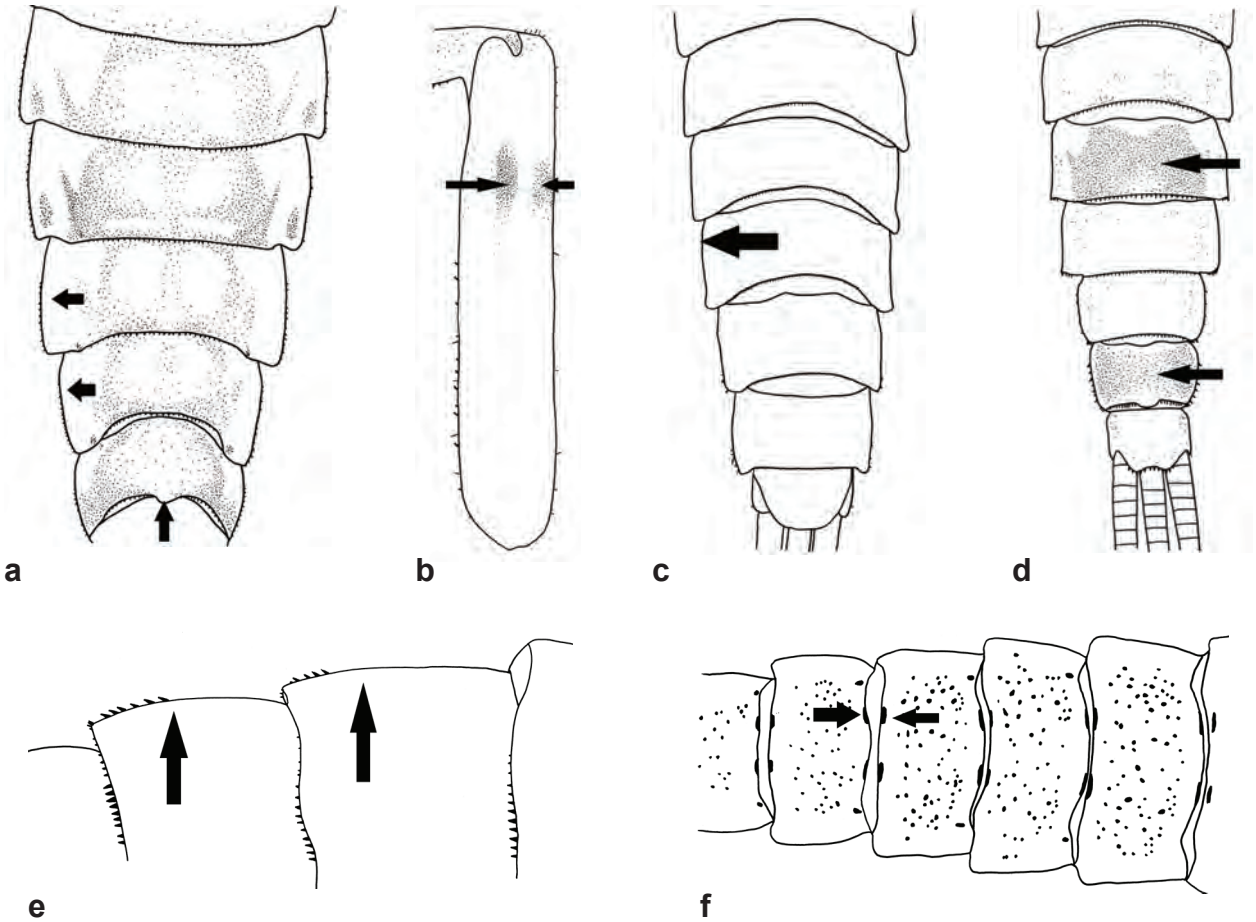


Figure 31. *Anafroptilum* (Baetidae). **a,** *A. bifurcatum*, terga V–IX; **b,** *A. bifurcatum*, front femur (anterior); **c,** *A. album*, terga V–X; **d,** *A. victoriae*, abdominal terga V–X; **e,** *A. conturbatum*, terga VIII–IX; **f,** *A. minor*, abdominal sterna.

Anafroptilum album (McDunnough), 1926 (Figs. 32 and 33)

Taxonomic History: *Anafroptilum album* (McDunnough), 1926 (curr. comb., Jacobus and McCafferty 2014); *Centroptilum album* McDunnough, 1926 (orig.); *Centroptilum convexum* Ide, 1930 (syn.); *Centroptilum walshi* McDunnough, 1929 (syn.); *Procloeon album* (McDunnough), 1926 (comb.); *Procloeon convexum* (Ide), 1930 (syn.); *Procloeon walshi* (McDunnough), 1929 (comb.); *Procloeon* sp. 2 McCafferty and Davis 1992 (syn.).

Larval Descriptions: Ide (1930a), as *Centroptilum convexum*; Leonard and Leonard (1962), as *C. album*; Bergman and Hilsenhoff (1978b), as *C. walshi*; Lowen and Flannagan (1991), as *C. album*.

Larval Habitus: Ide (1930a), as *Centroptilum convexum*; Bergman and Hilsenhoff (1978b), as *C. walshi*; Lowen and Flannagan (1991), as *C. album*.

Determination: Identification of *A. album* larvae is **Slightly Difficult**. Rarely, specimens have a weakly formed medial projection on abdominal tergum IX, leading to misidentifications. *Anafroptilum album* is highly variable in abdominal coloration, and with males more boldly patterned.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Centroptilum convexum*; Bergman and Hilsenhoff (1978b), as *C. walshi*.

New County Records: ASHLAND: 1L, Bad R., VI-5-1969 (UW); **BARRON:** 1L, Spring Crk., 23rd Ave., site "Chipr 6325", 45.537268°N 91.544923°W, Summer 2012, K. L. Schmude (THK); **FOREST:** 1L, Pine R., VIII-6-1980 (UW); **LA CROSSE:** 1L, Mormon Crk., IX-10-1968 (UW); **MARINETTE:** 1L, N. Branch Beaver Crk., VII-17-1968 (UW); **OCONTO:** 3L, Koopman Crk., at Konitzer and Maple, 44.85014°N 88.14716°W, IX-18-2012, A. Hudak (UWSP); **TAYLOR:** 1L, Copper Crk., VI-13-1978 (UW).

Status: *Anafroptilum album* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: *Anafroptilum album* is one of the most commonly collected members of the genus throughout much of North America (Wiersema and McCafferty 2004). Despite its wide distribution, not much more is known about its biology than for other *Anafroptilum*. Leonard and Leonard (1962) described its preferred habitat as warm-water streams and lakes. Ide (1930a) reported in from the upper surface of stones in moderately rapid water. Burian and Gibbs (1991) reported it from rocky substrates in both erosional and depositional reaches of small streams and rivers.

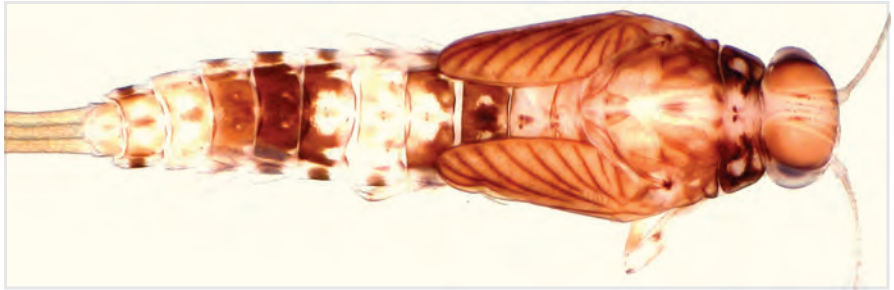


Figure 32. *Anafroptilum album,* larva.

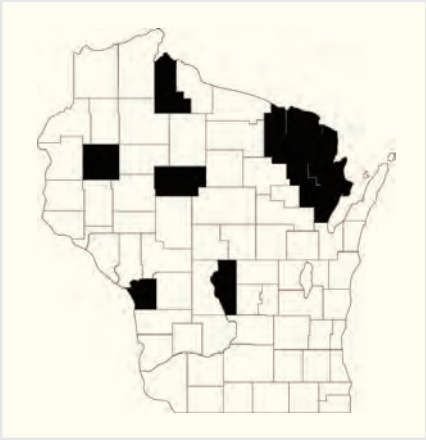


Figure 33. Wisconsin records of *Anafroptilum album.*

Anafroptilum bifurcatum (McDunnough), 1924 (Figs. 34 and 35)

Taxonomic History: *Anafroptilum bifurcatum* (McDunnough), 1924 (curr. comb., Kluge 2011); *Centroptilum bifurcatum* McDunnough, 1924 (orig.); *Centroptilum selanderorum* Edmunds, 1954 (syn.).

Larval Description and Habitus: Lowen and Flannagan (1991), as *Centroptilum bifurcatum*.

Determination: Identification of *A. bifurcatum* larvae is **Slightly Difficult**, but easier with fresh specimens. The presence of numerous minute lateral spines on abdominal terga VII–IX separates *A. bifurcatum* from all other species in the key (Figs. 19n, 31a). Larvae of this species also have distinctive tergal markings (Fig. 34).

Previous Wisconsin Records: None, with the first state record given below. *Anafroptilum bifurcatum* is known from the Sugar River in Winnebago County, Illinois, just south of the Wisconsin–Illinois border (Klubertanz and Hess 2001). It also is known from the Upper Iowa River in northeastern Iowa (McCafferty 2009). Its discovery in Wisconsin, therefore, was not unexpected.

New State Record: RICHLAND: 1L, Wisconsin R., Gotham–Orion, 0–2 ft. slow eddy with muck and debris, V-31-1986, R. A. Lillie, vial 010811A (UW).

Biological Information: No biological information has been published for *A. bifurcatum*. The Upper Iowa, Wisconsin, and Sugar Rivers all are medium to large rivers. As with most members of the genus, the species is associated with shoreline vegetation.

Figure 34. *Anafroptilum bifurcatum,* larva.

Figure 35. Wisconsin records of *Anafroptilum bifurcatum.*

Anafroptilum conturbatum (McDunnough), 1929 (Figs. 36 and 37)

Taxonomic History: *Anafroptilum conturbatum* (McDunnough), 1929 (curr. comb., Jacobus and Wiersema 2014); *Centroptilum conturbatum* (McDunnough), 1929 (orig.); *Procloeon conturbatum* (McDunnough), 1929 (comb.).

Larval Description and Habitus: Lowen and Flannagan (1991), as *Centroptilum conturbatum*.

Determination: Identification of *A. conturbatum* larvae is **Moderately Difficult**. Lateral spines of abdominal terga VIII and IX are minute (Fig. 31e) and are best viewed when backlit.

Previous Wisconsin Records: McCafferty et al. (2004).

Status: *Anafroptilum conturbatum* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). In the state, it is known only from the Black River in Trempealeau County.

Biological Information: This species is poorly known, with a notable absence of even basic biological information in the literature.

Figure 36. *Anafroptilum conturbatum,* larva (photo courtesy of S. Burian, Southern Connecticut State University; specimen courtesy of D. J. Giberson, University of Prince Edward Island).

Figure 37. Wisconsin records of *Anafroptilum conturbatum.*

Anafroptilum minor (McDunnough) (Figs. 38 and 39)

Determination: Identification of larvae of *A. minor* is **Slightly Difficult.** Larvae lack hind wingpads, a character found in no other *Anafroptilum* (Jacobus and McCafferty 2014). They have numerous dark speckles covering the body (Figs. 31f and 38). On the abdomen, these speckles are limited to the posterior two-thirds of each tergite and sternite. The first two terga each have a medial dark spot. All terga have a pair of sublateral dark spots near the anterior margin of the segment. There is no medial tooth-like structure along the posterior margin of the ninth tergum. The lateral spines on the terga are very minute and restricted to the last two or three segments. The sterna have a similar distribution of speckles and spots as the terga, but also have paired, long, dark submedial lines along the anterior and posterior margins of each sternite (Fig. 31f). The front wingpads are darkly marked with veins. Between the front wingpads, the posterior portion of the mesonotum has variously developed paired protuberances near the midline.

Previous Wisconsin Records: None, with the first state record given below. *Anafroptilum minor* is known from the Southeast United States north to Quebec and west to Oklahoma, with the only previous Upper Midwest records being from south-central Indiana (McCafferty 2009). I also have yet unpublished records of this species from the Upper Peninsula of Michigan.

New State Records: LINCOLN: 1L, New Wood R., VI-11-1974, vial 073012D (UW); **PRICE:** 3L, S. Fork Flambeau R. (site SFL1), St. Rd. 13, 45°54'49.03"N 90°26'51.69"W, VI-24-1998, vial 061812B (THK); **VILAS:** 1L, Wisconsin R., Co. Rd. K, 50 m upstream, 46.04779°N 89.26578°W, X-17-2011, H. Yang, vial 051513a (THK).

Biological Information: None. The sites listed above are on fourth- and fifth-order segments of rivers in northern Wisconsin.

Figure 38. *Anafroptilum minor*, larva.

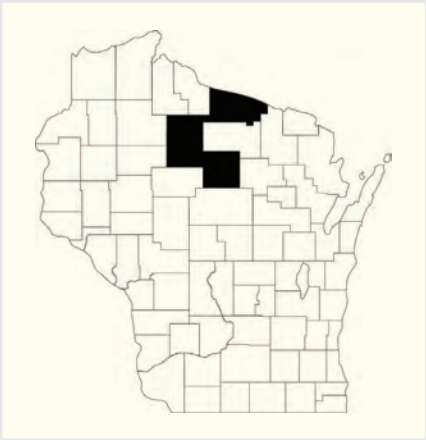


Figure 39. Wisconsin records of *Anafroptilum minor.*

Anafroptilum semirufum (McDunnough), 1926 (Fig. 40)

Taxonomic History: *Anafroptilum semirufum* (McDunnough), 1926 (curr. comb., Jacobus and Wiersema 2014); *Centroptilum semirufum* McDunnough, 1926 (orig.).

Larval Description: None.

Determination: Identification of *A. semirufum* larvae is **Difficult**. They are very similar in both structure and coloration to *A. victoriae* and *A. conturbatum*.

Previous Wisconsin Records: None. *Anafroptilum semirufum* is an eastern species, with nearest records from Pennsylvania (Jacobus and McCafferty 2001). Though not known from any of the states bordering Wisconsin, the difficulty of identification of this species easily could have allowed it to escape detection in the Midwest. Though I do not expect it in Wisconsin, the key may provide some security for those attempting to identify *Anafroptilum* larvae from Michigan, Indiana, or Ohio.

Biological Information: None.

Figure 40. *Anafroptilum semirufum,* larva (photo courtesy of S. Burian, Southern Connecticut State University).

Anafroptilum victoriae (McDunnough), 1938 (Figs. 41 and 42)

Taxonomic History: *Anafroptilum victoriae* (McDunnough), 1938 (curr. comb., Jacobus and Wiersema 2014); *Centroptilum victoriae* McDunnough, 1938 (orig.).

Larval Description and Habitus: Lowen and Flannagan (1991), as *Centroptilum victoriae*.

Determination: Identification of *A. victoriae* larvae is **Moderately Difficult**. Larvae have lateral spines of abdominal terga VIII and IX (Fig. 31d) that are minute and best viewed when backlit. Their tergal coloration is most similar to larvae of *A. semirufum*, a species not known from Wisconsin.

Previous Wisconsin Records: McCafferty et al. (2004), as *Centroptilum victoriae*.

New County Records: WALWORTH: 1L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VIII-4-2000, THK (THK).

Status: *Anafroptilum victoriae* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: There is no published information regarding the biology or habitat associations of *A. victoriae*. The Wisconsin records in McCafferty et al. (2004) are from a seventh-order segment of the Chippewa River (Pasture Island Access, Dunn Co.), a fourth-order segment of the Eau Claire River (Marathon Co.), and a fifth-order segment of the Jump River (Rusk Co.). The Jump River site primarily is in an agricultural landscape. The Turtle Creek site indicated above as the first Walworth County record is a medium-sized stream (fourth-order), also running through a mostly agricultural landscape. Tall, grassy shoreline vegetation occasionally extends into the stream channel, which has a significant amount of silt.

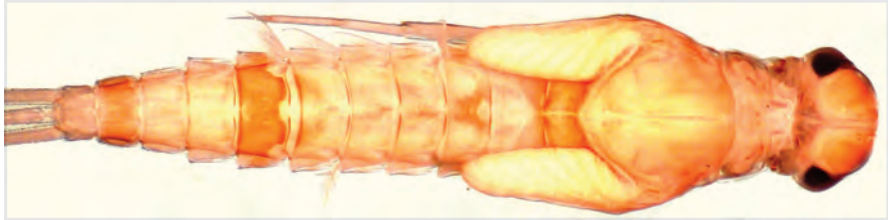


Figure 41. *Anafroptilum victoriae,* larva.

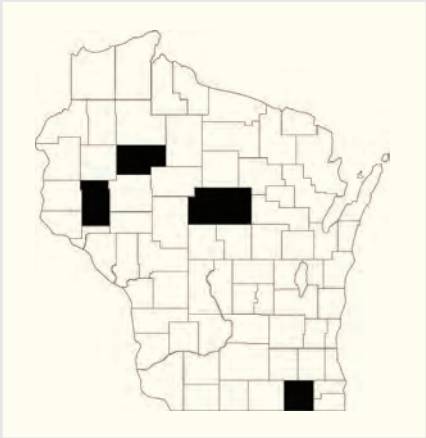


Figure 42. Wisconsin records of *Anafroptilum victoriae.*

Apobaetis

Comments: *Apobaetis* is known only from North and South America (Kluge 2014). There are three recognized species from North America (Anonymous 2014a), though none is known from Wisconsin.

Determination: Identification of *Apobaetis* larvae in Wisconsin is **Fairly Easy** for both the genus and the species within the genus.

Apobaetis etowah (Traver), 1935 (Fig. 43)

Taxonomic History: *Apobaetis etowah* (Traver), 1935 (curr. comb., Waltz and McCafferty 1986); *Apobaetis indeprensus* Day, 1955 (syn.); *Pseudocloeon etowah* Traver, 1935 (orig.).

Larval Descriptions: Day (1955), as *Apobaetis indeprensus*; Nieto (2006), in list form.

Determination: Identification of *A. etowah* larvae is **Fairly Easy**. Larvae can be confused with some *Anafroptilum*, *Neocloeon*, and *Procloeon*, which also have long claws. Structure of the labial palpi is most similar to *Paracloeodes minutus* (Fig. 20c). A closely related species, *A. lakota* McCafferty, is known from North Dakota and Nebraska (McCafferty 2000), but is not expected in Wisconsin. *Apobaetis lakota* has three-segmented maxillary palpi, whereas *A. etowah* has a short fourth segment.

Previous Wisconsin Records: None. Nearest records of *A. etowah* are from the western edge of Lower Michigan (McCafferty 2009). Given its scattered populations throughout the interior of North America, *A. etowah* is possible in Wisconsin.

Biological Information: Prior to its synonymy with *A. indeprensus* by Meyer and McCafferty (2003), *A. etowah* was not known from the Upper Midwest or eastern United States (Waltz and McCafferty 1986; Meyer and McCafferty 2003). Very little biological information is available for this species. The length of the claws suggests a psammophilous habit. Edmunds et al. (1976) reported it from a polluted, dredged river with fine sand substrate and rapidly flowing, warm water.

Figure 43. *Apobaetis etowah,* larva.

Baetis

Comments: The generic limits of *Baetis* have changed greatly since the treatment of Wisconsin species by Bergman and Hilsenhoff (1978a). Taxonomic revisions by several authors have reassigned most of those species to other genera and have revealed several synonymies. Nineteen species in North America remain in *Baetis* (Anonymous 2014a), but only five are known from Wisconsin. A sixth species, *B. bundyae*, is known from locations as near as Minnesota. The genus is nearly global in distribution (Kluge 2014).

Determination: Identification of larvae of *Baetis* is **Fairly Easy** at the generic level, but **Moderately Easy to Moderately Difficult** for species within the genus. With practice, most species can be recognized by tergal patterns. Faded specimens of some species are very challenging to identify.

Larval Keys: Traver (1935); Burks (1953); Bergman and Hilsenhoff (1978a); Morihara and McCafferty (1979b); Hilsenhoff (1982); Waltz et al. (1996); Wiersema et al. (2004).

Key to the Species of *Baetis*

1. Gills elongate, more than twice as long as wide (Fig. 44a); not known from Wisconsin . . . . . ***B. bundyae***

Gills less than twice as long as wide (Fig. 44b); common **2**

2. Labial palpus with a well-developed median projection (Fig. 44c); caudal filaments not banded at midlength **3**

Labial palpus with a poorly developed median projection (Fig. 44d, h); each tail with a dark band at midlength **4**

3. Pedicel with one or more robust, socketed setae near dorsal, apical margin visible under compound microscopy, along with hair setae, scale setae, and unsocketed microspines (Fig. 44e); abdominal sterna with robust setae at least in posterolateral corners; pronotum of fresh specimens with dark, submedian, bilobed marks (Fig. 44f); terga V, IX, and X of fresh specimens often distinctly paler than other terga (Fig. 54) . . . . . ***B. tricaudatus***

Pedicel with hair setae, scale setae, and microspines, but lacking socketed robust setae (Fig. 44g); abdominal sterna lacking robust setae; pronotum almost uniformly shaded, with at most an obscure oval maculation (Fig. 45); terga V, IX, and usually X similar in darkness to other terga, or with some limited pale areas (Fig. 45). . . . . ***B. brunneicolor***

4. Labial palpus slender, with second segment more than twice as long as width of base of third segment (Fig. 44h); rare . . . . . ***B. pluto***

Labial palpus broad, with second segment less than twice as long as width of base of third segment (Fig. 44d); abundant and widespread **5**

5. Each tergum of fresh specimens with paired, anterior, submedian white marks (Fig. 50b) and often with three posterior, oval, pale areas (Fig. 50a) . . . . . ***B. intercalaris***

Each tergum of fresh specimens without paired, anterior, submedian marks and usually with only two rounded, posterolateral pale marks (Fig. 48) . . . . . ***B. flavistriga*** **(species complex)**

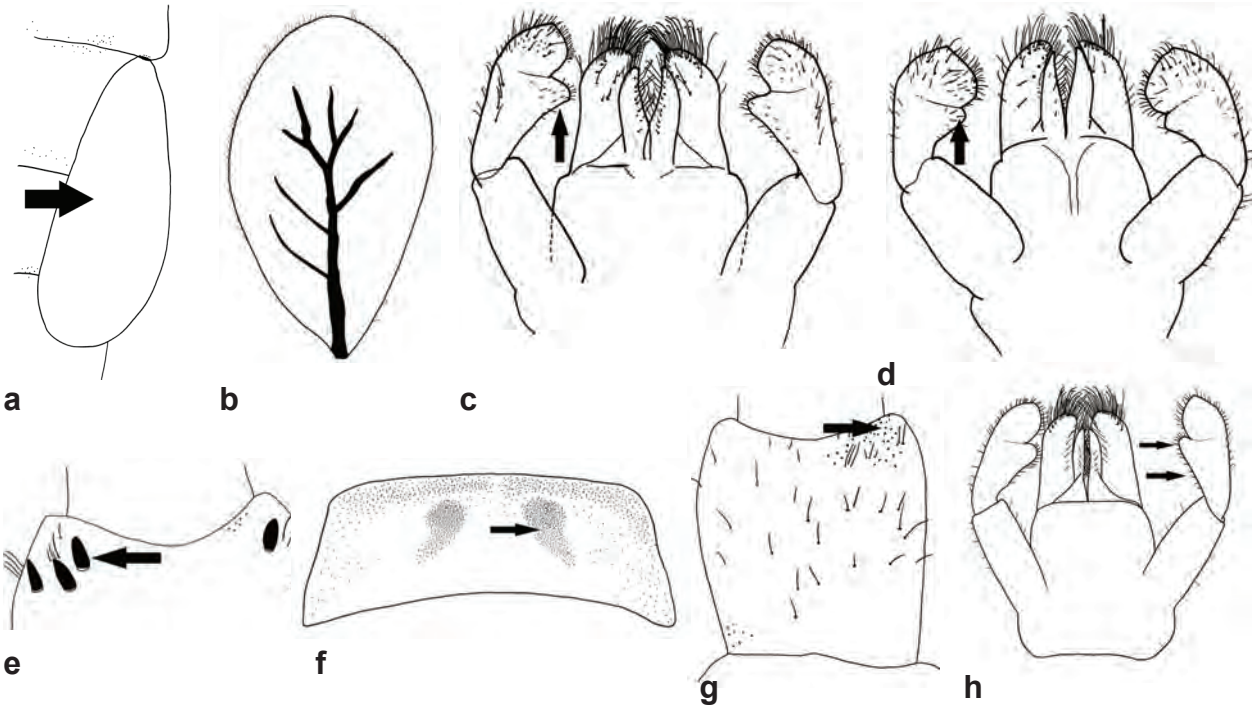


Figure 44. *Baetis* (Baetidae). **a,** *B. bundyae,* gill VI; **b,** *B. intercalaris,* gill VI; **c,** *B. tricaudatus,* labium (ventral); **d,** *B. intercalaris,* labium (ventral); **e,** *B. tricaudatus,* pedicel (dorsal); **f,** *B. tricaudatus,* pronotum; **g,** *B. brunneicolor,* pedicel (dorsal); **h,** *B. pluto,* labium (ventral).

Baetis brunneicolor McDunnough, 1925 (Figs. 45 and 46)

Taxonomic History: *Baetis anachris* Burks, 1953 (syn.); *Baetis hiemalis* Leonard, 1950 (syn.); *Baetis phyllis* Burks, 1953 (syn.).

Larval Descriptions: Leonard (1950), as *B. hiemalis*; Burks (1953), as *B. anachris* and *B. phyllis*; Leonard and Leonard (1962), as *B. brunneicolor* and *B. hiemalis*; Bergman and Hilsenhoff (1978a); Morihara and McCafferty (1979b).

Larval Habitus: Leonard (1950); Leonard and Leonard (1962), as *B. hiemalis*.

Determination: Identification of *B. brunneicolor* larvae is **Moderately Difficult**. *Baetis brunneicolor* and *B. tricaudatus* are the only commonly encountered *Baetis* species with unbanded caudal filaments. Faded specimens of many baetids, though, are easily misidentified as *B. brunneicolor* if only dorsal coloration is used. *Baetis brunneicolor* is most easily confused with *B. tricaudatus*. Both of these species become more darkly pigmented in later instars, grading from gray to reddish-brown to dark brown. Some specimens of *B. brunneicolor* have oval maculae on the pronotum, suggestive of faded *B. tricaudatus*. The difficulty of identification of *B. brunneicolor* is exemplified by the fact that although it is known from nearly all but one county of Wisconsin and often is the most abundant mayfly in its habitat, it has been reported from only a handful of counties in Illinois (Randolph and McCafferty 1998). Preparation of slide mounts of at least the antennae to confirm the absence of robust, socketed setae on the pedicel (Fig. 44g) is highly recommended for positive species determination. However, larvae of *B. brunneicolor* do have numerous unsocketed microspines and fine setae on the pedicel. These easily can be misinterpreted as the robust setae of *B. tricaudatus* (Fig. 44e) unless a proper slide mount is made.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); Hilsenhoff (1982); DuBois (1993); Hilsenhoff (1996); Lillie and Isenring (1996); Randolph and McCafferty (1998).

Biological Information: The most widespread and common baetid in Wisconsin, *B. brunneicolor* occurs in a wide variety of streams, rivers, and water quality (Bergman and Hilsenhoff 1978a). It often is associated with large clumps of organic debris (Burian and Gibbs 1991). Despite its abundance, little biological information is available for this species.

Figure 45. *Baetis brunneicolor,* larva.

Figure 46. Wisconsin records of *Baetis brunneicolor.*

Baetis bundyae Lehmkuhl, 1973 (Fig. 47)

Taxonomic History: *Baetis bundyi* Lehmkuhl, 1973 (spell.); *Baetis macani bundyae* Lehmkuhl, 1973 (stat.)

Larval Description: Morihara and McCafferty (1979b), as *B. macani bundyae*.

Determination: Identification of *B. bundyae* larvae is **Moderately Easy**. The narrow gills on larvae (Fig. 44a) are unlike those on any *Baetis* species known from Wisconsin.

Previous Wisconsin Records: None. The nearest record for the boreal *B. bundyae* is from northeastern Minnesota (Daggy 1945; Lager et al. 1982), though most of its range is in the Hudson Bay drainage system, not the Great Lakes. It is not expected in the state, other than in streams in northern Bayfield County that drain into Lake Superior.

Biological Information: *Baetis bundyae* occurs in a variety of boreal and arctic habitats, including ponds and small, slow-flowing streams (Hubbard and Peters 1978; Morihara and McCafferty 1979b; Webb et al. 2004). Its substrates are varied, including wood, rock, and sand (Lager et al. 1982).

Figure 47. *Baetis bundyae,* larva.

Baetis flavistriga McDunnough, 1921, species complex (Figs. 48 and 49)

Taxonomic History (*B. flavistriga*): *Baetis caurinus* Edmunds and Allen, 1957 (syn.); *Baetis levitans* McDunnough, 1925 (syn.); *Baetis nanus* McDunnough, 1923 (syn.); *Baetis ochris* Burks, 1953 (syn.); *Baetis sinuosus* Navas, 1924 (syn.).

Taxonomic History (*B. phoebus*): *Baetis cingulatus* McDunnough, 1925 (syn.); *Baetis pallidula* McDunnough, 1924 (syn.); *Baetis pallidulus* McDunnough, 1924 (syn.); *Baetis quebecensis* Hubbard, 1974 (syn.).

Larval Descriptions: Leonard and Leonard (1962), as *B. cingulatus*, *B. levitans*; and *B. phoebus*; Bergman and Hilsenhoff (1978a), as *B. flavistriga* and *B. levitans*; Morihara and McCafferty (1979b).

Larval Habitus: Bergman and Hilsenhoff (1978a), as *B. flavistriga* and *B. levitans*; Morihara and McCafferty (1979b).

Determination: Identification of *B. flavistriga* larvae is **Fairly Easy** as a species complex, but **Problematic** as a separate species. Boldly patterned larvae of *B. flavistriga (sensu latu)* easily are separated from *B. intercalaris* in the field as the dorsal coloration of *B. flavistriga* is fairly consistent (Fig. 48). Faded specimens, however, can be extremely difficult to differentiate from *B. intercalaris*. Zhou et al. (2010) recently reinstated *B. phoebus* McDunnough from synonymy with *B. flavistriga* based upon DNA barcoding (mitochondrial cytochrome oxidase subunit 1). Morphological evidence was not presented in that paper. Prior to its synonymy, *B. flavistriga* was separated from *B. phoebus* based upon the following characters: 1) strongly tracheated gills with numerous branches, 2) tergum V not significantly paler than other terga and lacking submedian black spots, 3) middle terga lacking a mid-dorsal line, and 4) median caudal filament almost as long as cerci. Conversely, *B. phoebus* was defined as having: 1) weakly tracheated gills with little or no branching, 2) tergum V pale and with two submedian black spots, 3) middle terga with, at most, a faint mid-dorsal line, and 4) median caudal filament relatively short, not more than three-fourths as long cerci (Traver 1935; Burks 1953; Bergman and Hilsenhoff 1978a). Examination of a large number of Wisconsin *Baetis* larvae previously identified as *B. flavistriga* reveals that almost all of them have at least two characters indicative of *B. phoebus* (characters 2 and 3 above), but rarely all four. It is likely that this species complex includes two or more cryptic species, including *B. phoebus* (L. Jacobus, pers. comm.). Without morphological characters allowing separation of these species, I have treated them as an inseparable species complex.

Previous Wisconsin Records: Peckarsky (1980), as *B. phoebus* (Sauk Co.). Hilsenhoff (1982), DuBois (1993), Hilsenhoff (1996), Lillie and Isenring (1996), and Randolph and McCafferty (1998), all as *B. flavistriga* (under the assumption of synonymy between *B. flavistriga* and *B. phoebus)*.

New County Records (as *B. flavistriga* species complex): **BAYFIELD:** 2L, Boyd Crk., St. Rd. 13, site "Lksup 2422", 46.614106°N 90.939862°W, Summer 2012, K. L. Schmude (UWS); **FLORENCE:** 23L, Brule R., Hwy. 141, VI-26-1996 (WiDNR); **IRON:** 20L, Flambeau R., 46.06545°N 90.23382°W, VI-13-2000, K. L. Schmude, C. Brennan, K. Mielke, and J. Denninger (UWS); **JACKSON:** Black R., Hawk Island Rd., 44.22176°N 90.87689°W, V-28-1997, R. A. Lillie and W. A. Smith (WiDNR); 18L, Robinson Crk., W. Pine Hill Rd., 44.2069°N 90.8780°W, V-28-1997, R. A. Lillie and W. A. Smith (WiDNR); **KEWAUNEE:** 21L, Red R., St. Rd. 57, 44.66732°N 90.87806°W, V-21-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **ONEIDA:** 2L, Wisconsin R., River Rd., 45.79607°N 89.53928°W, VI-6-1994, K. L. Schmude and R. L. Otto (UWS); 3L, Wolf R., Meister-Stockley Rd., Tuscobia Pk. Falls, 45.53194°N 89.11214°W, VI-9-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **OZAUKEE:** Milwaukee R., IX-26-2005, A. M. Lederer (UWGB); **PRICE:** 13L, Butternut Crk., 45.91155°N 90.59061°W, VI-13-2000, K. L. Schmude, C. Brennan, J. Denninger, and K. Mielke (UWS); 3L, Flambeau R., St. Rd. 70, 45.85259°N 90.60031°W, VI-14-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **ST. CROIX:** 6L, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); Eau Galle R., Co. Rd. N, 3 mi. S. of Woodville, 44°54'18"N 92°15'53"W, VII-12-2011, THK (THK); 35L, Willow R., Co. Rd. E, ½ mi. NW. of Dry Dam Lk., 45°2'10"N 92°38'20"W, VII-12-2011, THK (THK).

Biological Information: Larvae of the *B. flavistriga* complex are common to abundant throughout Wisconsin. They prefer erosional reaches of smaller streams and rivers, where rocky substrates are exposed, and where clumps of organic debris accumulate (Leonard and Leonard 1962; Morihara and McCafferty 1979b; Burian and Gibbs 1991). They can be associated with woody debris as well as rocks.

Figure 48. *Baetis flavistriga* species complex, larva.

Figure 49. Wisconsin records of *Baetis flavistriga* species complex.

Baetis intercalaris McDunnough, 1921 (Figs. 50 and 51)

Taxonomic History: *Baetis lasallei* Banks, 1924 (syn.).

Larval Descriptions: Leonard and Leonard (1962); Bergman and Hilsenhoff (1978a); Morihara and McCafferty (1979b); Waltz et al. (1996).

Larval Habitus: Bergman and Hilsenhoff (1978a); Morihara and McCafferty (1979b); Waltz et al. (1996).

Determination: Identification of fresh specimens of *B. intercalaris* is **Moderately Easy**. Larvae are variable in dorsal coloration, though most forms are recognizable in the field with a hand lens. Other baetids, such as some *Labiobaetis*, may also have larvae with paired, submedian marks near the anterior margins of terga, so following the key is advised. Faded specimens are extremely difficult to differentiate from *B. flavistriga*.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); Lillie and Hilsenhoff (1992); Randolph and McCafferty (1998).

New County Records: BUFFALO: 2L, Trempealeau R., Co. Rd. P, 2 mi. N. of St. Rd. 35, VII-10-2013, K. L. Schmude (UWS); **DOOR:** 2L, Lilly Bay Crk., Co. Rd. H, 44.8501°N 87.2837°W, V-21-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **ONEIDA:** Lk. Minocqua, IX-10-2005, T. Lechleitnera (UWGB); **SHAWANO:** 6L, Embarrass R., Hayman Falls Ln., 44.74853°N 88.84183°W, V-26-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 3L, Red R., Butternut Rd., 44.84305°N 88.7226°W, VI-8-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **ST. CROIX:** 2L, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); 2L, Willow R., Co. Rd. E, ½ mi. NW. of Dry Dam Lk., 45°2'10"N 92°38'20"W, VII-12-2011, THK (THK); **VILAS:** 2L, Manitowish R., Co. Rds. K and H, 2.5 mi. W. of Boulder Junction, VIII-8-2008, THK (THK).

Biological Information: *Baetis intercalaris* is the most common *Baetis* in Illinois (Burks 1953) and Iowa (McCafferty et al. 2003a). It is less ubiquitous in Wisconsin, though, than *B. brunneicolor*. It can coexist with *B. flavistriga* in similar erosional stream habitats, but is also known in transitional runs with more varied water depth and current (Berner and Pescador 1988; Burian and Gibbs 1991; Lillie and Hilsenhoff 1992). Larvae occur on a wide range of coarse substrate.

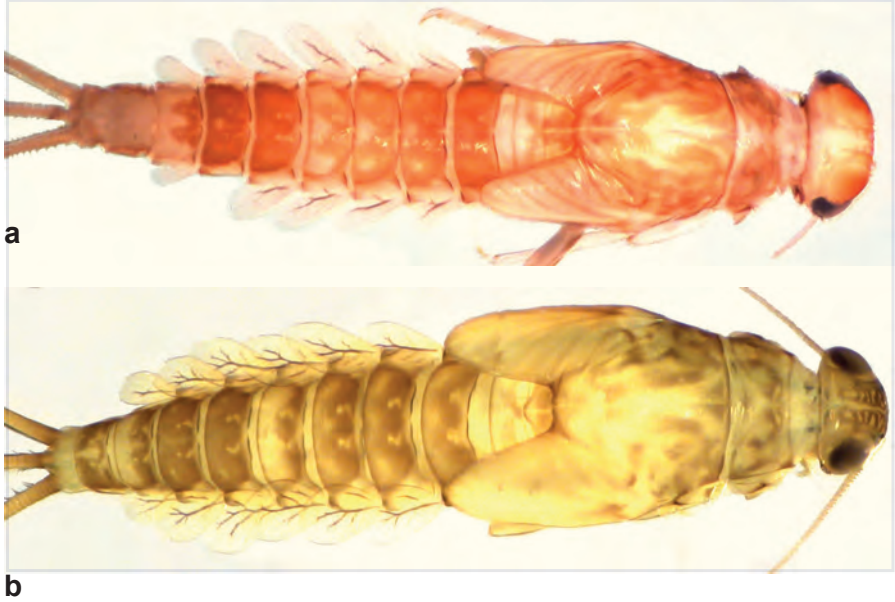


Figure 50. *Baetis intercalaris,* larvae; **a,** male; **b,** female.

Figure 51. Wisconsin records of *Baetis intercalaris.*

Baetis pluto McDunnough, 1925 (Figs. 52 and 53)

Larval Description: Morihara and McCafferty (1979b).

Determination: Identification of *B. pluto* larvae is **Slightly Difficult**. With practice, the narrow labial palpi are distinctive (Fig. 44h). The illustrations and photography of this species are based upon North Carolina specimens in the Purdue Entomological Research Collection.

Previous Wisconsin Records: Hilsenhoff et al. (1972).

Status: *Baetis pluto* has not been detected in Wisconsin since the original report from the Popple River in Florence County (Hilsenhoff et al. 1972). I have not been able to locate the specimen(s) from this record in the UW–Madison collection. Given the rarity of records of this species, it would be desirable to relocate that material. The necessity of examining small mouthparts for species identification likely means that populations of this species have escaped detection.

Biological Information: *Baetis pluto* is by far the poorest known member of the genus in Wisconsin. Burian and Gibbs (1991) described it as a species of riffles and transitional areas of small, first- and second-order streams.

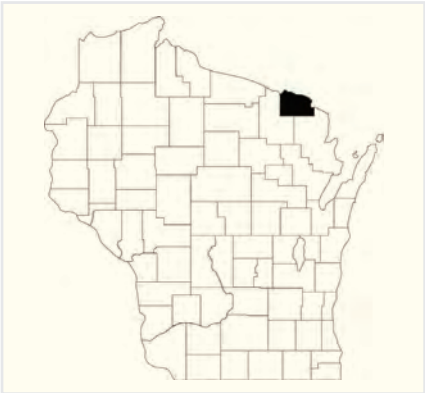


Figure 52. *Baetis pluto,* larva.

Figure 53. Wisconsin records of *Baetis pluto.*

Baetis tricaudatus Dodds, 1923 (Figs. 54 and 55)

Taxonomic History: *Baetis incertans* McDunnough, 1925 (syn.); *Baetis intermedius* Dodds, 1923 (syn.); *Baetis jesmondensis* McDunnough, 1938 (syn.); *Baetis moffati* Dodds, 1923 (syn. spell); *Baetis moffatti* Dodds, 1923 (syn.); *Baetis* sp. No. 1 Traver, 1932 (syn.); *Baetis parallelus* Banks, 1924 (syn.), *Baetis vagans* McDunnough, 1925 (syn.).

Larval Descriptions: Dodds (1923), as *B. brunneicolor* and *B. intermedius*; Traver (1937), as *B. incertans*; Leonard and Leonard (1962), as *B. vagans*.

Larval Habitus: Burks (1953), as *B. vagans*; Bergman and Hilsenhoff (1978a), as *B. tricaudatus* and *B. vagans*; Morihara and McCafferty (1979b).

Determination: Identification of *B. tricaudatus* larvae is **Moderately Difficult**. *Baetis tricaudatus* and *B. brunneicolor* are the only two commonly encountered *Baetis* with unbanded caudal filaments. Identification of *B. tricaudatus* based solely upon dorsal coloration of the pronotum (Fig. 44f) should be suspect, as some *B. brunneicolor* have oval maculae on the pronotum that contrast slightly with the background. These markings fade in alcohol in both species. Markings of the abdominal terga in *B. tricaudatus* vary with age and from specimen to specimen, but are very similar to *B. brunneicolor*. In many immature *B. tricaudatus*, however, abdominal tergum IX and X are entirely white and strongly contrasting with more anterior segments (Fig. 54). Slide mounts of at least the antennae to detect robust setae (Fig. 44e) are highly recommended for species determination. These setae are very robust and should not be confused with the smaller and shorter microspines and scale setae present on the antennae of both *B. tricaudatus* and *B. brunneicolor* (Fig. 44g).

Previous Wisconsin Records: Peterka (1969); Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976), as *B. vagans*; Hilsenhoff (1982); DuBois (1993); Hilsenhoff (1996); Lillie and Isenring (1996); Randolph and McCafferty (1998).

New County Records: BROWN: 1L, Green Bay, IX-23-2001, M. Rhoades (UWGB); **LAFAYETTE:** 7L, Spafford Crk., Wayne Rd., site "Rockr 13279", 42.501011°N 89.896842°W, Summer 2012, K. L. Schmude (UWS); **MANITOWOC:** 2L, Little Manitowoc R., Co. Rd. Q, site "Shema 1544", 44.122993°N 87.670533°W, Summer 2012, K. L. Schmude (UWS); **SAUK:** 4L, unnamed crk., site "Wisn 24920", Luebke Rd., 43.467296°N 89.606026°W, Summer 2012, K. L. Schmude (UWS); **SAWYER:** 1L, Badger Crk., N. Valley View Rd., site "Chipr 4870", 45.677266°N 91.307086°W, Summer 2012, K. L. Schmude (UWS); **WAUPACA:** 1L, Embarrass R., bridge on Old Hwy. 156 (7th Str.), 44.61996°N 88.70151°W, VI-8-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 1L, Peterson Crk., Matson Rd., 44.44913°N 89.18603°W, VI-5-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS).

Biological Information: *Baetis tricaudatus* is the most widespread *Baetis* in North America, occurring on much of the continent (Morihara and McCafferty 1979b). In Wisconsin, *B. tricaudatus* is much less common than *B. brunneicolor*, with which it easily can be confused. It prefers erosional reaches of streams and rivers where it is associated with stones, logs, vegetation, and leaf pack (Morihara and McCafferty 1979b; Burian and Gibbs 1991).

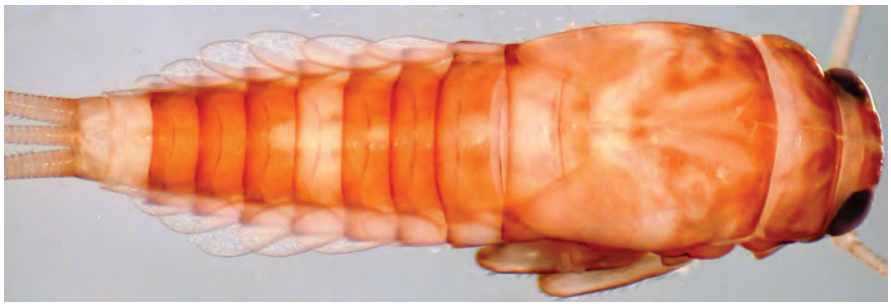


Figure 54. *Baetis tricaudatus,* larva.

Figure 55. Wisconsin records of *Baetis tricaudatus.*

Callibaetis

Comments: There are twelve species of the New World genus *Callibaetis* known from North America. Only five are known from or suspected in Wisconsin. Check (1982) gave the first complete key to the larvae in an unpublished dissertation. No comprehensive review of the genus has occurred since. The genus, therefore, is in need of review and clarification of a number of records. Identification of the species can be difficult because slide mounts often are required. Removal of a gill to correctly answer the first couplet is recommended. This gill should be permanently mounted on a slide and cross-referenced to the specimen, or should be placed in a microvial with the specimen. Larvae of *Callibaetis* can be misidentified as large *Procloeon*, because of the occasional pattern of alternating dark and light intersegmental bands on the caudal filaments of some *Callibaetis*.

Species of *Callibaetis* generally occur in slower current than other baetids, are some of the dominant mayflies of ponds and lakes, and are relatively tolerant of siltation and degraded water quality (Edmunds et al. 1976; Lillie and Hilsenhoff 1992).

Determination: Identification of *Callibaetis* larvae is **Easy** at the generic level, but **Slightly Difficult to Problematic** for species within the genus.

Larval Keys: Traver (1935); Burks (1953); Check (1982).

Key to the Species of *Callibaetis*

1. Each gill III–VI with ventral lamella broadly connected to dorsal lamella (Fig. 56a); dorsal margin of each tarsus with or without robust setae **2**

Each gill III–VI with ventral lamella narrowly connected to dorsal lamella (Fig. 19o); dorsal margin of each tarsus bare, or with only fine setae (Fig. 56b) **4**

2. Dorsal margins of tibiae and tarsi without robust setae (Fig. 56c); not known from Wisconsin . . . . . ***C. pictus***

Dorsal margins of tibiae and tarsi with robust setae (Fig. 56d) **3**

3. Each tarsus with a straight, single seta at its outer, ventral apex that is only 5–7.5 times longer than the seta's greatest width (Fig. 56e); each femur often with a darkened preapical band. . . . . ***C. ferrugineus ferrugineus***

Each tarsus with a straight, single seta at its outer, ventral apex that is 8–10.5 times longer than the seta's greatest width (Fig. 56f); femora lacking darkened preapical bands. . . . . ***C. pallidus/skokianus***

4. Each abdominal segment VII–VIII with a slightly concave lateral margin at midlength (Fig. 56g); caudal filaments weakly to distinctly darkened at every fourth intersegment at approximately midlength; not known from Wisconsin . . . . . ***C. floridanus***

Each abdominal segment VII–VIII not appearing slightly concave along lateral margin (Fig. 56h); caudal filaments without distinct coloration at every fourth intersegment at approximately midlength. . . . . ***C. fluctuans***

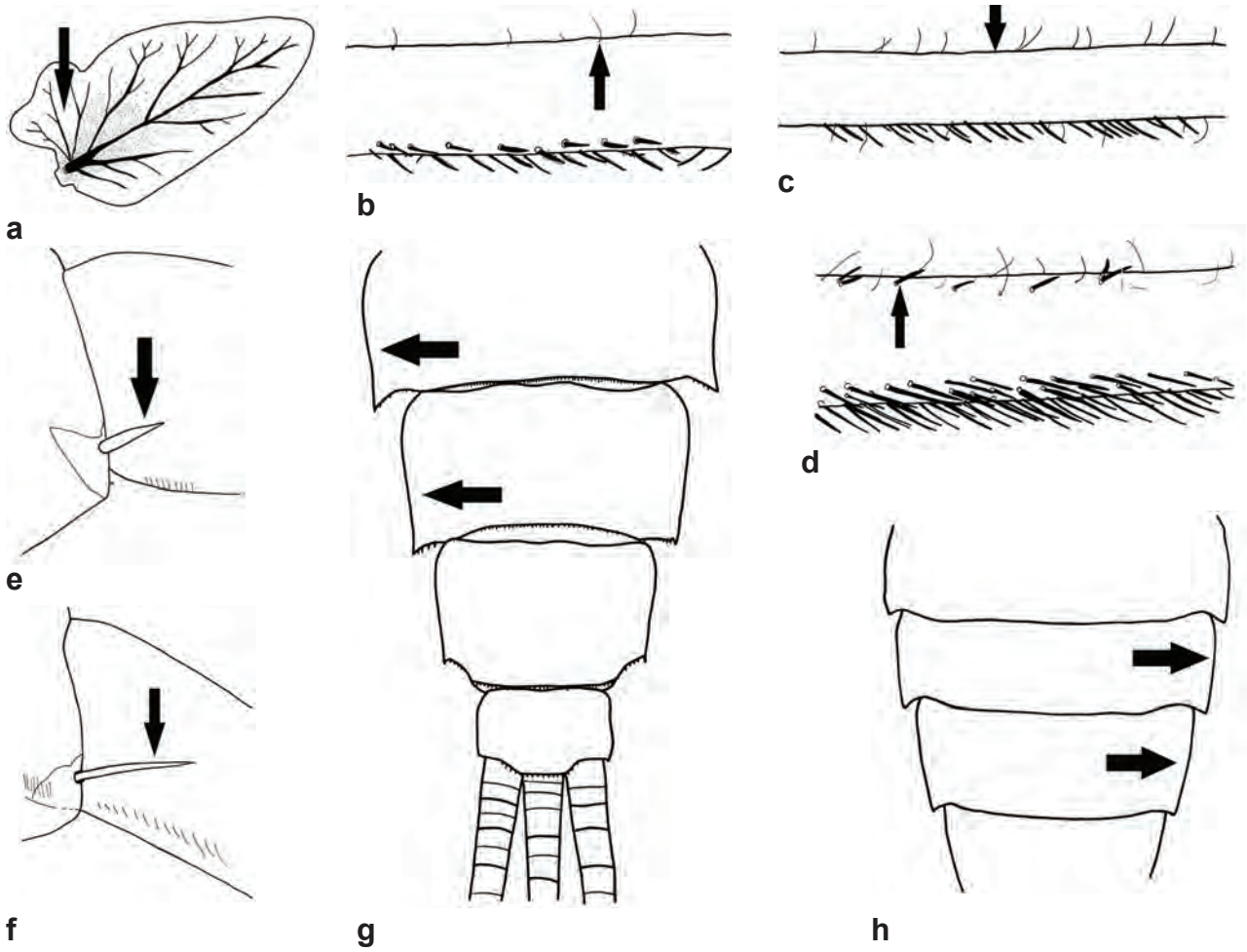


Figure 56. *Callibaetis* (Baetidae). **a,** *C. pallidus,* gill V; **b,** *C. fluctuans,* hind tarsus; **c,** *C. pictus,* hind tarsus; **d,** *C. pallidus,* tarsus; **e,** *C. ferrugineus,* claw; **f,** *C. pallidus,* claw; **g,** *C. floridanus,* terga VII–X; **h,** *C. fluctuans,* abdominal terga VI–IX.

Callibaetis ferrugineus ferrugineus (Walsh), 1862 (Figs. 57 and 58)

Taxonomic History: *Baetis ferrugineus* (Walsh), 1862 (comb.); *Callibaetis ferrugineus* (Walsh), 1862 (comb.); *Cloe ferruginea* Walsh, 1862 (orig.).

Larval Descriptions: Berry (1903), as *Callibaetis ferruginea* (spell.); Burks (1953); Leonard and Leonard (1962); Check (1982).

Larval Habitus: Burks (1953).

Determination: Identification of *C. f. ferrugineus* larvae is **Difficult**. The seta at the apex of the tarsus (Fig. 56e) can only be measured precisely using a compound microscope equipped with a micrometer or imaging equipment. Unfortunately, this seta often is broken or hidden from view in the slide mount. The preapical femoral bands fade in preservative, increasing the difficulty of identifying preserved material.

Previous Wisconsin Records: Traver (1935); Thew (1959); Randolph and McCafferty (1998). Wisconsin records of *C. pretiosus* Banks in Thew (1959) were reassigned to *C. ferrugineus* by Randolph and McCafferty (1998).

New County Records: BAYFIELD: 2L, Namekagon R., Forest Rd. 211, IV-20-1986, THK (THK); **BROWN:** Adult taken at Upahki Pond, UW–Green Bay campus, Green Bay, VI-21-2007, M. Draney (UWGB); **CLARK:** 2L, S. Branch Yellow R., Fair Haven Rd., site "Wiscn 11857", 44.634558°N 90.316366°W, Summer 2012, K. L. Schmude (UWS); **OZAUKEE:** 1L, Mud Lk., T11NR21E S31, VI-27-1978, J. Jass and G. Johnson (MPM); **RACINE:** 10L, Fox R., Fox R. Rd. bridge, T4NR19E S10, VIII-13-1976, J. Jass (MPM); **ROCK:** 3L, Rock R., Happy Hollow Co. Pk., 1 mi. S. of Janesville, V-5-2014, THK (THK); **WAUPACA:** 1M, Hartman Crk. St. Pk., IV-28-1990, J. Keso (UWO); 1M, Waupaca, V-3-1969, J. Richards (UWO); 1M, T25NR14E S1, V-19-2010, V. Hatfield (UWO); **WINNEBAGO:** 2L, Rush Crk., T18NR14E S36, III-12-1990 (UWO); 1F, T18NR14E S36, V-26-1992, M. Czarnecki (UWO); 4L, Rush Crk., 1L, T18NR14E S36, IV-16-2010, D. Olson (UWO); Rush Crk., T18NR14E S36, V-5-2010, D. Graff (UWO); **WOOD:** 2L, S. Branch Yellow R., Fair Haven Rd., site "Wiscn 11857", 44.634558°N 90.316366°W, Summer 2012, K. L. Schmude (UWS).

Biological Information: *Callibaetis ferrugineus* is the best known member of the genus (Check 1982) and is the most widespread species of the genus in Wisconsin. Larvae of the species occur in, as is typical for the genus, a variety of habitats with limited current flow, including stream pools, backwaters, and ponds (Check 1982; Burian and Gibbs 1991). They are most commonly associated with vegetation (Leonard and Leonard 1962).

Figure 57. *Callibaetis ferrugineus,* larva.

Figure 58. Wisconsin records of *Callibaetis ferrugineus.*

Callibaetis floridanus Banks, 1900 (Fig. 59)

Taxonomic History: *Callibaetis completa* Banks, 1930 (syn.).

Larval Descriptions: Berner (1940); Check (1982).

Larval Habitus: Berner and Pescador (1988).

Determination: Identification of *C. floridanus* larvae is **Difficult**. The species is most similar to the commonly encountered *C. fluctuans*. Positively identified adults are recommended for any potential new state record of *C. floridanus*, as Wisconsin is well north of its usual range.

Previous Wisconsin Records: None. Closest records are from west-central Indiana (Randolph and McCafferty 1998) and Iowa (Klubertanz 1995).

Biological Information: *Callibaetis floridanus* is not selective about its lentic habitats, occurring along pond margins and in temporary pools and ditches (Trost and Berner 1963; Check 1982; Berner and Pescador 1988).

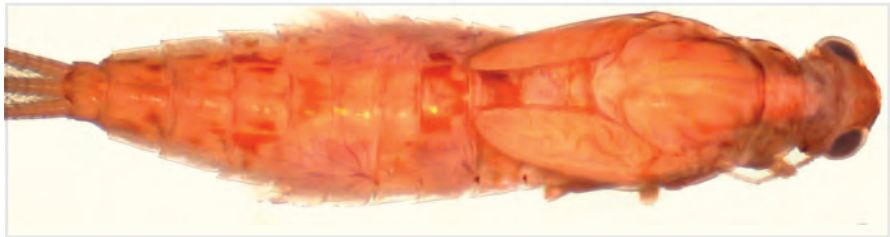


Figure 59. *Callibaetis floridanus,* larva.

Callibaetis fluctuans (Walsh), 1862 (Figs. 60 and 61)

Taxonomic History: *Baetis fluctuans* (Walsh), 1862 (comb.); *Callibaetis fluctuans* (Walsh), 1862 (curr. comb., Banks 1900); *Callibaetis traverae* Upholt, 1937 (syn.); *Cloe fluctuans* Walsh, 1862 (orig.).

Larval Descriptions: Burks (1953); Check (1982).

Determination: Identification of *C. fluctuans* is **Moderately Difficult**. The species is most similar to *C. floridanus*, which is not yet known from Wisconsin.

Previous Wisconsin Records: Randolph and McCafferty (1998).

New County Records: BROWN: larvae, Dragonfly Pond, UW–Green Bay Arboretum, Green Bay, X-7-2005, N. G. Walton (UWGB); 1F, Cofrin Arboretum, IX-5-2002, K. S. Groves (UWGB); 1F, Green Bay, X-5-2002, E. J. Jacobs (UWGB); 1F, Point au Sauble Nature Preserve, IX-22-2005, C. Bacelis (UWGB); larvae, Point au Sauble Nature Preserve, VIII-8-2007, J. Lee (UWGB); **JEFFERSON:** 1L, Whitewater Crk., Co. Rd. U, XI-8-1983 (UW); 1F, 1 mi. NE. of Cold Spring, VII-21-2000, THK (THK); **ROCK:** 1F, Janesville, IX-5-2007, THK (THK); 7A, UW–Rock Co., VIII-31-2007, THK (THK); **WINNEBAGO:** 1L, Rush Crk., T18NR14E S36, IX-19-2007, L. Nelson (UWO).

Biological Information: The known habitat and ecological tolerance of *C. fluctuans* are typical for the genus (Check 1982). Burian and Gibbs (1991) reported it along the shorelines of ponds and lakes, in stream backwaters, and in marshes. This species can occur in lotic conditions (McCafferty et al. 2003a), especially below an outlet of a pond or lake. Adults from Wisconsin have been taken from 21 July (Jefferson County) to 7 October (Brown County).

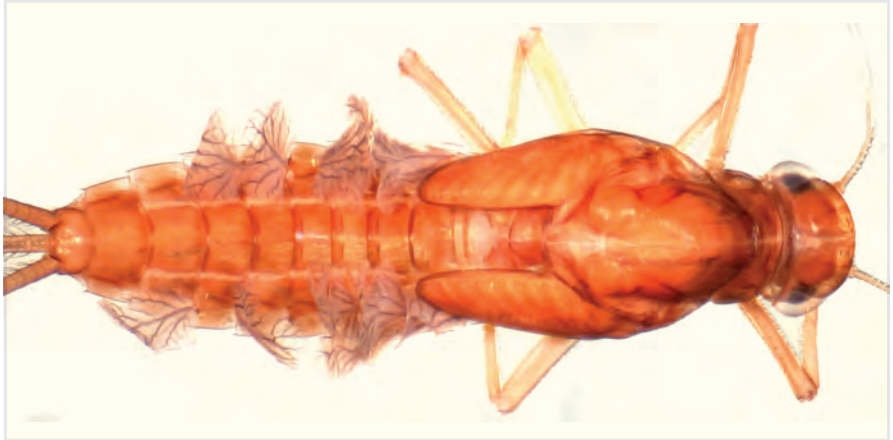


Figure 60. *Callibaetis fluctuans,* larva.

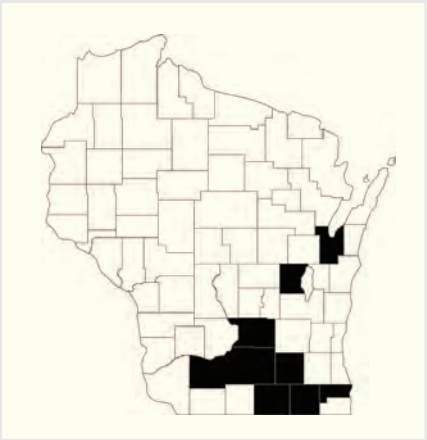


Figure 61. Wisconsin records of *Callibaetis fluctuans.*

Callibaetis pallidus Banks, 1900 (Figs. 62 and 63)

Taxonomic History: *Callibaetis semicostatus* Banks, 1914 (syn.).

Larval Description: Check (1982), but see comments in discussion section below.

Determination: Identification of *C. pallidus* larvae is **Problematic**. The apical seta on the tarsus (Fig. 56f) often suffers breakage and is difficult to see in slide mounts. In faded, preserved specimens, it is difficult to differentiate between *C. pallidus* and *C. ferrugineus* based solely upon femoral banding. Furthermore, there are no published characters to separate larvae of *C. pallidus* from *C. skokianus*. Distribution records and biological information of *C. pallidus* should be based, therefore, on adult material. In addition, there is taxonomic confusion related to *C. pallidus*. Check (1982) synonymized *C. skokianus* as a junior synonym of *C. pallidus*, but as this was in an unpublished dissertation, not all workers have adopted his nomenclature. I have not found published commentary regarding this synonymy. Randolph and McCafferty (1998) were unable to locate material Check considered to be *C. pallidus*, but believed that Wisconsin records of *C. pallidus* in Check (1982) likely are *C. skokianus*.

Previous Wisconsin Records: McCafferty et al. (2004).

New County Records: ROCK: 2F in two vials, UW–Rock Co., Janesville, VII-20-1999 and IX-30-2010, THK (THK).

Status: *Callibaetis pallidus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: As is typical for the genus, *C. pallidus* is known from a variety of habitats, including vegetation along the shorelines of ponds and lakes, in marshes, and in stream backwaters (Burian and Gibbs 1991). It apparently feeds on algae and other detritus.

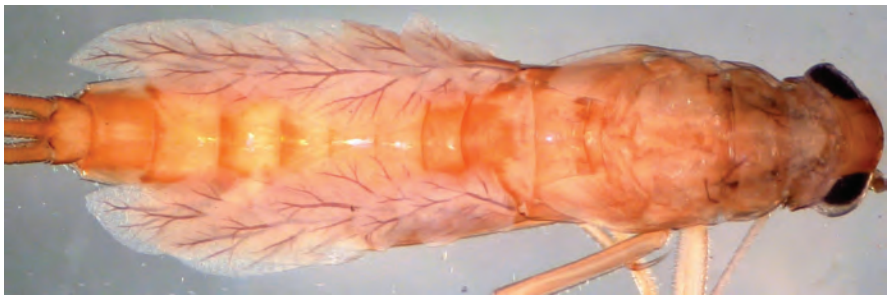


Figure 62. *Callibaetis pallidus,* larva.

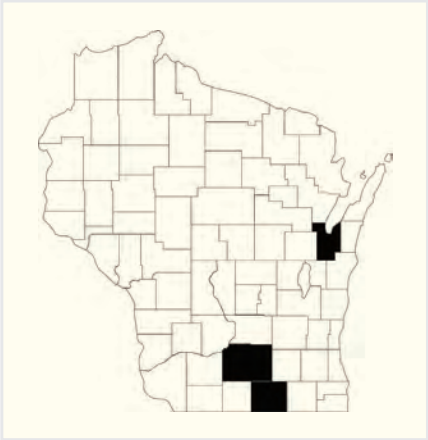


Figure 63. Wisconsin records of *Callibaetis pallidus.*

Callibaetis pictus (Eaton), 1871 (Figs. 64 and 65)

Taxonomic History: *Baetis pictus* Eaton, 1871 (orig.); *Callibaetis centralis* Peters, 1959 (syn.); *Callibaetis doddsi* Traver, 1935 (syn.); *Callibaetis pacificus* Seemann, 1927 (syn.); *Callibaetis pictus* (Eaton), 1871 (curr. comb., Eaton 1881); *Callibaetis signatus* Banks, 1918 (syn.); *Callibaetis vitrea* Dodds, 1923 (syn.).

Larval Description: Check (1982).

Larval Habitus: Check (1982); Lugo-Ortiz and McCafferty (1996).

Determination: Identification of *C. pictus* larvae is **Fairly Easy**. With practice, the absence of robust setae on tibiae and tarsi (Fig. 56c) can be seen with a dissecting microscope.

Previous Wisconsin Records: None. The first state records are given below.

New Wisconsin Records: BROWN: 1L, Upahki Pond, UW–Green Bay campus, Green Bay, IX-9-2003, A. Krause (UWGB); **ROCK:** 1F, Edgerton, VII-26-1985, THK (THK).

Biological Information: The habitat associations for *C. pictus* are similar to other species in the genus. Check (1982) found it in a variety of habitats, including pool areas of small streams and creeks.

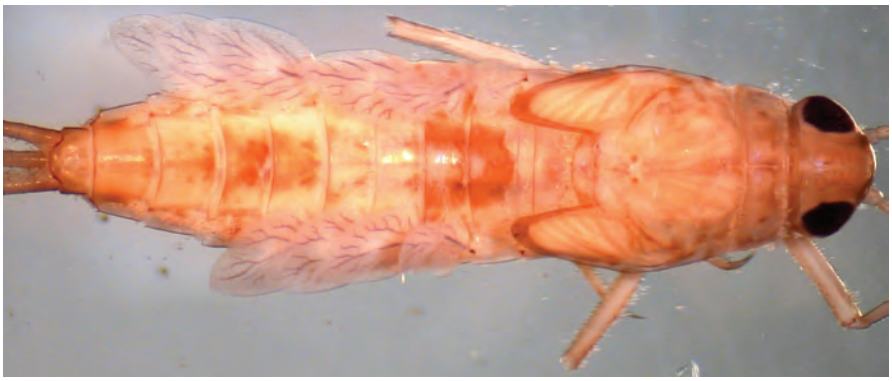


Figure 64. *Callibaetis pictus,* larva.

Figure 65. Wisconsin records of *Callibaetis pictus.*

Callibaetis skokianus Needham, 1903

Taxonomic History: *Callibaetis brevicostatus* Daggy, 1945 (syn.).

Larval Description: Burks (1953).

Determination: Identification of *C. skokianus* larvae is **Problematic**. No published characters separate *C. skokianus* from *C. pallidus*. Distribution records and biological information should be based, therefore, on adult material. In addition, there is taxonomic confusion related to this species. Check (1982) synonymized *C. skokianus* as a junior synonym of *C. pallidus*, but as this was in an unpublished dissertation, not all workers have adopted his nomenclature.

Previous Wisconsin Records: McCafferty et al. (2004). Randolph and McCafferty (1998) believed that Wisconsin records of *C. pallidus* in Check (1982) likely are *C. skokianus*.

Status: *Callibaetis skokianus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

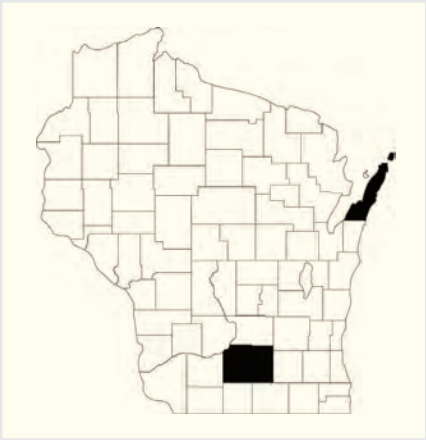


Figure 66. Wisconsin records of *Callibaetis skokianus.*

Camelobaetidius

Comments: Though fairly diverse in the southwestern United States, Mexico, and through Central America, with nine species recognized from continent, *Camelobaetidius* is represented by only one species in the Eastern Great Lakes region. The genus is not known from Wisconsin. It is of South American origin, having moved north through the Pan-American land bridge, in contrast to most North American mayflies (Allen 1990).

Determination: Identification of *Camelobaetidius* larvae to the generic level is **Easy** and **Fairly Easy** for the species within the genus that could occur in Wisconsin. No other genus in the Midwest has the spatulate claws of *Camelobaetidius*.

Larval Keys: Lugo-Ortiz and McCafferty (1995); McCafferty and Randolph (2000).

Key to the Species of *Camelobaetidius*

1. Labial palpi with pointed medial projection on second segment (Fig. 67a); procoxa never with osmobranchiae ..... ***C. waltzi***

Labial palpi with rounded medial projection on second segment (Fig. 67b); procoxa usually with osmobranchiae (Fig. 67c) ..... ***C. warreni***

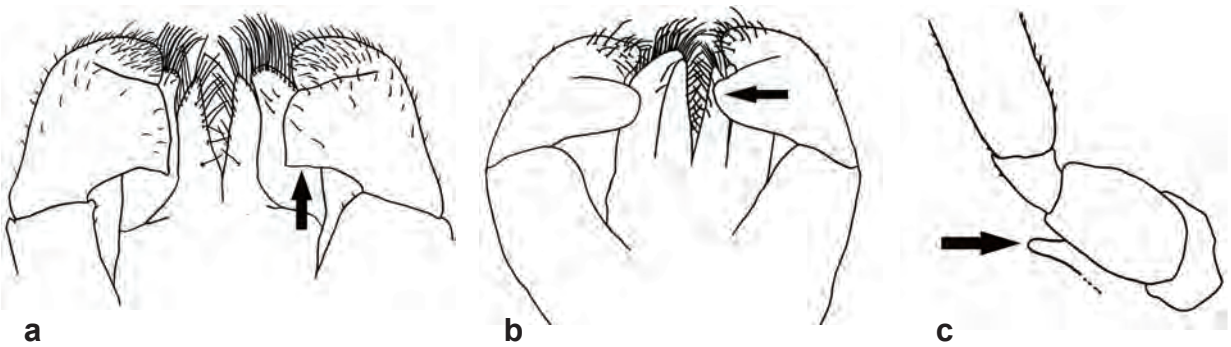


Figure 67. *Camelobaetidius* (Baetidae). **a,** *C. waltzi*, labium; **b,** *C. warreni*, labium; **c,** *C. warreni*, thoracic sterna showing osmobranchiae.

Camelobaetidius waltzi McCafferty, 1994 (Fig. 68)

Larval Description: McCafferty and Klubertanz (1994).

Determination: Identification of *C. waltzi* larvae in Wisconsin would be **Fairly Easy**. The spatulate tarsal claws (Fig. 19a), as with all members of the genus, easily can be seen using a dissecting microscope. It is the only member of the genus in North America with the second segment of the labial palpi bearing a pointed medial projection (Fig. 67a) and with only six to seven denticles on the tarsal claws (Fig. 19a) (Lugo-Ortiz and McCafferty 1995).

Previous Wisconsin Records: None. Closest records for *C. waltzi* are from southeastern Iowa, southeastern Illinois, and southwestern Indiana (McCafferty and Klubertanz 1994; Randolph and McCafferty 1998). It is possible in Wisconsin, particularly in the larger warm-water rivers of the southwestern portion of the state.

Biological Information: *Camelobaetidius waltzi* is known from both small and large rivers, in association with algal mats covering current-swept stones in riffle areas (Klubertanz and Jones 1999).

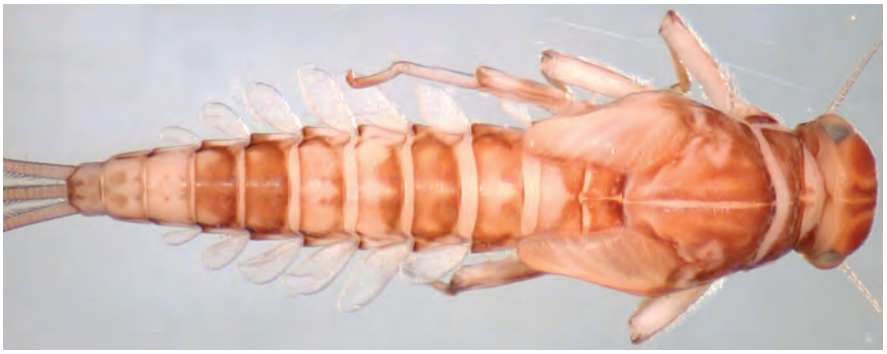


Figure 68. *Camelobaetidius waltzi,* larva.

Camelobaetidius warreni (Traver & Edmunds) 1968 (Fig. 69)

Taxonomic History: *Camelobaetidius cepheus* (Traver & Edmunds), 1968 (syn.); *Camelobaetidius navis* (Allen & Chao), 1978 (syn.); *Camelobaetidius similis* Lugo-Ortiz & McCafferty, 1995 (syn.); *Camelobaetidius trivialis* (Allen & Chao), 1978 (syn.); *Camelobaetidius warreni* (Traver & Edmunds), 1968 (curr. comb., McCafferty and Waltz 1990); *Camelobaetidius zenobia* (Traver & Edmunds), 1968 (syn.); *Dactylobaetis cepheus* Traver & Edmunds, 1968 (syn.); *Dactylobaetis navis* Allen & Chao, 1978 (syn.); *Dactylobaetis trivialis* Allen & Chao, 1978 (syn.); *Dactylobaetis warreni* Traver & Edmunds, 1968 (orig.); *Dactylobaetis zenobia* Traver & Edmunds, 1968 (syn.).

Larval Descriptions: Traver and Edmunds (1968), as *Dactylobaetis cepheus*, *D. warreni*, and *D. zenobia*; Allen and Chao (1978), as *D. navis* and *D. trivialis*; Lugo-Ortiz and McCafferty (1995), as *C. similis*.

Determination: Identification of *C. warreni* larvae in Wisconsin would be **Fairly Easy**.

Previous Wisconsin Records: None. Nearest records of *C. warreni* are from North and South Dakota (Guenther and McCafferty 2005). The species is not expected in Wisconsin, as it is not known east of the Great Plains.

Biological Information: None.

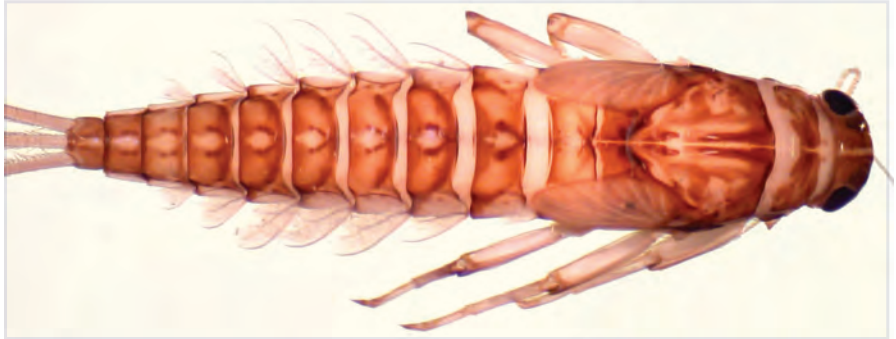


Figure 69. *Camelobaetidius warreni,* larva.

Cloeon

Comments: Only one species of *Cloeon* is known from North America, at least as defined by mayfly taxonomists in North America. Kluge and Novikova (1992) treated *Cloeon* as a much broader genus containing *Centroptilum, Procloeon*, *Pseudocentroptiloides,* and others as subgenera.

Determination: Determination of *Cloeon* larvae in Wisconsin is **Fairly Easy** for both the genus and the species within the genus.

Cloeon dipterum (Linnaeus), 1761 (Figs. 70 and 71)

Taxonomic History: *Chloeon dipterum* (Linnaeus), 1761 (comb.); *Cloe diptera* (Linnaeus), 1761 (comb.); *Cloeon cognatum* Stephens, 1835 (syn.); *Cloeon dipterum* (Linnaeus), 1761 (curr. comb., Leach 1815); *Cloeon inscriptum* Bengtsson, 1940 (syn.); *Cloeon pallida* Leach, 1815 (syn.); *Cloeopsis diptera* (Linnaeus), 1761 (comb.); *Ephemera diptera* Linnaeus, 1761 (orig.).

Larval Description: Elliott et al. (1988).

Determination: Identification of *C. dipterum* larvae is **Fairly Easy**. It is the only member of the genus in the Midwest. The oversized, bilamellate gills (Figs. 19d and 70) suggest *Callibaetis* or even a siphlonurid mayfly.

Previous Wisconsin Records: None, with the first state record given below. Nearest previous records of *C. dipterum* are from east-central Illinois and west-central Indiana (Randolph and McCafferty 1998) and Oakland County, Michigan (McCafferty et al. 2004). The record of *C. dipterum* from Crawford County, Michigan, in Leonard and Leonard (1962) was corrected to *Procloeon mendax* by Wiersema and McCafferty (2004).

New State Record: FLORENCE: 1L, VII-24-1990, vial 011011B (UW).

Biological Information: None. With no detail about sampling location given on the Florence County specimen, sampling should target this species to determine its habitat associations and status in Wisconsin.

Figure 70. *Cloeon dipterum,* larva.

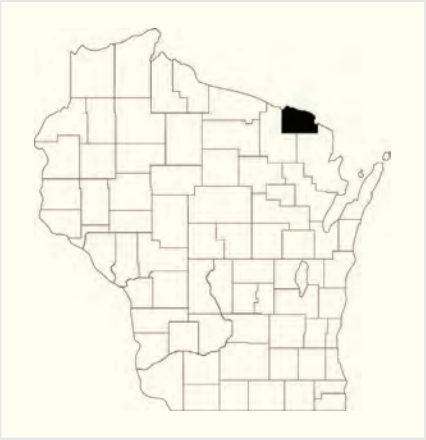


Figure 71. Wisconsin records of *Cloeon dipterum.*

Diphetor

Comments: The genus *Diphetor* is monotypic. Prior to Waltz and McCafferty (1987a), it was placed within *Baetis*.

Determination: Identification of *Diphetor* larvae is **Fairly Easy** for the genus.

Larval Keys: Bergman and Hilsenhoff (1978a), Morihara and McCafferty (1979b), and Hilsenhoff (1982), all as *Baetis*.

Diphetor hageni (Eaton), 1885 (Figs. 72 and 73)

Taxonomic History: *Baetis devinctus* Traver, 1935 (syn.); *Baetis hageni* Eaton, 1885 (renam.); *Baetis herodes* Burks, 1953 (syn.); *Baetis parvus* Dodds, 1923 (syn.); *Baetis unicolor* (Hagen), 1861 (hom. comb.); *Cloe unicolor* Hagen, 1861 (hom.: *C. unicolor* Curtis, 1834); *Diphetor devinctus* (Traver), 1935 (syn.); *Diphetor hageni* (Eaton), 1885 (curr. comb., Waltz and McCafferty 1987a).

Larval Descriptions: Ide (1930a), as *Baetis parvus*; Burks (1953), as *B. herodes*; Bergman and Hilsenhoff (1978a) and Morihara and McCafferty (1979b), both as *B. hageni*; Waltz and McCafferty (1987a).

Larval Habitus: Ide (1930a), as *Baetis parvus*; Bergman and Hilsenhoff (1978a) and Morihara and McCafferty (1979b), both as *B. hageni*.

Determination: Identification of *D. hageni* larvae is **Fairly Easy**. They closely resemble other baetids, including species of *Baetis*. Any baetid specimen lacking Gill I should be examined for other characters of *Diphetor*, such as the absence of a femoral villopore on the prothoracic leg and the absence of dark gill-attachment "scars" on the first abdominal tergum.

Previous Wisconsin Records: Bergman and Hilsenhoff (1978a), as *Baetis hageni*.

New County Records: DOOR: 20+ L, Sugar Crk., Sugar Crk. Co. Pk., 150 ft. upstream of mouth, 44.788302°N 87.660484°W, IX-21-2010, M. Gansberg (THK and UWSP); **KEWAUNEE:** 3L, Little Scarboro Crk., Co. Rd. A, 5 mi. SE. of Luxemburg, V-23-2010, THK (THK); **SAUK:** 1L, Hill Point Crk., St. Rd. 154 bridge, 43.424908°N 90.11233°W, X-16-2013, J. Unmuth (UWSP); **VERNON:** 6L, S. Jug Crk., 350 ft. upstream of confluence with Jug Crk., 43.625656°N 90.59052°W, XI-14-2013, K. Rasmussen (UWSP).

Status: *Diphetor hageni* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Bergman and Hilsenhoff (1978a, 1978c) considered it a rare species in Wisconsin, as it had been reported only from one stream in the state (Jericho Crk., Waukesha County). Records of specimens collected from 2010 to 2013 from Kewaunee (THK), Door, Sauk, and Vernon Counties (J. Dimick and the Aquatic Biomonitoring Laboratory at UW–Stevens Point) expand the known range of this species in the state. In addition, I collected one larva from Jericho Creek in Waukesha County on 31 May 2011. Though misidentifications of this species as *Baetis brunneicolor* or *B. tricaudatus* are possible, I am confident that this species is uncommon to rare in the state.

Biological Information: *Diphetor hageni* prefers small, well-oxygenated rocky streams (Hubbard and Peters 1978; Burian and Gibbs 1991). Within such streams, though, it is not selective in regards to water current (Ferro and Sites 2007). The specimen collected from Jericho Creek in Waukesha County in 2011 was taken in or just below an area of sluggish water created by a natural rock dam. The species' reported substrates range from moss-covered gravel and rubble (Bergman and Hilsenhoff 1978a) to coarse organic matter, especially leaf litter and woody debris (Burian and Gibbs 1991). Bergman and Hilsenhoff (1978a, 1978c) observed that males were not present in the Wisconsin populations they studied, and concluded that the species was an obligate parthenogenetic. Morihara and McCafferty (1979b) did, however, find males in other populations.

Figure 72. *Diphetor hageni,* larva.

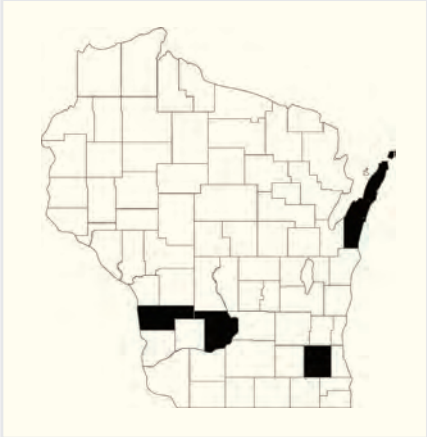


Figure 73. Wisconsin records of *Diphetor hageni.*

Fallceon

Comments: Six species of *Fallceon* are recognized from North America, with greatest diversity in the southwestern United States and in Mexico. There is one, wide-ranging species in the mid-continental area.

Determination: Identification of *Fallceon* larvae in Wisconsin is **Slightly Difficult**, though only one species in the genus is known from the Midwest.

Larval Keys: Morihara and McCafferty (1979b), as *Baetis*; Lugo-Ortiz et al. (1994).

Fallceon quilleri (Dodds), 1923 (Figs. 74 and 75)

Taxonomic History: *Baetis buenoi* Allen, 1985 (syn.); *Baetis byblis* Allen and Murvosh, 1983 (syn.); *Baetis cleptis* Burks, 1953 (syn.); *Baetis endymion* Traver, 1935 (syn.); *Baetis erebus* Traver, 1935 (syn.); *Baetis leechi* Day, 1954 (syn.); *Baetis quilleri* Dodds, 1923 (orig.); *Fallceon buenoi* (Allen), 1985 (syn.); *Fallceon byblis* (Allen and Murvosh), 1983 (syn.); *Fallceon quilleri* (Dodds), 1923 (curr. comb., Waltz and McCafferty 1987a).

Larval Description: Morihara and McCafferty (1979b), as *Baetis quilleri*.

Determination: Identification of *F. quilleri* larvae is **Slightly Difficult**. Preparation of a slide mount of the right mandible is recommended for any presumed *Baetis* that does not easily match any species in that genus. The right mandible of *F. quilleri* has a distinct patch of setae between the prostheca and the molar region (Fig. 21g). Tergal patterns change as larvae mature, becoming more darkly colored overall and usually with a pale mid-dorsal stripe on abdomen, thorax, and head. Larvae of *F. quilleri* are smaller and less robust than those of *B. intercalaris*.

Previous Wisconsin Records: None, with the first Wisconsin record given below. Nearest previous records of *F. quilleri* were from Iowa (Klubertanz 1995; McCafferty et al. 2003a), and eastern and north-central Illinois (Burks 1953; DeWalt et al. 1999). I am grateful to Jeffrey Dimick, University of Wisconsin–Stevens Point, who discovered this species in Wisconsin, sent specimens to me for examination, and provided the collection data given below.

New State Record: GRANT: 18L, Little Platte R., 30 m upstream of Oak Rd., 42.65259°N 90.60632°W, IX-30-2013, J. Amrhein, vial 050714C (THK and UWSP).

Biological Information: *Fallceon quilleri* is a common species of the Great Plains, and is one of the most frequently collected baetids in that region in a number of moderately silty or polluted streams (Liechti 1980; McCafferty et al. 2003a). It can be associated with a number of substrates, including vegetation and wood (Lager 1985). The Wisconsin site is along a fifth-order segment of the Little Platte River, a considerably degraded stream with occasional shoreline pasturing.

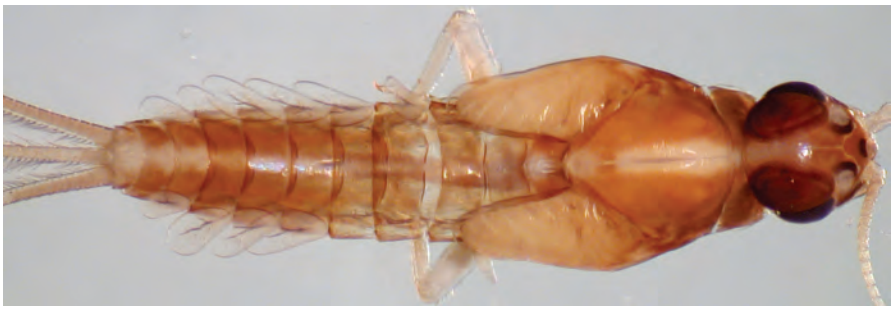


Figure 74. *Fallceon quilleri,* larva.

Figure 75. Wisconsin records of *Fallceon quilleri.*

Heterocloeon

Comments: There are six species of *Heterocloeon* known from North America. The genus contains species that previously were placed with other two-tailed baetids in *Acentrella*, *Baetis*, *Plauditus*, and *Rheobaetis*. Two species of *Heterocloeon* are known from Wisconsin.

Determination: Identification of *Heterocloeon* larvae is **Slightly Difficult** for both the genus and the species within the genus.

Larval Keys: Morihara and McCafferty (1979b) and Hilsenhoff (1982), both as *Baetis*.

Key to the Species of *Heterocloeon*

1. Procoxa with gill-like osmobranchiae (Fig. 20l); each claw with two well-developed rows of denticles (Fig. 76a); tibiae without specialized setae near dorsal margins . . . . . ***H. curiosum***

Procoxa without osmobranchiae; each claw with only one well-developed row of denticles and with a secondary ridge lacking denticles (Fig. 76b); each tibia with broadly spatulate setae on anterior surface and fimbriate setae on posterior surface near dorsal margin (Fig. 76c) . . . . . ***H. amplum***

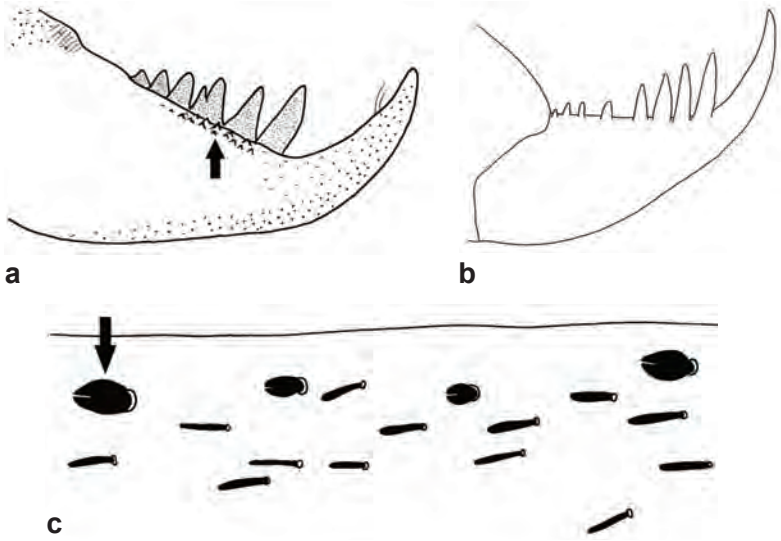


Figure 76. *Heterocloeon* (Baetidae). **a,** *H. curiosum,* claw; **b,** *H. amplum,* front claw (posterior); **c,** *H. amplum,* front tibia (posterior).

Heterocloeon amplum (Traver), 1932 (Figs. 77 and 78)

Taxonomic History: *Acentrella ampla* Traver, 1932 (orig.), *Baetis amplus* (Traver), 1932 (comb.); *Heterocloeon amplum* (Traver), 1932 (curr. comb., McCafferty et al. 2005).

Larval Descriptions: Traver (1932b), as *Acentrella ampla*; Morihara and McCafferty (1979b), as *Baetis amplus*; McCafferty et al. (2005).

Determination: Identification of *H. amplum* larvae is **Slightly Difficult**. Separation of *H. amplum* from *H. curiosum* is perhaps easier than separation of *H. amplum* from the current concept of *Acentrella*, because of the presence of osmobranchiae on the procoxae of *H. curiosum* (Fig. 20l).

Previous Wisconsin Records: Randolph and McCafferty (1998), as *Acentrella ampla.*

Biological Information: *Heterocloeon amplum* can be locally common (Randolph and McCafferty 1998), though it has not been reported from many sites in the southern half of Wisconsin. It most commonly occurs along erosional reaches of streams with swift current (Burian and Mack 1990; Burian and Gibbs 1991). Burian and Mack (1990) found this species associated with mats of *Fontinalis* algae on rocks.

Figure 77. *Heterocloeon amplum,* larva.

Figure 78. Wisconsin records of *Heterocloeon amplum.*

Heterocloeon curiosum (McDunnough), 1923 (Figs.79 and 80)

Taxonomic History: *Baetis curiosus* (McDunnough), 1923 (comb.), *Centroptilum curiosum* McDunnough, 1923 (orig.); *Heterocloeon curiosum* (McDunnough), 1923 (curr. comb., McDunnough 1925); *Rheobaetis traverae* Müller-Liebenau, 1974 (syn.).

Larval Descriptions: Müller-Liebenau (1974), as *Rheobaetis traverae*; McCafferty et al. (2005).

Determination: Identification of *H. curiosum* larvae is **Slightly Difficult**. Dorsal coloration, including a rich chocolate color common in fresh specimens, can be useful in field identification of the species. Not all specimens have osmobranchiae, so examination of claw dentition (Fig. 76a) is recommended.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Baetis curiosum*; Randolph and McCafferty (1998). Close examination of specimens in the University of Wisconsin–Madison collection apparently used as county records in Randolph and McCafferty (1998) reveal that many were incorrectly identified larvae of *Acentrella turbida*. Twelve county records of *H. curiosum* are now without verified specimens and herein removed (Bayfield, Iron, Marathon, Pierce, Portage, Price, Richland, Rusk, Shawano, Taylor, Vernon, and Waupaca Counties).

New County Records: DUNN: 1L, Chippewa R., 220th St. Landing, VII-9-2013, K. L. Schmude (UWS); **MARINETTE:** 1L, Peshtigo R., VI-26-1973 (UW); 5L, Peshtigo R., VI-6-1977 (UW); **ONEIDA:** 1L, Wolf R., Meister-Stockley Rd., 45.53194°N 89.11214°W, VI-9-2000; K. L. Schmude, C. Brennan, and J. Denninger (UWS); **PEPIN:** 5L, Chippewa R., Ella Boat Landing, VII-9-2013, K. L. Schmude (UWS); **SAWYER:** 7L, Flambeau R., River Rd., 45.82868°N 90.70914°W, VI-14-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **WASHBURN:** 1L, Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK).

Biological Information: *Heterocloeon curiosum* prefers streams with moderate to strong current (Müller-Liebenau 1974; Edmunds et al. 1976; Burian and Gibbs 1991). Edmunds et al. (1976) reported it most common on rocks with vascular plants *(Podostemon ceratophyllum* Michx.). Apparently, the species prefers being within crevices in rocks, or beneath larger rocks among smaller gravel (Edmunds et al. 1976; Burian and Gibbs 1991). As with *H. amplum*, it is absent in southern counties.

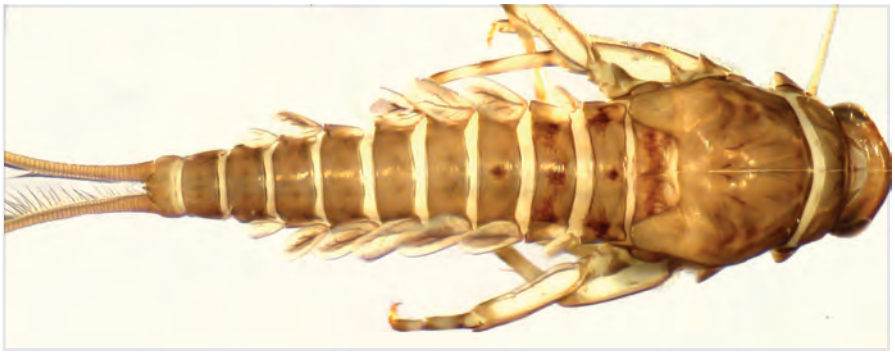


Figure 79. *Heterocloeon curiosum,* larva.

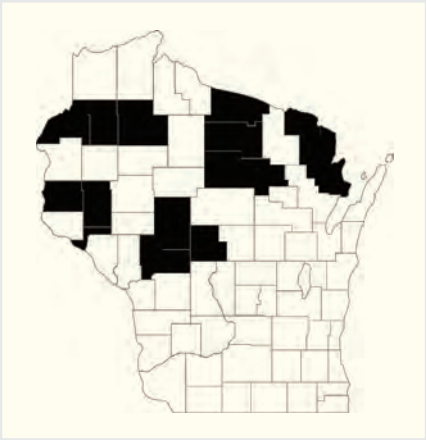


Figure 80. Wisconsin records of *Heterocloeon curiosum.*

Iswaeon

Comments: There are three species of *Iswaeon* in North America. Two of the three of these two-tailed baetids are not expected in Wisconsin. They are most similar, and closely related to, *Heterocloeon*. McCafferty et al. (2005) created *Iswaeon* as a subgenus of *Heterocloeon* based upon claw morphology and other characteristics. Guenther and McCafferty (2008) then elevated *Iswaeon* to the genus level.

Determination: Identification of *Iswaeon* larvae in Wisconsin is **Fairly Easy**. Only one species is known from the state.

Iswaeon anoka (Daggy), 1945 (Figs. 81 and 82)

Taxonomic History: *Heterocloeon anoka* (Daggy), 1945 (comb.); *Iswaeon anoka* (Daggy), 1945 (curr. comb., Guenther and McCafferty 2008); *Pseudocloeon anoka* Daggy, 1945 (orig.); *Pseudocloeon edmundsi* Jensen, 1969 (syn.).

Larval Descriptions: Daggy (1945) and Leonard and Leonard (1962), both as *Pseudocloeon anoka*; McCafferty et al. (2005), as *Heterocloeon anoka*.

Larval Habitus: Leonard and Leonard (1962), as *Pseudocloeon anoka*.

Determination: Identification of *I. anoka* larvae is **Fairly Easy**. They are most easily confused with larvae of *Plauditus punctiventris*. These two species formerly were synonymized, until McCafferty et al. (2005) recognized clear anatomical differences between them. In the case of *P. punctiventris*, each abdominal sternum can have a dark spot near the posterior margin of the segment (Fig. 100e). Only *I. anoka* can have a central spot on each abdominal sternum (Fig. 20h), though many specimens of the species lack any sternal markings whatsoever. Because sternal markings are highly variable in both *Iswaeon* and *Plauditus*, inspection of tibial shape of all larvae initially identified as *Plauditus* is recommended. The tibiae of *I. anoka* are broader and more robust (Fig. 20g) than in larvae of *Plauditus* (Fig. 20j).

Previous Wisconsin Records: McCafferty et al. (2005), as *Heterocloeon anoka*. Many of the larvae identified as *Plauditus punctiventris* in the University of Wisconsin–Madison collection, likely during the time when the two species were synonymized, are herein corrected to *I. anoka*. The majority of these are listed below as new county records for *I. anoka*.

New County Records: BARRON: 4L, Brill R., 29th Ave., 1.5 mi. N. of Brill, 45°37'28"N 91°40'38"W, VII-15-2011, THK (THK); 1L, Red Cedar R., X-27-1979 (UW); 11L, Red Cedar R., St. Rd. 48, 2 mi. NE. of Rice Lake, 45°31'49"N 91°42'11"W, VII-15-2011, THK (THK); 8L, Yellow R., X-27-1979 (UW); **BAYFIELD:** 1L, White R., VI-25-1973 (UW); **BURNETT:** 1L, St. Croix R., VIII-29-1988, K. L. Schmude (UW); 1L, St. Croix R., Co. Rd. O, Summer 1996 (WiDNR); 5L (including blackwing), St. Croix R., canoe landing on S. Markville Rd., 1000 ft. W. of St. Rd. 35 bridge, 46°4'26"N 92°15'3"W, VII-13-2011, THK (THK); 4L, Trade R., VI-20-1974 (UW); 1L, Wood R., VIII-26-1974 (UW); **CLARK:** 1L, Poplar R., VIII-30-1973 (UW); **DANE:** 31L in nine vials, Sugar R., dates from VII-30-1984 to X-2-1985 (UW); 1L, W. Branch Sugar R., Co. Rd. PB, 1.6 mi. NW. of Belleville, 42°52'45"N 89°33'32"W, VIII-8-2011, THK, E. Wolf, and C. Brown (THK); **DOUGLAS:** 1L, St. Croix R., X-20-1979 (UW); **DUNN:** 1L, Eau Galle R., VI-18-1973 (UW); **FLORENCE:** 1L, Pine R., IX-12-1967 (UW); 5L in two vials, Popple R., VI-28-1967 and IX-13-1967 (UW); **GRANT:** 1L, Platte R., Bridge on Co. Rd. B, 2 mi. E. of Rockville, T3NR2W S17, VI-3-2011, THK, E. Wolf, and C. Brown (THK); **GREEN:** 1L, Allen Crk., Co. Rd. E, 1.75 mi. NNE. of Albany, 42°44'9"N 89°25'57"W, VIII-8-2011, THK, E. Wolf, and C. Brown (THK); **JEFFERSON:** 2L, Duck Crk., VI-9-1975 (UW); **KEWAUNEE:** 16L, Kewaunee R., VI-4-1979 (UW); 3L, E. Twin R., V-29-1979 (UW); **LANGLADE:** 4L, E. Branch Eau Claire R., X-18-1979 (UW); 1L, W. Branch Eau Claire R., X-17-1979 (UW); **LINCOLN:** 2L, Wisconsin R., X-18-1979 (UW); **MANITOWOC:** 30L, E. Twin R., V-29-1979 (UW); 25L, Manitowoc R., V-22-1979 (UW); **MARATHON:** 8L, Eau Claire R., X-17-1979 (UW); 1L, Little Rib R., X-25-1979 (UW); 1L, Spring Brk., X-17-1979 (UW); **MARINETTE:** 2L in two vials, Menominee R., Co. Rd. Z, T36NR22E S20, VI-25-1996 (WiDNR); **MARQUETTE:** 3L, Mecan R., VI-25-1973 (UW); **OCONTO:** 1L, Little R., VI-12-1980 (UW); 13L, Oconto R., V-23-1980 (UW); **ONEIDA:** 1L, Tomahawk R., X-15-1979 (UW); **POLK:** 13L, McKenzie Crk., VI-18-1973 and IX-6-1972 (UW); 1L, St. Croix R., Sunrise, Summer 1996 (WiDNR); **PRICE:** 20L in three vials, S. Fork Flambeau R., St. Rd. 13, T39NR1E S18, VI-24-1998, R. A. Lillie (WiDNR); **RICHLAND:** 3L, Pine R., VI-17-1974 and IX-21-1973 (UW); **ROCK:** 3L, Badfish Crk., X-30-1985 and XI-13-1985 (UW); 2L, Turtle Crk., Carver's Rock Rd., 2.5 mi. NE. of Clinton, T2NR14E S27, VIII-5-2011, THK, C. Brown, and E. Wolf (THK); 5L in two vials, Turtle Crk., Lather's Rd., Shopiere, T2NR13E S9, VIII-27-1999, THK and VI-6-2011, THK, C. Brown, and E. Wolf (THK); 1L, Turtle Crk.,

Smith Rd., VIII-27-1999, THK (THK); 3L, Turtle Crk., Sweet Allyn Park on Belding Rd. in Shopiere, T1NR13E S3, VI-6-2011, THK, C. Brown, and E. Wolf (THK); **RUSK:** 2L in two vials, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998, R. A. Lillie (WiDNR); 1L, Flambeau R., Washington, T33NR7W S22, VI-19-1997 (WiDNR); **SAWYER:** 2L, Flambeau R., Oxbo Rd., T39NR3W S14, VI-18-1997 (WiDNR); **SHAWANO:** 1L, Red R., VI-5-1979 (UW); **SHEBOYGAN:** 1L, Sheboygan R., IX-11-1973 (UW); 1L, Mullet R., VIII-18-1972 (UW); **ST. CROIX:** 1L, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); 1L, Willow R., Co. Rd. E, ½ mi. NW. of Dry Dam Lk., 45°2'10"N 92°38'20"W, VII-12-2011, THK (THK); **VERNON:** 6L, N. Fork Bad Axe R., XI-8-1979 (UW); **VILAS:** 1L, Wisconsin R., X-15-1979 (UW); **WALWORTH:** 4L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VII-20-2000, THK (THK); **WAUPACA:** 1L, Little Wolf R., VI-6-1969 (UW); 1L, S. Branch Pigeon R., V-22-1980 (UW); 3L, Waupaca R., VI-4-1980 (UW); **WASHBURN:** 4L, Brill R., 29th Ave., 1.5 mi. N. of Brill, 45°37'28"N 91°40'38"W, VII-15-2011, THK (THK); 4L, Brill R., Bridge Rd., 2.5 mi. N. of Brill, 45°38'21"N 91°40'27"W, VII-15-2011, THK (THK); 3L, Namekagon R., VI-19-1973 (UW); **WAUSHARA:** 6L, Mecan R., X-23-1985 and VIII-30-1972 (UW); 1L, Pine R., XI-8-1979 (UW); **WOOD:** 1L, Yellow R., VIII-30-1973 (UW).

Biological Information: Little to no information has been published regarding the biology of *I. anoka*. In Wisconsin, it usually is associated with riffles with moderate current in third- to fifth-order streams and rivers. Leonard and Leonard (1962) reported it from shallow riffles with gravel substrates and along stream margins in Michigan.

Figure 81. *Iswaeon anoka,* larva.

Figure 82. Wisconsin records of *Iswaeon anoka*.

Labiobaetis

Comments: In North America, *Labiobaetis* includes a discrete group of species that was in *Baetis* for many years and was known as the *propinquus* group. They were moved to *Labiobaetis* by McCafferty and Waltz (1995). Lugo-Ortiz et al. (1999), based upon adult morphology, reassigned the *propinquus* group to *Pseudocloeon* Klapalek, a name once applied to many of the two-tailed baetids in North America (now in *Acentrella*, *Plauditus*, and several other genera). This was a controversial placement since the larvae of *P. kraepelini* Klapalek, the type species of *Pseudocloeon*, are not known. McCafferty et al. (2010), without explanation, resumed the use of *Labiobaetis* for the *propinquus* group. This is the current generic placement of these species on Mayfly Central (Anonymous 2014a) and in this text. The use of *Labiobaetis* in this context also follows the conservative approach of Kubendran et al. (2014). Proper identification of *Labiobaetis* species in the *propinquus* group can be challenging, involving slide mounting of mouthparts. Four of the five species are known from Wisconsin.

Determination: Identification of *Labiobaetis* larvae is **Slightly Difficult** for the genus, and **Slightly to Moderately Difficult** for identification of species within the genus. *Labiobaetis* larvae are larger and more robust than in most species of *Baetis*. Identification of the genus requires good magnification with a dissecting microscope to detect the subapical constriction of the maxillary palpi (Fig. 21b), or examination of a slide mount of an antenna to detect a notch along the distal margin of the scape (Fig. 21a). The structure of the labral setae is most commonly used for species determination.

Larval Keys: Traver (1935), Burks (1953), Bergman and Hilsenhoff (1978a), Morihara and McCafferty (1979b), Soluk (1981), and Hilsenhoff (1982), all as *Baetis*; McCafferty and Waltz (1995).

Key to the Species of *Labiobaetis*

1. Labrum with dense dorsal setation, especially in distal third (Fig. 83a); labial palpus with second segment not expanded medially, appearing narrow and elongate (Fig. 83b) . . . . . ***L. longipalpus***

Labrum with moderate number of setae evenly distributed over dorsal surface (Fig. 8k) or with submarginal dorsal setae differing in structure from other setae (Fig. 83e); labial palpus with second segment expanded medially (Fig. 83c) **2**

2. Labrum with submarginal dorsal setae terminating in numerous spiny projections, appearing branched (Fig. 83e); medial surface of maxillary palpus usually abruptly and strongly narrowed at tip (Fig. 83f). **3**

Labrum with submarginal dorsal setae simple (Fig. 8k) or slightly spatulate (Fig. 83h); medial surface of maxillary palpus with less distinctive narrowing at tip (Fig. 83d) **4**

3. Right mandible with abrupt prominence between incisor and molar region (Fig. 83g). . . . . ***L. ephippiatus***

Right mandible with only a rounded projection between incisor and molar region (Fig. 83i) . . . . . ***L. dardanus***

4. Labrum with spatulate dorsal submarginal setae arranged as in Fig. 83h . . . . . ***L. frondalis***

Labrum with simple dorsal submarginal setae arranged as in Fig. 8k . . . . . ***L. propinquus***

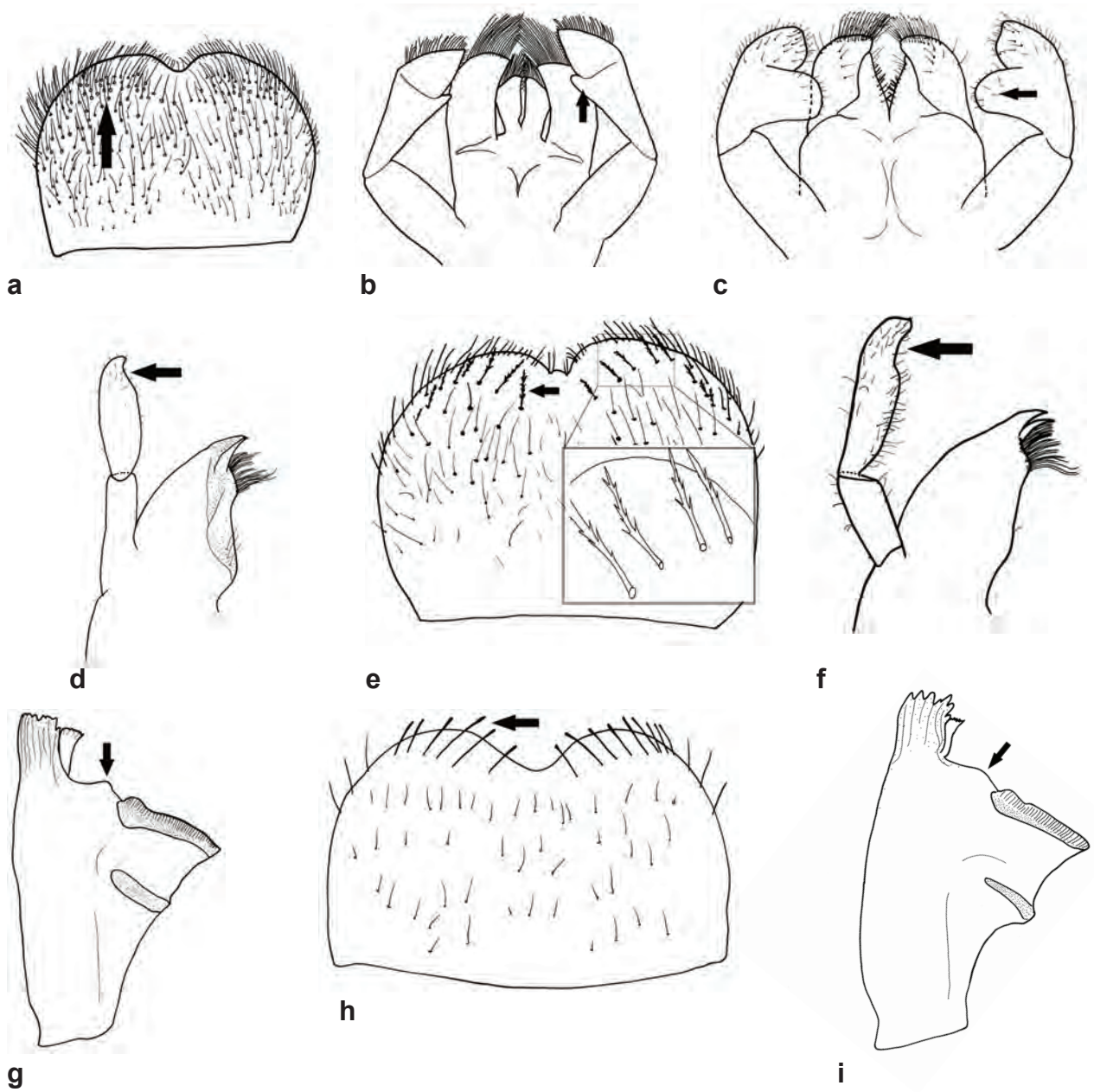


Figure 83. *Labiobaetis* (Baetidae). **a,** *L. longipalpus,* labrum (dorsal); **b,** *L. longipalpus,* labium (ventral); **c,** *L. propinquus,* labium (ventral); **d,** *L. propinquus,* maxilla (ventral); **e,** *L. ephippiatus,* labrum (dorsal); **f,** *L. ephippiatus,* maxilla (ventral); **g,** *L. ephippiatus,* mandible (right, ventral); **h,** *L. frondalis,* labrum (dorsal); **i,** *L. dardanus,* mandible (right, ventral).

Labiobaetis dardanus (McDunnough), 1923 (Figs. 84 and 85)

Taxonomic History: *Baetis dardanus* McDunnough, 1923 (orig.); *Baetis elachistus* Burks, 1953 (syn.); *Labiobaetis dardanus* (McDunnough), 1923 (curr. comb. sensu McCafferty and Waltz 1995); *Pseudocloeon dardanum* (McDunnough), 1923 (comb.).

Larval Descriptions: Soluk 1981, as *Baetis dardanus*.

Larval Habitus: Bergman and Hilsenhoff (1978a), as *Baetis propinquus*; Soluk (1981), as *B. dardanus*.

Determination: Identification of *L. dardanus* larvae is **Moderately Difficult**. Field determination is virtually impossible, as dissection of mouthparts is required. The species structurally is most similar to *L. ephippiatus*, but has a rounded protuberance between the incisor and molar regions of the right mandible (Fig. 83i).

Previous Wisconsin Records: Lillie (1995), misidentified as *Baetis caelestis* Allen & Murvosh (Randolph and McCafferty 1998). Bergman and Hilsenhoff (1978a) reported and described larvae of *B. propinquus* from Wisconsin. These larvae were corrected to *B. longipalpus* by Morihara and McCafferty (1979a). Soluk (1981) subsequently corrected the same larvae to *B. dardanus*.

New County Records: BURNETT: 1L, St. Croix R., canoe landing on S. Markville Rd., 1000 ft. W. of St. Rd. 35 bridge, 46°4'26"N 92°15'3"W, VII-13-2011, THK (THK); **COLUMBIA:** 1L, Wisconsin R., Levee Rd., Pine Island Wildl. Area, 43°32'35"N 89°34'57"W, VII-26-2011, THK (THK); **POLK:** 1L, St. Croix R., Nevers Landing, 1 mi. S. of Wolf Creek, 45°32'10"N 92°43'25"W, VII-13-2011, THK (THK); **RICHLAND:** Wisconsin R., Gotham, IX-28-1986, R. A. Lillie, (UW); **SAUK:** 1L, Wisconsin R., St. Rd. 130/133 bridge, 43°9'55"N 90°11'34"W, VII-26-2011, THK (THK).

Status: *Labiobaetis dardanus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List, as *Pseudocloeon dardanum* (Anonymous 2014b).

Biological Information: Very little biological information has been published for *L. dardanus.* In Wisconsin, Iowa, and Nebraska, I have found it most commonly in medium to large rivers.

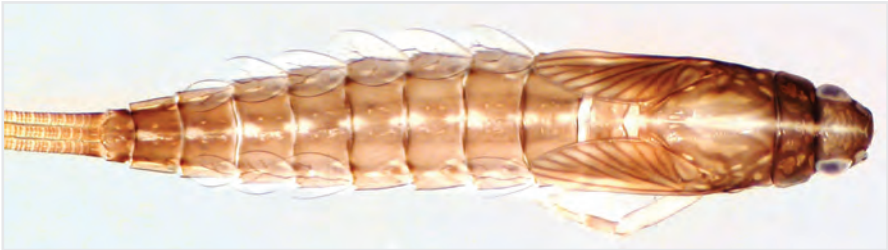


Figure 84. *Labiobaetis dardanus,* larva.

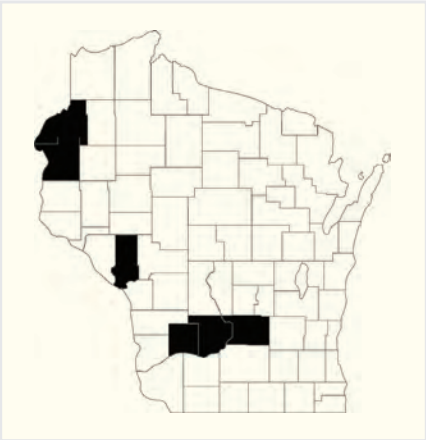


Figure 85. Wisconsin records of *Labiobaetis dardanus.*

Labiobaetis ephippiatus (Traver), 1935 (Figs. 86 and 87)

Taxonomic History: *Acentrella ephippiatus* (Traver), 1935 (comb.); *Baetis ephippiatus* Traver, 1935 (orig.); *Labiobaetis ephippiatus* (Traver), 1935 (curr. comb. sensu McCafferty and Waltz 1995); *Pseudocloeon ephippiatum* (Traver), 1935 (comb.).

Larval Descriptions: Berner (1940), as *Acentrella ephippiatus*; Morihara and McCafferty (1979a,b), as *Baetis ephippiatus*.

Determination: Identification of *L. ephippiatus* larvae is **Moderately Difficult**. Mature larvae taken from the Sugar River in extreme northern Illinois were darkly colored, as shown in Fig. 86. Slightly less mature larvae have abdominal terga II and V–VI distinctly darker than other terga. Abdominal sterna I–VII each has a dark, median spot on anterior margin, suggestive of *Plauditus punctiventris*. In very young larvae, the only remaining dark coloration on the terga is a median spot on abdominal tergum II, suggestive of *Paracloeodes minutus*, while the sternal markings are similar to those of more mature larvae. Though these notes on the coloration of *L. ephippiatus* may assist in sorting, dissection of mouthparts is required for reliable identification. The right mandible bears a more sharp and angular projection between the incisor and molar regions (Fig. 83g) than in larvae of *L. dardanus* (Fig. 83i). The angle of view is important, being best from an awkward, unnatural angle. The mandible often will not lie in a suitable position in a permanent slide mount, making a wet mount more desirable. The dissected mandible should be retained with the specimen in a microvial.

Previous Wisconsin Records: None, with the first Wisconsin records given below. Closest records of *L. ephippiatus* were from northwestern Indiana (Randolph and McCafferty 1998) and in the Sugar River in extreme northern Illinois (Klubertanz and Hess 2001). It is likely that other populations in Wisconsin have been overlooked.

New Wisconsin Records: COLUMBIA: 1L, Wisconsin R., Levee Rd., Pine Island Wildl. Area, 43°32'35"N 89°34'57"W, VII-26-2011, THK (THK); **GREEN:** 2L, Sugar R., Co. Rd. C, 0.2 mi. E. of Attica, 42°46'12"N 89°28'35"W, VIII-8-2011, THK, E. Wolf, and C. Brown (THK); **JACKSON:** 2L, Black R., River Rd. Canoe Launch, VII-11-2013, K. L. Schmude (UWS); **LA CROSSE:** 2L, Black R., St. Rd. 35, N. side of Rd., VII-10-2013, K. L. Schmude (UWS); **PEPIN:** 1L, Chippewa R., St. Rd. 35, W. side, VII-10-2013, K. L. Schmude (UWS).

Biological Information: *Labiobaetis ephippiatus* is known from a variety of stream sizes in Kansas, including small, intermittent streams to large rivers (Liechti 1980). Berner and Pescador (1988) described the habitat of this species in Florida as sand-bottomed stream margins, where larvae cling to vegetation. It also has been reported from woody debris (Berner 1950; Lager 1985).

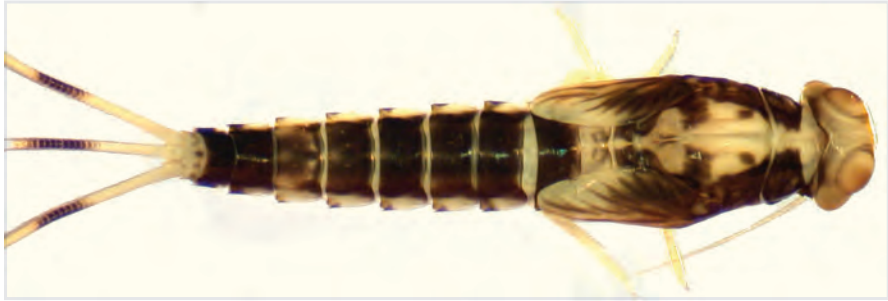


Figure 86. *Labiobaetis ephippiatus,* larva.

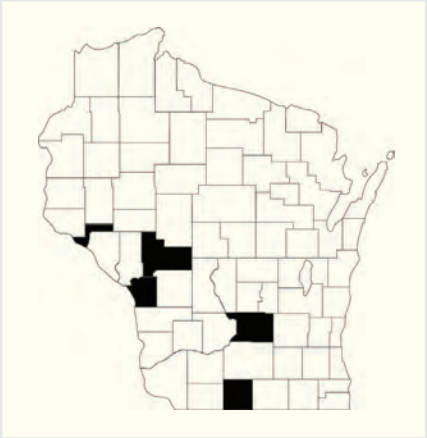


Figure 87. Wisconsin records of *Labiobaetis ephippiatus.*

Labiobaetis frondalis (McDunnough), 1925 (Figs. 88 and 89)

Taxonomic History: *Baetis australis* Traver, 1932 (syn.); *Baetis baeticatus* Burks, 1953 (syn.); *Baetis frondalis* McDunnough, 1925 (orig.); *Labiobaetis frondalis* (McDunnough), 1925 (curr. comb. sensu McCafferty and Waltz 1995); *Pseudocloeon frondale* (McDunnough), 1925 (comb.).

Larval Descriptions and Habitus: Bergman and Hilsenhoff (1978a) and Morihara and McCafferty (1979a,b), both as *Baetis frondalis*.

Determination: Identification of *L. frondalis* larvae is **Moderately Difficult**. They are easily misidentified as the more common *L. propinquus* unless a slide mount of the labrum is made. Dorsal submarginal setae of the labrum are only slightly spatulate in *L. frondalis* (Fig. 83h) and easily misinterpreted. In *L. frondalis*, these setae are more evenly spaced than in larvae of *L. propinquus* (Fig. 8k).

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Baetis frondalis*; Randolph and McCafferty (1998).

New County Records: SAUK: 1L, Otter Crk., St. Rd. 60, 2.5 mi. W. of Sauk City, 43°16'16"N 89°47'5"W, VII-26-2011, THK (THK).

Biological Information: *Labiobaetis frondalis* is a common species of depositional areas and backwaters of small streams and rivers, where silt or sand is on the bottom (Berner 1950; Bergman and Hilsenhoff 1978a; Berner and Pescador 1988). It is widespread in Wisconsin and is second in abundance in the genus to *L. propinquus*. Burian and Gibbs (1991) reported *L. frondalis* as most common on submerged, long-leafed vegetation and on the stems and leaves of rushes and sedges.

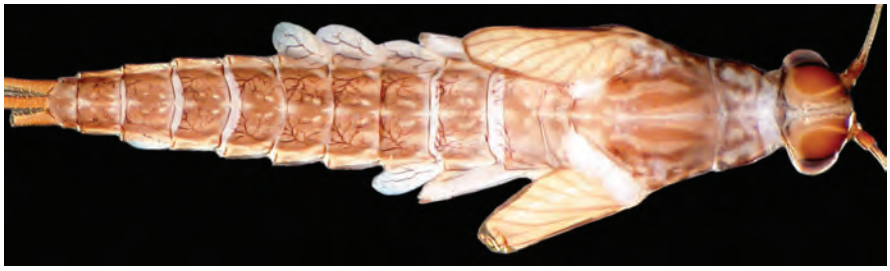


Figure 88. *Labiobaetis frondalis,* larva.

Figure 89. Wisconsin records of *Labiobaetis frondalis.*

Labiobaetis longipalpus (Morihara & McCafferty), 1979 (Figs. 90 and 91)

Taxonomic History: *Baetis longipalpus* Morihara and McCafferty, 1979 (orig.); *Labiobaetis longipalpus* (Morihara and McCafferty), 1979 (curr. comb. sensu McCafferty and Waltz 1995); *Pseudocloeon longipalpus* (Morihara and McCafferty), 1979 (comb.).

Larval Description and Habitus: Morihara and McCafferty (1979a,b), both as *Baetis longipalpus*.

Determination: Identification of *L. longipalpus* larvae is **Slightly Difficult**. They have the combination of dense setation of the labrum (Fig. 83a), narrow shape of the labial palpi (Fig. 83b), and distinct dorsal coloration. The species is the only member of the genus that readily can be identified without slide mounts. Some larvae of *L. longipalpus* are similar in dorsal coloration to *Acerpenna macdunnoughi*.

Previous Wisconsin Records: Morihara and McCafferty (1979b), as *Baetis longipalpus*; Randolph and McCafferty (1998). Bergman and Hilsenhoff (1978a) reported and described larvae of *B. propinquus* from Wisconsin. These larvae were corrected to *B. longipalpus* by Morihara and McCafferty (1979a). Soluk (1981) corrected the same larvae to *B. dardanus*.

Status: *Labiobaetis longipalpus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List, as *Pseudocloeon longipalpus* (Anonymous 2014b). It is known in the state only from the Wisconsin and Black Rivers.

Biological Information: *Labiobaetis longipalpus* occurs in larger rivers, in stronger currents, and in deeper waters than other members of the genus (Morihara and McCafferty 1979b; Lillie and Hilsenhoff 1992; Klubertanz 1995). Klubertanz (1995) reported it from large stones and logs in deep riffles in Iowa, while Liechti (1980) reported it from various debris piles in a sandy river in Kansas.

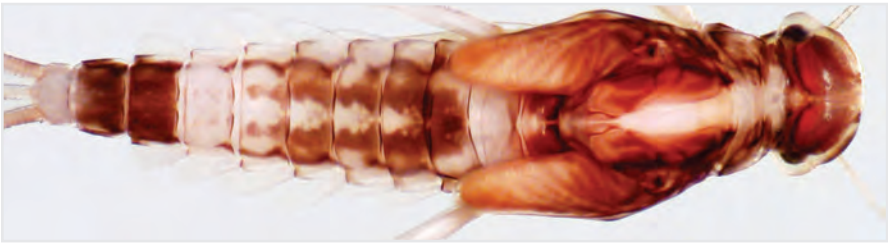


Figure 90. *Labiobaetis longipalpus,* larva.

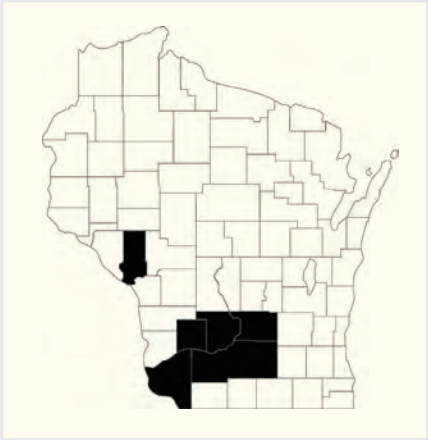


Figure 91. Wisconsin records of *Labiobaetis longipalpus.*

Labiobaetis propinquus (Walsh), 1863 (Figs. 92 and 93)

Taxonomic History: *Acentrella propinquus* (Walsh), 1863 (comb.); *Baetis propinquus* (Walsh), 1863 (comb.); *Baetis spinosus* McDunnough, 1925 (syn.); *Cloe propinqua* Walsh, 1863 (renam.); *Cloe vicina* Walsh, 1862 (hom. *C. vicina* Hagen, 1861); *Labiobaetis propinquus* (Walsh), 1863 (curr. comb. sensu McCafferty and Waltz 1995); *Pseudocloeon propinquum* (Walsh), 1863 (comb.).

Larval Descriptions and Habitus: Clemens (1913, 1915c), as *Baetis propinquus*; Bergman and Hilsenhoff (1978a), as *B. spinosus*; Morihara and McCafferty (1979a,b), as *B. propinquus*.

Determination: Identification of *L. propinquus* larvae is **Moderately Difficult**. They are larger and more robust than most stream baetids, but are not easily separated from other species in the genus. Preparation of slide mounts of mouthparts is required for proper identification. In *L. propinquus*, the dorsal submarginal setae of the labrum are fewer in number than in *L. frondalis*, with clear and consistent submedian gaps (Fig. 8k).

Previous Wisconsin Records: Shapas and Hilsenhoff (1976), as *Baetis spinosus*; Bergman and Hilsenhoff (1978a), as *B. spinosus*; Lillie and Hilsenhoff (1992), as *B. propinquus*; Hilsenhoff (1996); Randolph and McCafferty (1998). Bergman and Hilsenhoff (1978a) reported and described larvae of *B. propinquus* from Wisconsin. These larvae were corrected to *B. longipalpus* by Morihara and McCafferty (1979a). Soluk (1981) corrected the same larvae to *B. dardanus*.

New County Records: BARRON: 2L, Brill R., 29th Ave., 1.5 mi. N. of Brill, 45°37'28"N 91°40'38"W, VII-15-2011, THK (THK); 1L, Red Cedar R., St. Rd. 48, 2 mi. NE. of Rice Lake, 45°31'49"N 91°42'11"W, VII-15-2011, THK (THK); **WALWORTH:** 1L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VIII-4-2000, THK (THK); 2L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VI-23-2011, THK, C. Brown, and E. Wolf (THK); 4L, Turtle Crk., School Section Rd., T2NR15E S15, VI-23-2011, THK, C. Brown, and E. Wolf (THK); **WASHBURN:** 1L, Brill R., Bridge Rd., 2.5 mi. N. of Brill, 45°38'21"N 91°40'27"W, VII-15-2011, THK (THK); 2L, Hay Crk., Hamilton Rd., 0.6 mi. NW. of Springbrook, 45°57'27"N 91°41'29"W, VII-15-2011, THK (THK); 1L, Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK); 11L, Namekagon R., Stinnett Landing on Stinnett Landing Rd., 45°59'9"N 91°35'34"W, VII-15-2011, THK (THK); **WINNEBAGO:** 1L, Fish Trap Pond (likely in Rush Crk.), T18NR14E S36, IX-17-2007, J. Meyer (UWO).

Biological Information: Lillie and Hilsenhoff (1992) found larvae of *L. propinquus* abundant in the lower Wisconsin River, on a variety of substrates in shorelines and shallows. Likewise, I have found it as the dominant baetid at a number of sites. Bergman and Hilsenhoff (1978a), however, considered it uncommon overall in Wisconsin. It can be associated with plants, logs, and rubble, particularly in stream backwaters (Bergman and Hilsenhoff 1978a; Burian and Gibbs 1991).

Figure 92. *Labiobaetis propinquus,* larva.

Figure 93. Wisconsin records of *Labiobaetis propinquus.*

Neocloeon

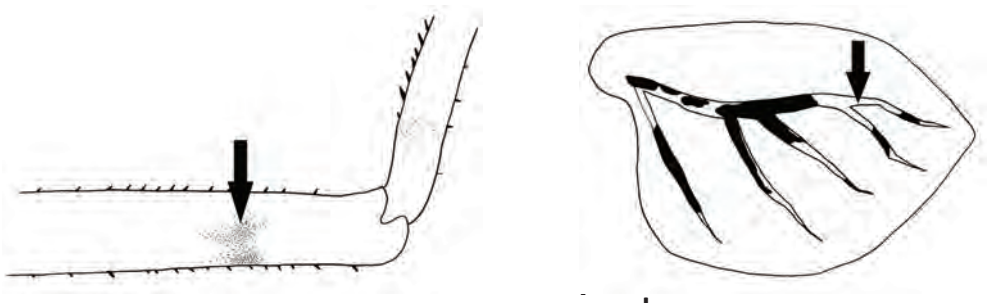
Comments: The two recognized species of North American *Neocloeon* most recently were included in *Centroptilum*. Kluge (2011) and Jacobus and Wiersema (2014) reassigned all of the North American species of *Centroptilum* to *Neocloeon* and *Anafroptilum*. *Centroptilum* is now restricted to Old World species.

Determination: Identification of *Neocloeon* larvae is **Slightly Difficult** for the genus and **Difficult** for the species within the genus. Larvae of the two North American species lack metathoracic wingpads, unlike almost all *Anafroptilum*. In *Neocloeon*, the third segment of the maxillary palpi is long, sharply tipped, and weakly separated from the second segment. In contrast to most Wisconsin species of *Anafroptilum*, the abdominal terga of *Neocloeon* have spines along the lateral margin that are sufficiently robust to also suggest *Procloeon*.

Key to the Species of *Neocloeon*

1. Each femur of fresh specimens with a dark band extending from dorsal margin at two-thirds length (Fig. 94a); gill tracheation interrupted by a white band at two-thirds length (Fig. 94b); males never present . . . . . ***N. triangulifer***

Each femur unbanded or with an indistinctly shaded band extending from dorsal margin at two-thirds length; gill tracheation uninterrupted in distal half of gills; males usually present in populations . . . . . ***N. alamance***



a **b**

Figure 94. *Neocloeon* (Baetidae). **a,** *N. triangulifer,* hind femur (posterior); **b,** *N. triangulifer,* gill.

Neocloeon alamance Traver, 1932 (Fig. 95)

Taxonomic History: *Centroptilum alamance* (Traver), 1932 (comb.); *Cloeon alamance* (Traver), 1932 (comb.); *Neocloeon alamance* Traver, 1932 (orig., curr. comb. Jacobus and Wiersema 2014).

Larval Description: Traver (1932a); Funk et al. (2006), as *Centroptilum alamance*.

Larval Habitus: Traver (1932a, 1932b, 1935).

Determination: Identification of *N. alamance* larvae is **Difficult**. Faded specimens can be particularly hard to identify, as no structural characters separate *N. alamance* from *N. triangulifer* (Jacobus and Wiersema 2014).

Previous Wisconsin Records: Hilsenhoff et al. (1972); Randolph and McCafferty (1998), as *Centroptilum alamance*.

Status: Published records of *N. alamance* are only from Florence and Forest Counties in northeastern Wisconsin. There are unverified reports from the Wisconsin Department of Natural Resources that this species also occurs in several other far northern counties of the state.

Biological Information: In contrast to *N. triangulifer*, parthenogenesis is not obligatory and males of *N. alamance* may be present within a given population. There are no previously published details regarding the habitat associations of this species.

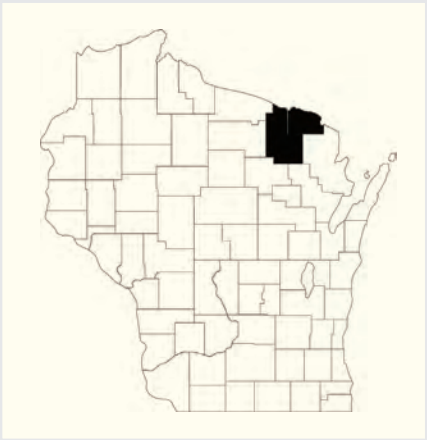


Figure 95. Wisconsin records of *Neocloeon alamance.*

Neocloeon triangulifer (McDunnough), 1931 (Figs. 96 and 97)

Taxonomic History: *Centroptilum* sp. 1 McCafferty and Davis, 1992 (syn.); *Centroptilum triangulifer* (McDunnough), 1931 (comb.); *Cloeon triangulifer* McDunnough, 1931 (orig.); *Neocloeon triangulifer* (McDunnough), 1931 (curr. comb., Jacobus and Wiersema 2014).

Larval Description: Funk et al. (2006), as *Centroptilum triangulifer*.

Determination: Identification of *N. triangulifer* larvae is **Difficult**. They are very similar to larvae of *N. alamance*. Though color differences traditionally have been used to separate the species, there are no known morphological differences (Jacobus and Wiersema 2014). Separation of the two species usually requires fresh, unfaded specimens. In most Wisconsin specimens I have examined, the anterior margin of the ninth abdominal sternum has a transverse, dark band. The band is much less well-defined than similar marks found on larvae of *Procloeon viridoculare* (Fig. 111f), *P. fragile*, or *Pseudocentroptiloides*. The remaining sterna of these specimens are entirely white or have barely evident speckles in posterior half of each segment. Such specimens are consistent in having lateral spines on the third abdominal tergum and usually have at least one such spine on the second tergum. In much rarer specimens, the abdominal sterna are much more patterned throughout. They lack the transverse mark on the anterior margin of the ninth segment. Instead, they have well-defined submedial spots in the anterior quarter of each sternum and many speckles throughout each sternum. This pattern is suggestive of *Anafroptilum* sp. A, except for having more circular submedian spots on the sterna and, of course, lacking metathoracic wingpads. The pattern occurs in both immature and mature (blackwing) larvae. Interestingly, all larvae of this form I have observed lack lateral spines on abdominal terga II and III. Such larvae have been found in both northern (Lincoln and Burnett Counties) and southern (Sauk) Wisconsin. Both of these forms tentatively identified as *N. triangulifer* have distinct bands near the distal ends of the femora in contrast to *N. alamance*. No other differences between these forms have been found, so it is not known whether they are separate species or simply variations of *N. triangulifer*.

Previous Wisconsin Records: McCafferty et al. (2004).

New County Records: LINCOLN: 1L, Devil Crk., upstream 20 m from Highland Dr., 45.13443°N 89.84708°W, X-6-2011, H. Yang (UWSP); **MARATHON:** 1L, Silver Crk., upstream 17 m from 72nd Ave., 45.07773°N 89.72725°W, X-5-2011,

H. Yang (UWSP); **ROCK:** 2L, Turtle Crk., Smith Rd., between Shopiere and Tiffany, VII-27-1999, THK and C. Hess (THK); **RUSK:** 2L, Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998 (WiDNR); 1L, Hay Crk., Singer Rd., site "Chipr 7220", 45.479244°N 91.380158°W, Summer 2012, K. L. Schmude (UWS); **SAUK:** 1L, Otter Crk., Baxter's Hollow, Stone's Pocket Rd., VII-31-2007, THK (THK); **SAWYER:** 1L, Flambeau R., Hervas, T37N R4W S35, VI-19-1997 (WiDNR); 2L, Flambeau R., Oxbo Rd., 39NR3W S14, VI-18-1997 (WiDNR); **VILAS:** 1L, Haymeadow Crk., X-17-1968 (UW); 1L, Wisconsin R., upstream 50 m from Co. Rd. K, 46.04779°N 89.26578°W, X-17-2011, H. Yang (THK).

Status: *Neocloeon triangulifer* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is the most widely distributed and most commonly encountered member of the genus in the state.

Biological Information: The biology of *N. triangulifer* apparently is similar to that of species of *Anafroptilum*. Burian and Gibbs (1991) described its habitat as emergent vegetation along the shoreline of second- to fourth-order streams. *Neocloeon triangulifer* is an obligatory parthenogenetic species that is very closely related to the sexually reproducing *N. alamance* (McCafferty et al. 2004). Funk et al. (2006) found both genetic and morphological differences between the two species, validating their status as separate species.

Figure 96. *Neocloeon triangulifer,* larva.

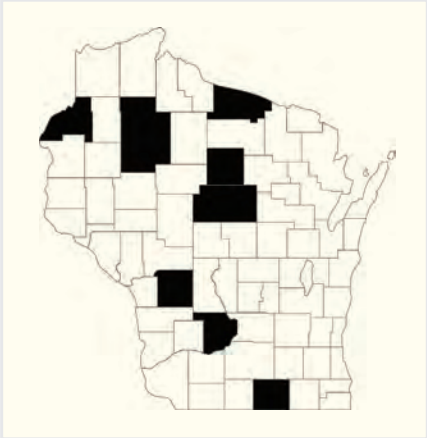


Figure 97. Wisconsin records of *Neocloeon triangulifer.*

Paracloeodes

Comments: There are three species of *Paracloeodes* in North America (Anonymous 2014a). Only one of them is known from the Midwest. The remaining species are from South America (Kluge 2014).

Determination: Identification of *Paracloeodes* larvae in Wisconsin is **Fairly Easy.**

Paracloeodes minutus (Daggy), 1945 (Figs. 98 and 99)

Taxonomic History: *Paracloeodes abditus* Day, 1955 (syn.); *Paracloeodes minutus* (Daggy), 1945 (curr. comb., Edmunds et al. 1976); *Pseudocloeon minutum* Daggy, 1945 (orig.).

Larval Description: Daggy (1945), as *Pseudocloeon minutum*.

Larval Habitus: Lillie (1995).

Determination: Identification of *Paracloeodes minutus* larvae is **Fairly Easy**. Misidentification most likely is as a very small *Procloeon*, *Anafroptilum*, *Neocloeon*, *Pseudocentroptiloides*, or *Apobaetis*. Careful use of the key is recommended. Larvae of *Paracloeodes minutus,* in addition to the characters used in the key, usually have a distinctive, dark ring around a pale area on the second abdominal tergum.

Previous Wisconsin Records: Lillie and Hilsenhoff (1992); Lillie (1995).

New County Records: ASHLAND: Marengo R., Government Rd., IX-9-2009, K. L. Schmude (UWS); **EAU CLAIRE:** 10L (including blackwing), Eau Claire R., adjacent to Co. Rd. Q, 44.819648°N 91.363869°W, IX-29-2009, M. Hazuga (THK); **GRANT:** 2L, Wisconsin R., Woodman, 3–4 ft. sand, moderate flow, VI-20-1986, R. A. Lillie (UW); **IOWA:** 1L, Wisconsin R., Co. Rd. C, 2.2 mi. NNE. of Spring Green, 43°8'41"N 90°3'13"W, VIII-8-2011, THK, E. Wolf, and C. Brown (THK); **MARINETTE:** 1L, Pike R., 45.496827°N 87.982493°W, VIII-12-2009 (THK); **ROCK:** 22L, Turtle Crk., Shopiere, VII-13-1999, THK (THK); **SAUK:** 1L, Wisconsin R., St. Rd. 130/133 bridge, 43°9'55"N 90°11'34"W, VII-26-2011, THK (THK); **WAUPACA:** 3L, Little Wolf R., Bridge Road, upstream along bridge riprap, 44.4946065°N 88.8999065°W, IX-20-2012, J. Riebe (UWSP).

Status: *Paracloeodes minutus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Lillie (1995) recommended that it be considered for conservation efforts. Randolph and McCafferty (1998) believed, rather, that the species was uncommonly collected because of size, not because of its rarity.

Biological Information: The very small larvae of *P. minutus* are not easily collected, though a significant amount of biological information is available for the species. They mostly occur in warm-water streams (Edmunds et al. 1976). Mature larvae can occur in large numbers in extremely shallow, silted pools and puddles of water along shorelines and floodwaters (Edmunds et al. 1976; Lillie and Hilsenhoff 1992; McCafferty et al. 2003a). Apparently, larvae occupy sandbars in deeper water during most of their development and only migrate to shallows when mature. In southeastern Nebraska streams and rivers, I have observed large numbers of mature *P. minutus* larvae in extremely shallow water and isolated puddles along the shoreline. Despite the larvae being excellent swimmers, a shallow pan could be used to scoop up large numbers of individuals in a short time.

Figure 98. *Paracloeodes minutus,* larva.

Figure 99. Wisconsin records of *Paracloeodes minutus.*

Plauditus

Comments: The species currently placed in *Plauditus* have been the subject of numerous taxonomic changes and historically have been placed in various combinations in a number of genera, including *Acentrella, Barbaetis*, *Baetis*, *Cloeon*, and *Pseudocloeon.* Because of the difficulty of identifying *Plauditus* larvae, the number of species unknown as larvae, and the number of very recently described species, there likely are many misidentified specimens in various collections (Wiersema 1999a). There are ten recognized species, all from North America (Kluge 2014), with only four known from Wisconsin.

Determination: Identification of *Plauditus* larvae is **Fairly Easy** for identification of the genus, and **Moderately Easy to Problematic** for the species within the genus.

Larval Keys: Traver (1935) and Burks (1953), both as *Pseudocloeon*; Hilsenhoff (1982), as *Baetis* and *Pseudocloeon*.

Key to the Species of *Plauditus* (*P. elliotti* and *P. veteris* not keyed)

1. Antennae of mature larvae equal to or shorter than one and a half times the length of head capsule (Fig. 100a); labial palpus with broadened third segment (Fig. 100b); protarsal claw with dorsal margin relatively straight, with a gently curved tip (Fig. 100c); tergum and sternum of either V or VII darkened in contrast to other segments (Fig. 101); males and females similarly patterned **2**

Antennae of mature larvae usually at least two times longer than length of head capsule; labial palpus with third segment appearing truncate but not broadened (Fig. 20m); protarsal claw with dorsal margin more distinctly curved from base to tip (Fig. 20j); terga and sterna variously colored, usually with all terga uniformly colored (females) or with three or more segments darker than others (males) **3**

2. Antennae distinctly longer (usually at least one and a half times) than head capsule; tergum and sternum V similar in darkness to other segments and often not as dark as VII; pro- and mesofemora each with a short and long, dark mark on anterior surface in fresh specimens (Fig. 100d); tergum and sternum IX usually not darkened; abdominal sterna usually with dark, medial mark in intersegmental spaces (similar to *P. punctiventris*). . . . . ***P. gloveri***

Antennal length subequal to length of head capsule (Fig. 100a); tergum and sternum V usually darker than IV, VI, and VII (Fig. 101); pro- and mesofemora not marked as above, each usually with a dark crossband near base in fresh specimens; tergum and sternum IX sometimes slightly darker than other segments; abdominal sterna without a dark, medial mark in each intersegmental space. . . . . ***P. cestus***

3. At least some abdominal sterna with a median dark spot or dash along posterior margins, sometimes extending into the intersegmental membranes (Fig. 100e) . . . . . ***P. punctiventris / P. virilis***

Abdominal sterna with pairs of submedian spots or streaks, but without median posterior spots; a series of unfaded specimens recommended **4**

4. Each caudal filament without a dark band at midlength . . . . . ***P. cingulatus***

Each caudal filament with a dark band at midlength; male larva with terga V–VII strikingly darker than other segments (Fig. 105); female larva with terga uniformly colored (Fig. 106) . . . . . ***P. dubius***

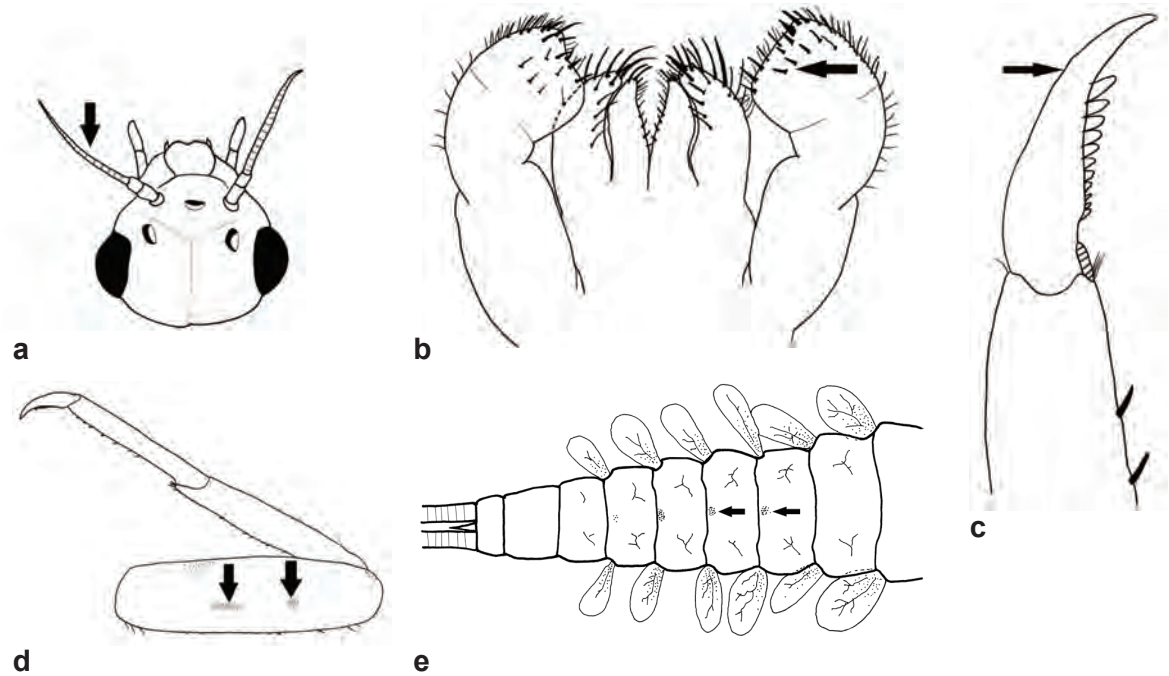


Figure 100. *Plauditus* (Baetidae). **a,** *P. cestus,* head (anterior); **b,** *P. cestus,* labium (ventral); **c,** *P. cestus,* front claw; **d,** *P. gloveri,* front leg (anterior); **e,** *P. punctiventris,* abdominal sterna.

Plauditus cestus (Provonsha & McCafferty), 1982 (Figs. 101 and 102)

Taxonomic History: *Barbaetis cestus* (Provonsha and McCafferty), 1982 (comb.); *Plauditus cestus* (Provonsha and McCafferty), 1982 (curr. comb., Lugo-Ortiz and McCafferty 1998a); *Pseudocloeon cestum* Provonsha and McCafferty, 1982 (orig.).

Larval Descriptions: Provonsha and McCafferty (1982), as *Pseudocloeon cestum*; Lugo-Ortiz and McCafferty (1998b); McCafferty and Jacobus (2001).

Larval Habitus: Provonsha and McCafferty (1982), as *Pseudocloeon cestum*.

Determination: Identification of *Plauditus cestus* larvae is **Moderately Easy** for fresh specimens. Though mature larvae of *Plauditus cestus* are quite small, the distinctive abdominal coloration usually is a reliable field mark. In male larvae of *P. dubius*, abdominal terga IV through VI usually are darker than other segments (Fig. 105). In *P. gloveri*, the only darkened abdominal segment usually is VII. In most *P. cestus*, both the tergum and the sternum of the fifth abdominal segment contrast strongly with adjacent segments (Fig. 101). Structurally, *P. cestus* is most similar to *P. gloveri*. Intraspecific and interspecific variability of these two species was covered in detail by McCafferty and Jacobus (2001).

Previous Wisconsin Records: McCafferty and Jacobus (2001).

New County Record: ASHLAND: Marengo R., Government Rd., IX-9-2009, K. L. Schmude (UWS); **BURNETT:** 2L, St. Croix R., Nelson, SW. of Danbury, Summer 1996 (WiDNR); 1L, St. Croix R., Sand Rock Cliffs, 5 mi. NW. of Grantsburg, T38NR19W S7, Summer 1996 (WiDNR); **SHAWANO:** 6L in two vials, Mill Crk., Willow Crk. Rd., 44.75561°N 88.75651°W, VI-6-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **WAUPACA:** 2L, Wolf R., River Rd., 44.65431°N 88.60595°W, VI-3-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Status: *Plauditus cestus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is known only from scattered locations in the northern half of the state.

Biological Information: *Plauditus cestus* is a very small species occurring in clean streams and rivers with pea-sized gravel bottoms (Provonsha and McCafferty 1982; Webb et al. 2004). In Wisconsin, it is known from both small and large rivers. Because of their size, larvae are often overlooked if fine-meshed nets are not used (Lugo-Ortiz and McCafferty 1998b). Little is known regarding the phenology of this species in Wisconsin. All of the adults of *P. cestus* that I have examined from Wisconsin were taken in June.

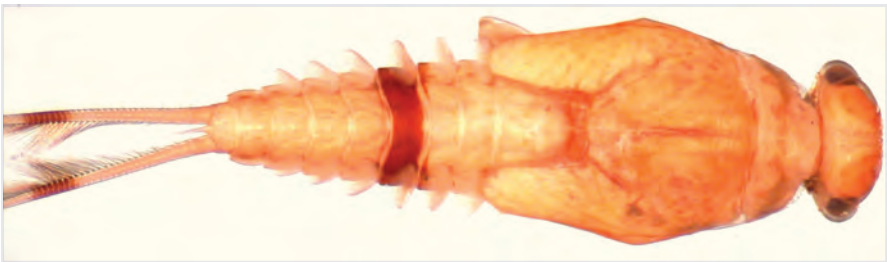


Figure 101. *Plauditus cestus,* larva.

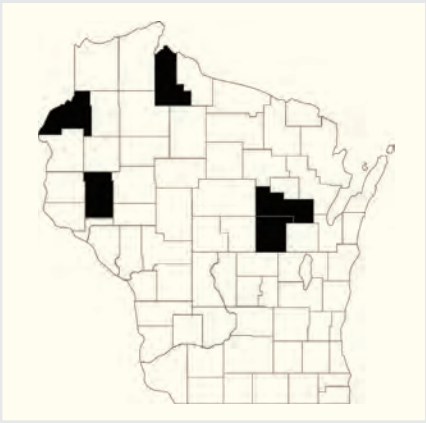


Figure 102. Wisconsin records of *Plauditus cestus.*

Plauditus cingulatus (McDunnough), 1931 (Figs. 103 and 104)

Taxonomic History: *Baetis cinctutus* McCafferty and Waltz, 1990 (syn.), *Plauditus cinctutus* (McCafferty and Waltz), 1990 (syn. comb.); *Plauditus cingulatus* (McDunnough), 1931 (curr. comb., McCafferty 1999); *Pseudocloeon cingulatum* McDunnough, 1931 (orig.). In 1925, McDunnough described *Baetis cingulatus*, which later was synonymized with *Baetis flavistriga*. In 1931, McDunnough applied the similar name *Pseudocloeon cingulatum*, which is the correct origin of *Plauditus cingulatus* (McDunnough 1931a).

Larval Description: Leonard and Leonard (1962).

Determination: Identification of *P. cingulatus* larvae is **Moderately Easy** for unfaded, intact specimens, but **Moderately Difficult** for specimens with broken caudal filaments. Faded material of *P. cingulatus* may be inseparable from *P. dubius*.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Baetis cingulatus*; Randolph and McCafferty (1998), as *B. cinctutus*.

New County Records: POLK: 1L, St. Croix R., Nevers Landing, near Wolf Creek, Summer 1996 (WiDNR).

Status: *Plauditus cingulatus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It likely is the least common member of the genus in the state.

Biological Information: *Plauditus cingulatus* was reported from erosional reaches of first- to third-order streams (Burian and Gibbs 1991), though the St. Croix River record above suggests a tolerance of larger rivers.

Figure 103. *Plauditus cingulatus,* larva.

Figure 104. Wisconsin records of *Plauditus cingulatus.*

Plauditus dubius (Walsh), 1862 (Figs. 105–107)

Taxonomic History: *Baetis dubius* (Walsh), 1862 (comb.); *Cloe dubia* Walsh, 1862 (orig.); *Cloeon chlorops* McDunnough, 1923 (syn.); *Cloeon dubium* (Walsh), 1862 (comb.); *Plauditus dubius* (Walsh), 1862 (curr. comb., Lugo-Ortiz and McCafferty 1998a); *Pseudocloeon chlorops* (McDunnough), 1923 (syn.); *Pseudocloeon dubium* (Walsh), 1862 (comb.).

Larval Description: Clemens (1913, 1915c), as *Cloeon dubium*; Burks (1953), as *Pseudocloeon dubium*.

Larval Habitus: Clemens (1913), as *Cloeon dubium*.

Determination: Identification of *Plauditus dubius* larvae is **Moderately Easy**. Larvae are sexually dimorphic, with males (Fig. 105) having more contrasting abdominal terga. Females (Fig. 106) can be confused with *Acentrella turbida*. Faded specimens may be inseparable from *P. cingulatus* and *P. punctiventris*.

Previous Wisconsin Records: Hilsenhoff (1972), Shapas and Hilsenhoff (1976), and Hilsenhoff (1982), all as *Pseudocloeon dubium*; Randolph and McCafferty (1998), as *Baetis dubius*.

New County Records: DUNN: 1L, Chippewa R., 640th St. Landing, VII-9-2013, K. L. Schmude (UWS); **JACKSON:** 1L, Black R., River Rd. Canoe Launch, VII-11-2013, K. L. Schmude (UWS); **MARINETTE:** 2L, Menominee R., Co. Rd. Z, T36NR22E S20, VI-25-1996 (WiDNR); **PEPIN:** 2L, Chippewa R., Ella Boat Landing, VII-9-2013, K. L. Schmude (UWS); **POLK:** 1L, St. Croix R., Sunrise, VI-10-1996 (WiDNR); **ROCK:** 3L in two vials, Turtle Crk., Carver's Rock Rd., VI-1-2005 and VII-20-2007, THK (THK); Turtle Crk., Shopiere, VII-20-2007, THK (THK); 3L, Turtle Crk., Lathers Rd., 1 mi. WSW. of Shopiere, T2NR13E S9, THK, C. Brown, and E. Wolf (THK); 6L, Turtle Crk., Sweet Allyn Pk. on Belding Rd. in Shopiere, T1NR13E S3, VI-6-2011, THK, C. Brown, and E. Wolf (THK); 2L, Yahara R., Murwin Pk. in Fulton, VII-7-2011, THK, E. Wolf, and C. Brown (THK); **RUSK:** 15L in three vials (including blackwing), N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998 (WiDNR); **SAWYER:** 30L in three vials, Chippewa R., Town Line Rd., T37NR7W S35, VI-23-1998 (WiDNR); **WASHBURN:** 6L, Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK); 1L, Namekagon R., Co. Rd. K, T40NR12W S18, VI-24-1998 (WiDNR).

Biological Information: Burian and Gibbs (1991) described the habitat of *Plauditus dubius* as erosional and transitional reaches of second- and third-order streams. In Wisconsin, though, the species also is known from a number of medium to large rivers, including the St. Croix, Chippewa, and Menominee Rivers.

Figure 105. *Plauditus dubius,* male larva.

Figure 106. *Plauditus dubius,* female larva.

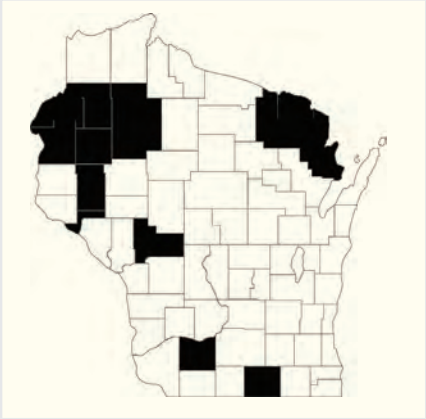


Figure 107. Wisconsin records of *Plauditus dubius.*

Plauditus elliotti (Daggy), 1945

Taxonomic History: *Baetis elliotti* (Daggy), 1945 (comb.); *Plauditus elliotti* (Daggy), 1945 (curr. comb., Lugo-Ortiz and McCafferty 1998a); *Pseudocloeon elliotti* Daggy, 1945 (orig.); *Pseudocloeon ida* Daggy, 1945 (syn.).

Determination: Identification of *Plauditus elliotti* larvae is **Problematic**. The species has not been formally described as larvae.

Previous Wisconsin Records: None. *Plauditus elliotti* was originally described by Daggy (1945) based upon adults collected from the Mississippi River in Fridley, Minnesota (north of Minneapolis).

Biological Information: No accounts of the biology of this species have been published.

Plauditus gloveri McCafferty & Waltz, 1998 (Fig. 108)

Larval Descriptions: McCafferty and Waltz (1998); McCafferty and Jacobus (2001).

Larval Habitus: McCafferty and Waltz (1998).

Determination: Identification of *P. gloveri* larvae is **Fairly Easy**. Faded specimens may be difficult to separate from other species in the genus. Adults of *P. gloveri* have not been formally described.

Previous Wisconsin Records: None. Closest records of *P. gloveri* are from south-central Indiana (Jacobus and McCafferty 2006). Since the species has a fairly widespread distribution, from the southeastern United States to Manitoba (McCafferty and Waltz 1998; Jacobus and McCafferty 2001; McCafferty and Jacobus 2001; McCafferty et al. 2004; Webb et al. 2004; Jacobus and McCafferty 2006), the absence of records from Wisconsin and neighboring states likely is because of being overlooked. It is expected in Wisconsin.

Biological Information: No accounts of the biology of this species have been published.

Figure 108. *Plauditus gloveri,* larva.

Plauditus punctiventris (McDunnough), 1923 (Figs. 109 and 110)

Taxonomic History: *Baetis punctiventris* (McDunnough), 1923 (comb.); *Baetis* sp. 1 McCafferty and Davis, 1992 (syn.); *Cloeon punctiventris* McDunnough, 1923 (orig.); *Plauditus punctiventris* (McDunnough), 1923 (curr. comb., Lugo-Ortiz and McCafferty 1998a); *Pseudocloeon myrsum* Burks, 1953 (syn.); *Pseudocloeon punctiventris* (McDunnough), 1923 (comb.).

Larval Descriptions: Burks (1953), as *Pseudocloeon myrsum* and *P. punctiventris*.

Determination: Identification of *Plauditus punctiventris* larvae is **Difficult**, even for fresh specimens. Larvae are easily confused with other species, including *P. dubius*, *P. gloveri*, *P. virilis*, and *Iswaeon anoka*. Larvae of *I. anoka* can have a dark spot centrally located on each abdominal sternum (Fig. 20h), rather than between segments, and always have more robust tibiae (Fig. 20g) than *Plauditus*. Many collections have specimens of *I. anoka* misidentified as *P. punctiventris*, to which it formerly was a junior synonym. In *P. punctiventris*, each abdominal sternum has a dark medial spot along the posterior margin of the segment that usually bleeds into the intersegmental membrane (Fig. 100e). Most *P. gloveri* are similarly patterned (McCafferty and Waltz 1998; McCafferty and Jacobus 2001) but have thinner claws, among other characters. I am not aware of reliable characters to separate larvae of *P. punctiventris* from *P. virilis*, and I have not examined confirmed, reared specimens of *P. virilis*. Specimens in the Purdue Entomological Research Collection labeled as *P. virilis* (Bartholomew Co., IN, IV-19-2005) have a ventral spot along the posterior margin of each sternum (and intersegmental membrane) as in *P. punctiventris*. Ide (1937) made no mention of these marks in his description of *P. virilis*, so I am unsure of the identity of the Indiana specimens. Larvae of *P. punctiventris, P. virilis*, and *P. dubius* are sexually dimorphic, with males having more contrasting abdominal terga than females (as in Fig. 109). Structural characters to separate these three species as larvae are lacking.

Previous Wisconsin records: Hilsenhoff et al. (1972), as *Pseudocloeon punctiventris*; Shapas and Hilsenhoff (1972), as *P. punctiventris*; Hilsenhoff (1982), as *P. punctiventris*; Randolph and McCafferty (1998), as *Baetis punctiventris*. All Midwest records of this species prior to McCafferty et al. (2005) should be considered with some skepticism. The former synonymy with *Iswaeon anoka* (as *Pseudocloeon*) and the similarity between *Plauditus punctiventris* and *I. anoka* make it clear that all records of *P. punctiventris* should be revalidated. Many of the specimens in the University of Wisconsin collection previously identified as *P. punctiventris* are now corrected to *I. anoka*. The confirmed and new county records of *P. punctiventris* listed below do not eliminate the possibility that some could actually be *P. virilis*.

Confirmed County Records: **BARRON:** Bear Crk. (UWS); **BURNETT:** St. Croix R. (WiDNR); **CLARK:** Cunningham Crk. (UWS); **POLK:** St. Croix R. (THK); **PRICE:** S. Fork Flambeau R. (WiDNR); **ROCK:** Marsh Crk. (UWS), Turtle Crk. (THK); **RUSK:** N. Fork Chippewa R. (WiDNR); **WASHBURN:** Bean Brk. (THK).

New County Records: MARINETTE: 2L, Menominee R., Mine Rd., T27NR21E S25, VI-24-1997, R. A. Lillie (WiDNR).

Biological Information: Burian and Gibbs (1991) described the habitat of *P. punctiventris* as second- and third-order streams. Field work is needed to clarify the habitat and tolerance of this species independent of *Iswaeon anoka*. Taxonomic work, likely including a molecular component, is needed to determine if *P. punctiventris* as it currently is defined represents one variable species or a species complex potentially including species known to date only as adults.

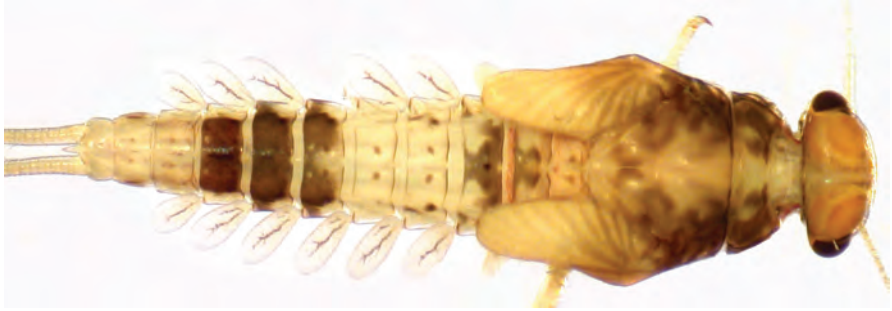


Figure 109. *Plauditus punctiventris,* larva.

Figure 110. Wisconsin records of *Plauditus punctiventris.*

Plauditus veteris (McDunnough), 1924

Taxonomic History: *Baetis veteris* (McDunnough), 1924 (comb.); *Plauditus veteris* (McDunnough), 1924 (curr. comb., Lugo-Ortiz and McCafferty 1998a); *Pseudocloeon veteris* McDunnough, 1924 (orig.).

Determination: Identification of *Plauditus veteris* larvae is **Problematic**. No larval description of the species has been published.

Previous Wisconsin Records: None. The nearest record of *Plauditus veteris* is from central Illinois (McDunnough 1924b). It is expected in Wisconsin.

Biological Information: Because larvae of *P. veteris* are not described, very little is known about this species. Burian and Gibbs (1991) found it associated with second-order streams in Maine.

Plauditus virilis (McDunnough), 1923

Taxonomic History: *Acentrella* sp. 1 Lugo-Ortiz and McCafferty, 1995 (syn.); *Acentrella* sp. 2 Lugo-Ortiz and McCafferty, 1995 (syn.); *Baetis virile* (McDunnough), 1923 (comb. spell.); *Baetis virilis* (McDunnough), 1923 (comb.); *Cloeon virilis* McDunnough, 1923 (orig.); *Plauditus virilis* (McDunnough), 1923 (curr. comb., Lugo-Ortiz and McCafferty 1998a); *Pseudocloeon virile* (McDunnough), 1923 (comb.); *Pseudocloeon virilis* (McDunnough), 1923 (comb. spell.).

Determination: Identification of *Plauditus virilis* larvae is **Problematic**. Reliable characters to separate larvae of this species from *P. punctiventris* are lacking. See discussion under *P. punctiventris*.

Previous Wisconsin Records: None. The nearest record of *P. virilis* is from northern Indiana (Randolph & McCafferty 1998). As it is known from widely scattered locations from Colorado to the states of the Northeast, it could occur in Wisconsin.

Biological Information: Burian and Gibbs (1991) described the habitat of *P. virilis* as erosional and transitional reaches of second- and third-order streams.

Procloeon

Comments: There currently are 21 species of *Procloeon* in North America. Countless specimens of *Procloeon* exist as undetermined baetid larvae in collections throughout the Midwest. It is frustratingly difficult to identify them to species, and even separating *Procloeon* from *Anafroptilum* and *Neocloeon* is a challenge. No recent key to the *Procloeon* has been published, even though several new species have been described since Traver (1935). Larvae of *Procloeon* often have species-specific color patterns, useful primarily at a regional level. The following provisional key was developed based upon various larval descriptions and specimens examined. Because of the likelihood of significant range extensions in this genus, and the number of species not identifiable as larvae, the following key for Wisconsin *Procloeon* should be considered provisional.

The validity of North American records of *Procloeon bellum* is questioned by mayfly specialists. The larval description of *P. bellum* in Ide (1930a) and the records from Maine in Burian and Gibbs (1991) are based upon misidentifications of *P. rivulare* (S. Burian, pers. comm.). The larvae of *P. bellum* therefore remain unknown. Larvae in the Purdue Entomological Research Collection labeled as this species vary widely in morphology and clearly include misidentifications of several species. *Procloeon bellum* was reported from the Pine and Popple Rivers (Florence and Forest Counties) in Wisconsin by Hilsenhoff et al. (1972) as *Centroptilum bellum*. It currently is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Because of taxonomic uncertainty, I have not included *P. bellum* in the state records listed throughout this book.

Determination: Identification of *Procloeon* larvae is **Slightly Difficult** for the genus, but **Moderately Easy to Problematic** for species within the genus.

Larval Keys: Traver (1935), as *Centroptilum* and *Cloeon*.

Partial Key to the Species of *Procloeon* (Not keyed: *P. ingens*)

1. Metathoracic wingpads present; maxillary palpus three-segmented (Fig. 19k) **2**

Metathoracic wingpads absent; maxillary palpus two-segmented (Fig. 111a); third segment of labial palpus medially expanded (Fig. 111b) **7**

2. Gills I–IV with dorsal flap or appearing bilamellate (Fig. 111c) **3**

Gill I with or without a dorsal flap, but all remaining gills simple **5**

3. Lateral spines present on at least abdominal segments IV–VII; abdominal segment IX with 11–14 lateral spines (Fig. 111d); not known from Wisconsin . . . . . ***P. quaesitum***

Lateral spines absent from abdominal segments I–VII; abdominal segment IX with variable numbers of lateral spines **4**

4. Gill VI with minute to small dorsal flap (Fig. 111c) . . . . . ***P. pennulatum***

Gill VI simple . . . . . ***P. rivulare***

5. Claws slender, each longer than half the length of its respective tarsus (Fig. 111e); abdominal segments IV–VII with lateral spines; maxillary palpus narrow and elongate, extending well beyond the galea-lacinia; gill I without dorsal flap; sterna VII–IX with or without wide, black-brown bar along each anterior margin (Fig. 111f); mesothoracic wingpads of mature specimens usually with dark lines resembling veins **6**

Claws thicker and shorter than half the length of its respective tarsus (Fig. 111k); abdominal segments IV–VII lacking lateral spines; maxillary palpus with short apical segment thick at base; gill I with small dorsal flap; sterna VII–IX lacking dark transverse bars, though sometimes with diffuse brown or purplish coloration across anterior margins of sterna; mesothoracic wingpads creamy white and unmarked . . . . . ***P. rufostrigatum***

6. Abdominal sterna boldly patterned, with sterna VII–IX each with a wide, black-brown bar along anterior margin and all sterna with distinct sublateral dark spots (Fig. 111f); left mandible with incisors divergent and deeply cleft beyond half way to base (Fig. 111g); terga patterned as in Fig. 125; gill tracheation intermittent, with unpigmented gaps (Fig. 111i); each femur often with diffuse dark band across anterior surface in distal third, but not with clearly circular spot (Fig. 111e); each tail with diffuse dark band near tip, but without a distinct white terminal band . . . . . ***P. viridoculare***

Abdominal sterna with indistinct or diffuse markings, not as above; terga patterned as in Fig. 112; left mandible with incisors less divergent and with cleft between them less than half as deep as the length of the incisors (Fig. 111h); gill tracheation dark and without unpigmented gaps; each femur with dark, circular spot on anterior surface in distal third (Fig. 111j); each tail of fresh specimen with well-defined, dark subterminal band and a distinct white terminal band . . . . . ***P. fragile***

7. Protarsal claw slender and lacking denticles (Fig. 111l); gills II–V with dorsal flaps; terga VI and IX of males darker than other segments (Fig. 119a); each tail with dark band at two-thirds of its length . . . . . ***P. rubropictum***

Protarsal claw thicker at base and with denticles (Fig. 111m); gills I–V all with small dorsal flaps; terga VI and IX of males not darker than other segments; each tail with a dark band at tip **8**

8. Terga IV–VI each with one to three lateral spines, with spine at posterolateral corner of each segment similar in size to other spines; terga VIII–IX each with no more than nine lateral spines. . . . . ***P. simplex***

Terga IV–VI each with five to seven lateral spines, with spine at posterolateral corner of each segment more robust than other spines; terga VIII–IX each with nine to eleven lateral spines. . . . . ***P. mendax***

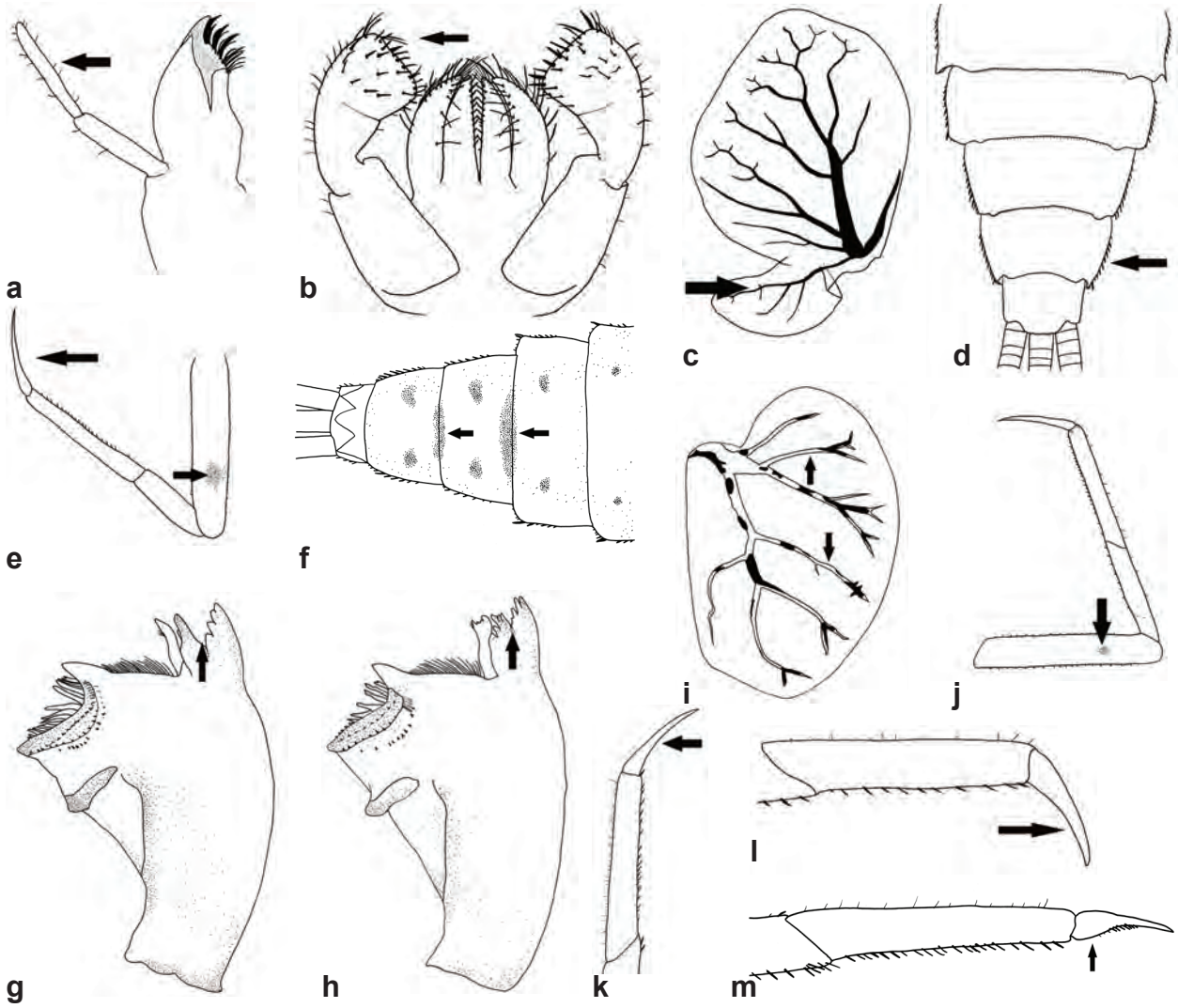


Figure 111. *Procloeon* (Baetidae). **a,** *P. rubropictum,* maxilla (ventral); **b,** *P. rubropictum,* labium (ventral); **c,** *P. pennulatum,* gill VIl; **d,** *P. quaesitum,* terga VI–X; **e,** *P. viridoculare,* front leg (anterior); **f,** *P. viridoculare,* sterna V–IX; **g,** *P. viridoculare,* left mandible; **h,** *P. fragile,* left mandible; **i,** *P. viridoculare,* gill IV; **j,** *P. fragile,* front leg (anterior); **k,** *P. rufostrigatum,* front tarsus; **l,** *P. rubropictum,* front tarsus; **m,** *P. simplex,* front tarsus.

Procloeon fragile (McDunnough), 1923 (Figs. 112 and 113)

Taxonomic History: *Centroptilum fragile* McDunnough, 1923 (orig.); *Procloeon fragile* (McDunnough), 1923 (curr. comb., McCafferty and Waltz 1990).

Determination: Identification of *P. fragile* larvae is **Moderately Difficult**. They structurally are most similar to *P. viridoculare*. The key will reliably separate middle to late instars of these two species.

Previous Wisconsin Records: None. The first Wisconsin records of *P. fragile* are given below. Nearest previous records were from northernmost Lower Michigan (Randolph and McCafferty 1998).

New Wisconsin Records: BURNETT: 6L in two vials, St. Croix R., Pansy, VI-18-1997, R. A. Lillie (WiDNR); 2L in two vials, St. Croix R., RR-silt/sand, Sand Rock Cliffs Pk., 5 mi. NW. of Grantsburg, T38NR19W S7, Summer 1996 (THK and WiDNR); 1L, St. Croix R., Sand Rock Cliffs Pk., 5 mi. NW. of Grantsburg, T38NR19W S7, VI-17-1997 (WiDNR); **LANGLADE:** 1L, Hunting R., Co. Rd. T, VI-14-2011, K. L. Schmude (THK); **SAWYER:** 21L in three vials, Flambeau R., Hervas, T37NR4W S35, VI-19-1997 (WiDNR); 1L, Flambeau R., Oxbo Rd., T39NR3W S14, VI-18-1997 (WiDNR); 1L, N. Fork Flambeau R., Co. Rd. W, T38NR3W S20, VI-18-1997 (WiDNR).

Biological Information: Unfortunately, no biological information has been published for *P. fragile*. In Wisconsin, it is known from third- to sixth-order segments of rivers.

Figure 112. *Procloeon fragile,* larva.

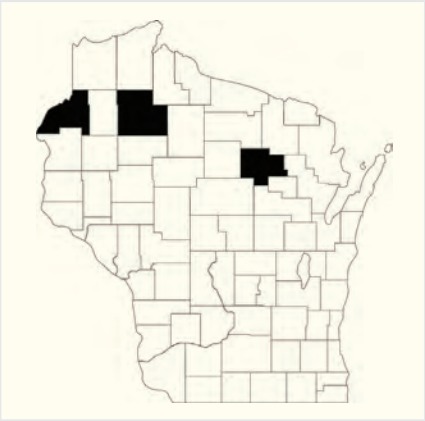


Figure 113. Wisconsin records of *Procloeon fragile.*

Procloeon ingens (McDunnough), 1923

Taxonomic History: *Cloeon implicatum* McDunnough, 1924 (syn.); *Cloeon ingens* McDunnough, 1923 (orig.); *Procloeon implicatum* (McDunnough), 1924 (syn.); *Procloeon ingens* (McDunnough), 1923 (curr. comb., McCafferty and Waltz 1990).

Determination: Identification of *P. ingens* larvae is **Problematic**. Diagnostic characters, other than the absence of metathoracic wingpads, have not been published. This species, therefore, is not included in the key.

Previous Wisconsin Records: None. The nearest record of *P. ingens* is from Marquette County, in the Upper Peninsula of Michigan. These larvae originally were identified as *P. mendax* in Randolph and McCafferty (1998), but subsequently were corrected to *P. ingens* by Wiersema and McCafferty (2004). The species is expected in Wisconsin.

Biological Information: At least some biological information is available for *P. ingens*, in contrast to several other members of the genus. Burian and Gibbs (1991) described its habitat as variable, including second- to third-order streams, stream backwater, ponds, lakes, and marshes. Generally, the species is associated with aquatic vegetation in depositional areas with little current.

Procloeon mendax (Walsh), 1862

Taxonomic History: *Cloe mendax* Walsh, 1862 (orig.); *Cloeon mendax* (Walsh), 1862 (comb.); *Procloeon mendax* (Walsh), 1862 (curr. comb., McCafferty and Waltz 1990).

Larval Description and Habitus: Ide (1930a), as *Cloeon mendax*.

Determination: Identification of *P. mendax* larvae is **Problematic**. Diagnostic characters, other than the absence of metathoracic wingpads, have not been published. The placement of this species in the key is provisional, as it is based upon non-reared specimens in the Purdue Entomological Research Collection. These specimens are very similar to *P. simplex*, but have greater numbers of lateral spines on abdominal terga.

Previous Wisconsin Records: None. The nearest records for *P. mendax* are from northwestern Illinois (Walsh 1863b; Burks 1953) and the Upper Peninsula of Michigan. The record of *Cloeon* from Crawford County in the Upper Peninsula reported by Leonard and Leonard (1962) was corrected to *P. mendax* by Wiersema and McCafferty (2004). This replaced the original record of *P. mendax* from the Upper Peninsula in Randolph and McCafferty (1998), which Wiersema and McCafferty (2004) corrected to *P. ingens*. *Procloeon mendax* is expected in Wisconsin.

Biological Information: The only habitat information for *Procloeon mendax* is that it occurs in depositional areas of streams (Hubbard and Peters 1978; Burian and Gibbs 1991).

Procloeon pennulatum (Eaton), 1870 (Figs. 114 and 115)

Taxonomic History: *Centroptilum infrequens* McDunnough, 1924 (syn.); *Centroptilum pennulatum* Eaton, 1870 (orig.); *Procloeon pennulatum* (Eaton), 1870 (curr. comb., McCafferty and Waltz 1990); *Pseudocentroptilum pennulatum* (Eaton), 1870 (comb.).

Larval Description: Lowen and Flannagan (1990), as *Centroptilum infrequens*.

Larval Habitus: Elliott et al. (1988).

Determination: Identification of *Procloeon pennulatum* larvae is **Moderately Difficult**. Tergal patterns are variable, being more boldly patterned in mature larvae. The small dorsal flap on gill VI (Fig. 111c) easily is missed without close examination. This species is most similar to *P. rivulare* (see discussion regarding these two species in the species account for *P. rivulare* below).

Previous Wisconsin Records: McCafferty et al. (2004).

New County Records: SAWYER: 2L, Chippewa R., Townline Rd., T37NR7W S35, VI-23-1998 (THK); **ST. CROIX:** 3L, Eau Galle R., bridge on Co. Rd. N, 3 mi. S. of Woodville, 44°54'18"N 92°15'53"W, VII-12-2011, THK (THK); **TAYLOR:** 1L, Copper Crk., VI-7-1977 (UW).

Status: *Procloeon pennulatum* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: *Procloeon pennulatum* is a mayfly of cool, spring-fed streams and small rivers (Lowen and Flannagan 1990). The five sites in Wisconsin where the species has been taken, however, include a fourth-order segment of the Eau Galle River (see above) and a sixth-order segment of the Oconto River in Oconto County (McCafferty et al. 2004). In Sauk County, I have collected this species in a shallow riparian stream. Lowen and Flannagan (1990) reported it as being associated with submerged vegetation.

Figure 114. *Procloeon pennulatum,* larva.

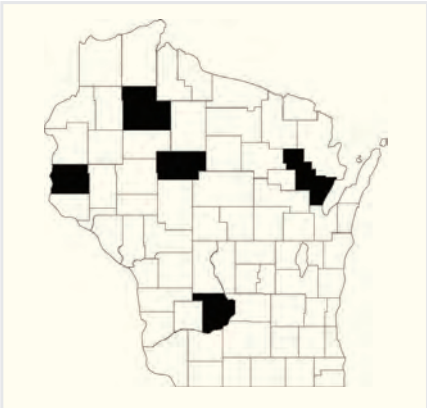


Figure 115. Wisconsin records of *Procloeon pennulatum.*

Procloeon quaesitum (McDunnough), 1931 (Fig. 116)

Taxonomic History: *Centroptilum quaesitum* McDunnough, 1931 (orig.); *Procloeon quaesitum* (McDunnough), 1931 (curr. comb., McCafferty and Waltz 1990).

Larval Description and Habitus: Lowen and Flannagan (1992).

Determination: Identification of *P. quaesitum* larvae is **Moderately Difficult**. As with many *Procloeon*, larvae in collections often have missing gills, making identification particularly difficult.

Previous Wisconsin Records: None. Nearest records of *P. quaesitum* are from north-central Indiana (Randolph and McCafferty 1998). This species is unlikely in Wisconsin.

Biological Information: No biological information is available for this species.

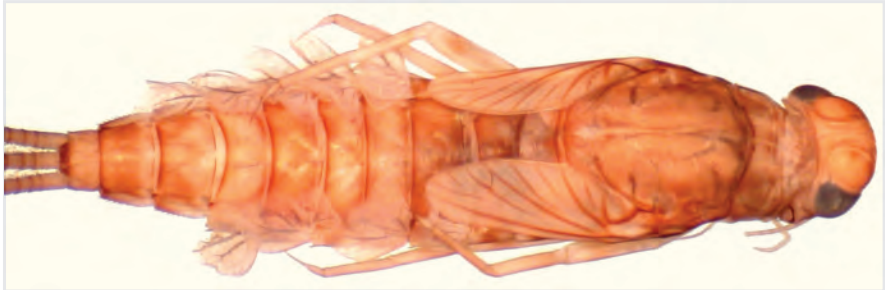


Figure 116. *Procloeon quaesitum,* larva.

Procloeon rivulare (Traver), 1935 (Figs. 117 and 118)

Taxonomic History: *Centroptilum rivulare* Traver, 1935 (orig.); *Procloeon rivulare* (Traver), 1935 (curr. comb., McCafferty and Waltz 1990).

Larval Description: Ide (1930a), as misidentified *P. bellum*; Wiersema (1999b).

Determination: Identification of *P. rivulare* larvae is **Very Difficult**. Larvae are most similar in tergal coloration to *P. pennulatum*. Specimens in collections often have missing gills, making identification nearly impossible. Immature specimens of *P. pennulatum* can have gill VI with a minute dorsal flap, suggesting *P. rivulare*. Specimens from Connecticut collected and identified by S. K. Burian and the first Wisconsin specimens reported below lack spines on the posterior margin of abdominal sternum III, whereas Wisconsin specimens of *P. pennulatum* have a distinct row of spines along the posterior margin of that segment. It is not known, however, if these differences are consistent beyond the few specimens examined here.

Previous Wisconsin Records: None, with the first state record reported below. Nearest records were from west-central Indiana (Randolph and McCafferty 1998).

New Wisconsin State Record: SAUK: Otter Crk., St. Rd. 60, 2.5 mi. W. of Sauk City, 43°16'16"N 89°47'5"W, VII-26-2011, THK (THK).

Biological Information: Burian and Gibbs (1991) described the habitat of *P. rivulare* as first- to third-order streams, with larvae associated with submerged plants.

Figure 117. *Procloeon rivulare,* larva.

Figure 118. Wisconsin records of *Procloeon rivulare.*

Procloeon rubropictum (McDunnough), 1923 (Figs. 119 and 120)

Taxonomic History: *Cloeon rubropictum* McDunnough, 1923 (orig.); *Procloeon rubropictum* (McDunnough), 1923 (curr. comb., McCafferty and Waltz 1990).

Larval Descriptions: Lowen and Flannagan (1992); Wiersema (1999b).

Larval Habitus: Lowen and Flannagan (1992).

Determination: Identification of *P. rubropictum* larvae is **Moderately Difficult**. Male larvae (Fig. 119a) have more contrasting abdominal terga than females (Fig. 119b), with VI and IX darker than other segments. Males also usually have a pair of submedian dark spots at the center of the mesonotum.

Previous Wisconsin Records: The first and only published record of this species from Wisconsin is in Klubertanz and Hess (2001). Voucher specimens for this record were deposited both at PERC and in my collection. Though the specimens at PERC were not examined, two larvae in my collection and notes from the original identification clearly show these specimens actually are *Neocloeon triangulifer*. The records of *P. rubropictum* listed below, therefore, are the first for Wisconsin. Based upon records, the species is relatively common and widespread in Wisconsin, in comparison with *N. triangulifer*.

New State Records: BAYFIELD: 1L, Ounce R., IX-13-1968, vial 010511V (UW); **BURNETT:** 3L, St. Croix R., VIII-29-1985, K. L. Schmude, vial 011011A (UW); **DOOR:** 2L, "Pond 2", IX-16-1982, vial 073112C (UW); **FLORENCE:** 3L in three vials, Pine R., IX-13-1967, vials 122110M, 010511N, and 010511U (UW); 2L in two vials, Popple R., VIII-8-1967 vial 010511Q, and IX-13-1967 vial 010511U (UW); **FOREST:** 4L in three vials, Pine R., VIII-8-1967 to IX-18-1967, vials 010511R, 010511L, and 010511S (UW); **LINCOLN:** 18L in three vials, New Wood R., VI-19-1973 vial 011011H, VI-11-1974 vial 073012D, and VIII-5-1980 vial 011411C (UW); 1L, N. Fork Copper R., upstream 50 m from Cranberry Trail, 45.20729°N 89.87702°W, X-6-2011, H. Yang, vial 051513C (UWSP); **MARINETTE:** 1L, Menominee R., Jones Landing, 1.5 mi. NW. of Faithorn, T37NR22E S8, VI-24-1997, vial 080312I (WiDNR); 3L, Menominee R., Wallace / McAllister bridge, 45.324986°N 87.66209°W, IX-4-2012, vial 051513G (UWSP); **OCONTO:** 3L, Little Suamico R., VI-10-1974, vial 122110G (UW); **PRICE:** 4L, VIII-28-1974, vial 122110I (UW); 3L in two vials, S. Fork Flambeau R., St. Rd. 13, T39NR1E S18, VI-24-1998, R. A. Lillie, vials 061812C and 062012C (WiDNR); **RUSK:** 1L, Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998, vial 061812G (WiDNR); **SAWYER:** 3L, Chippewa R., Town Line Rd., T37NR7W S35, VI-23-1998 (WiDNR); 3L in two vials, Flambeau R., Hervas, T37NR4W S35, VI-19-1997, vials 080212G and 080212H (WiDNR); 19L, Flambeau R., Oxbo Rd., T39NR3W S14, VI-18-1997, vial 080312D (WiDNR); **ST. CROIX:** 1L, St. Croix R., Somerset Landing on Marine Rd., 7 mi. NW. of Somerset, 45°12'14"N 92°45'47"W, VII-13-2011, THK, vial 071911P (THK); **TAYLOR:** 4L in two vials, Copper Crk., VI-7-1977 vial 011011F, and VI-13-1978 vial 073012A (UW); **WOOD:** 2L, Squaw Crk., VIII-5-1968, vial 010511K (UW); 5L, Little Hemlock Crk., VI-11-1976, vial 011111A (UW).

Status: *Procloeon rubropictum* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Because

that listing was based upon previously misidentified material, and with the new state records given above, that informal conservation status warrants review.

Biological Information: Very little biological information is available for *P. rubropictum*. The new county records listed above show a tolerance of larger rivers in Wisconsin, such as the St. Croix, Chippewa, and Flambeau Rivers. Berner and Pescador (1988) described its habitat in Florida as "slowly flowing water."

Figure 119. *Procloeon rubropictum,* larvae. **a,** male; **b,** female.

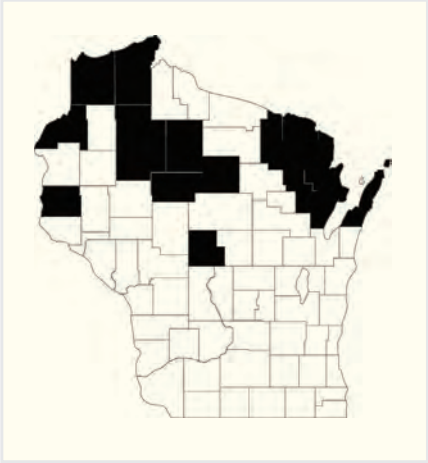


Figure 120. Wisconsin records of *Procloeon rubropictum.*

Procloeon rufostrigatum (McDunnough), 1924 (Figs. 121 and 122)

Taxonomic History: *Centroptilum bistrigatum* Daggy, 1945 (syn.); *Centroptilum hobbsi* Berner, 1941 (syn.); *Centroptilum rufostrigatum* McDunnough, 1924 (orig.); *Procloeon hobbsi* (Berner), 1941 (syn.); *Procloeon rufostrigatum* (McDunnough), 1924 (curr. comb., McCafferty and Waltz 1990).

Larval Descriptions: Daggy (1945), as *Centroptilum bistrigatum*; Lowen and Flannagan (1992).

Larval Habitus: Daggy (1945), as *Centroptilum bistrigatum*; Lowen and Flannagan (1992).

Determination: Identification of *P. rufostrigatum* larvae is **Moderately Difficult**. Tergal patterns of larvae are fairly consistent, even among males and females, in contrast to *P. rubropictum.*

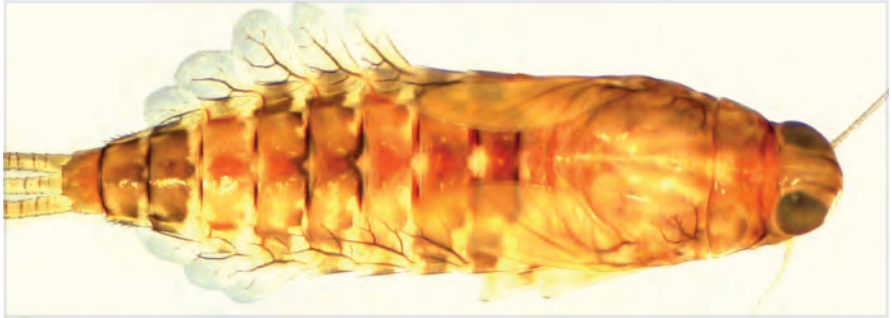
Previous Wisconsin Records: Leonard and Leonard (1962), as *Centroptilum rufostrigatum*; Randolph and McCafferty (1998); McCafferty et al. (2004).

New County Records: FLORENCE: 1L, Popple R., VIII-8-1967 (UW); **JACKSON:** 2L, Black R., River Rd. Canoe Launch, VII-11-2013, K. L. Schmude (UWS); **KEWAUNEE:** 1L, Kewaunee R., 100 m upstream from Co. Rd. C, 44.477512°N 87.565674°W, IX-12-2012, J. Riebe (UWSP); **MARINETTE:** 1L, Menominee R., Saler, T38NR22E S17, VI-26-1996 (WiDNR); **MARQUETTE:** 3L, Lawrence Crk., VIII-13-1970 (UW); **PEPIN:** 1L, Chippewa R., boat landing on River Str. to sandbar 1500 ft. N., Durand, 44°37'46"N 91°58'4"W, VII-16-2011, THK (THK); **PRICE:** 1L, S. Fork Flambeau R., St. Rd. 13, T39NR1E S18, VI-24-1998 (WiDNR); **ROCK:** 2L, Turtle Crk., Shopiere, VII-13-1999, THK (THK); 3L, Turtle Crk., Smith Rd., VII-16-1999, THK (THK); **RUSK:** 1L, Chippewa R., Bruce, T34NR7W S5, VI-23-1998, R. A. Lillie (WiDNR); **SAUK:** 15L, Otter Crk., St. Rd. 60, 2.5 mi. W. of Sauk City, 43°16'16"N 89°47'5"W, VII-26-2011, THK (THK); **SAWYER:** 1L, Chippewa R., Co. Rd. G, T39NR6W S23, VI-23-1998 (WiDNR); 3L in two vials, Chippewa R., Town Line Rd., T37NR7W S35, VI-23-1998 (WiDNR); 10L, Flambeau R., Hervas, T37NR4W S35, VI-19-1997, R. A. Lillie (WiDNR); **WALWORTH:** Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VIII-4-2000, THK (THK); **WOOD:** 1L, Yellow R., XI-2-1973 (UW).

Status: *Procloeon rufostrigatum* is listed as a Species of Special Concern on

the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It arguably is the most widespread and common member of the genus in the state.

Biological Information: *Procloeon rufostrigatum* was reported from depositional and transitional areas of second- to third-order streams with moderate current (Hubbard and Peters 1978). However, the new county records listed above include fifth-order (Kewaunee, Menominee, and South Fork of the Flambeau Rivers), sixth-order (Flambeau River), and eighth-order (Chippewa River) segments.



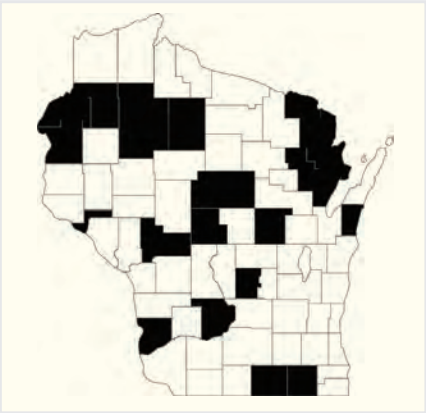


Figure 121. *Procloeon rufostrigatum,* larva.

Figure 122. Wisconsin records of *Procloeon rufostrigatum.*

Procloeon simplex (McDunnough), 1925 (Figs. 123 and 124)

Taxonomic History: *Cloeon simplex* McDunnough, 1925 (orig.); *Procloeon simplex* (McDunnough), 1925 (curr. comb., McCafferty and Waltz 1990).

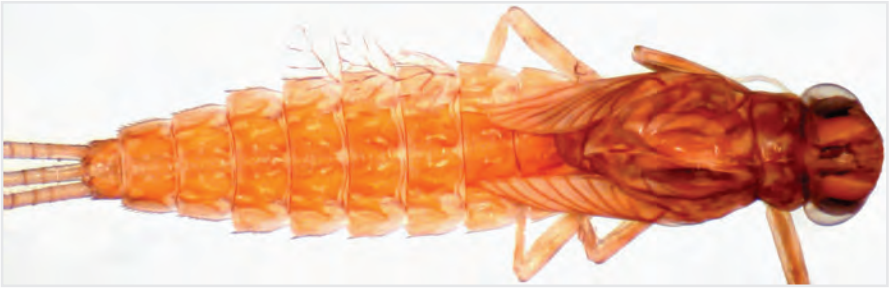
Determination: Identification of *P. simplex* larvae is **Difficult**. They are structurally similar to larvae of *P. rubropictum*. The treatment of this species in the key and the new county records given below are based upon comparison with mature larvae from Minnesota identified as *P. simplex* by Nick Wiersema. I was unable to examine specimens of the presumed similar *P. ingens*, which is expected in Wisconsin but is not included in the key.

Previous Wisconsin Records: McCafferty et al. (2004).

New County Records: CLARK: 10L, tributary of Cunningham Crk., VI-11-1975 (UW); **COLUMBIA:** 1L, Fox R., Portage, Clark Rd., VI-17-1982 (UW); 1L, Fox R., Portage, above WWTP, VI-17-1982 (UW); **DOOR:** 4L, "Pond 2", IX-16-1982 (UW); **MARINETTE:** 3L in two vials, Menominee R., Jones Landing, 1.5 mi. NW. of Faithorn, T37NR22E S8, VI-24-1997 (WiDNR); **VILAS:** 1L, Pioneer Crk., upstream 20 m from Church Rd., 46.02219°N 89.22235°W, XI-2-2011, H. Yang (THK).

Status: *Procloeon simplex* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: This species is known from depositional reaches of first- and second-order streams where there is submerged vegetation (Webb et al. 2004).



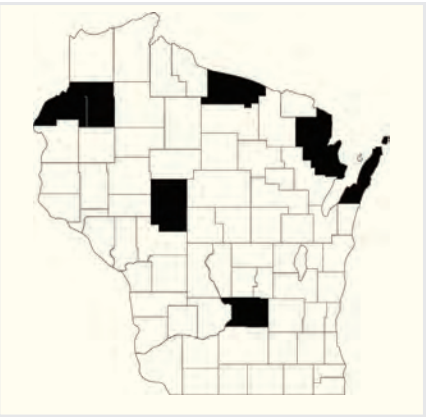


Figure 123. *Procloeon simplex,* larva.

Figure 124. Wisconsin records of *Procloeon simplex.*

Procloeon viridoculare (Berner), 1940 (Figs. 125 and 126)

Taxonomic History: *Centroptilum viridocularis* Berner, 1940 (orig.); *Procloeon irrubrum* Lowen and Flannagan, 1992 (syn.); *Procloeon viridoculare* (Berner), 1940 (curr. comb., McCafferty and Waltz 1990); *Procloeon viridocularis* (Berner), 1940 (comb., spell.).

Larval Descriptions: Berner (1940) and Edmunds et al. (1976), both as *Centroptilum viridocularis*; Lowen and Flannagan (1992), as *P. irrubrum*.

Larval Habitus: Lowen and Flannagan (1992), as *P. irrubrum*; Edmunds et al. (1976) and Berner and Pescador (1988), both as *Centroptilum viridocularis*.

Determination: Identification of *P. viridoculare* larvae is **Moderately Easy**. They have longer claws (Fig. 111e) than other members of the genus (Waltz and Munro 1996) and can be mistaken for an oversized *Pseudocentroptiloides*. In addition, sternal markings of some *Pseudocentroptiloides* larvae are very similar to *Procloeon viridoculare*. All potential *P. viridoculare* should be examined carefully for labral and labial characters attributable to *Pseudocentroptiloides*. Because of the deep cleft between the incisors of the left mandible (Fig. 111g), larvae of *Procloeon viridoculare* also can be misidentified as *Anafroptilum* or *Neocloeon*.

Previous Wisconsin Records: Klubertanz and Hess (2001) as *Procloeon irrubrum*; McCafferty (2009).

New County Records: BROWN: 1L, Neshoto R., X-2-1968 (UW); **CHIPPEWA:** 3L, Chippewa R., Cornell, T31NR7W S24, VI-19-1997 (WiDNR); **DANE:** 1L, Wisconsin R., Mazomanie Wildl. Area, IX-28-1986, R. A. Lillie (UW); **FLORENCE:** 3L, Pine R., IX-13-1967 (UW); **IOWA:** 5L, Wisconsin R., Spring Green, IX-7-1985, R. A. Lillie (UW); **JUNEAU:** 1L, Yellow R., Co. Rd. F, 40 m downstream, T20N R3E Sec10, X-2-2013, A. Scheunemann (THK); **LINCOLN:** 2L, Snow Crk., XI-11-1965 (UW); **PEPIN:** 6L, Chippewa R., Co. Rd. M, VIII-28-1985, K. L. Schmude (UW); **PRICE:** 5L, S. Fork Flambeau R., St. Rd. 13, T39NR1E S18, VI-24-1998 (WiDNR); **RUSK:** 7L in two vials, Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998 (WiDNR); **SAUK:** 6L, Wisconsin R., Spring Green, VI-6-1986, R. A. Lillie (UW); **WALWORTH:** 10L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VII-20-2000, THK (THK); 1L, Turtle Crk., School Section Rd., T2NR15E S15, VI-23-2011, THK, C. Brown, and E. Wolf (THK).

Status: *Procloeon viridoculare* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is, with *P. rufostrigatum*, one of the most widespread and common members of the genus in the state.

Biological Information: *Procloeon viridoculare* occurs in both medium and large rivers. It occurs over a wide geographic range, including both North America and Europe (McCafferty 1993). Published reports of the habitat of this species vary widely. Berner and Pescador (1988), working in the southeastern United States, reported it from sandy streams with moderate currents. In contrast, Webb et al. (2004) reported it from silt-covered, medium-sized cobble in Saskatchewan streams. Waltz and Munro (1996) found it associated with riffles, where it preferred locations downstream of rocks or rooted plants that disrupted the current. The species is fairly common in Turtle Creek, a stream in Rock and Walworth Counties that is silty and nutrient enriched. Apparently, *P. viridoculare* is at least moderately tolerant of degraded stream quality.

Figure 125. *Procloeon viridoculare,* larva.

Figure 126. Wisconsin records of *Procloeon viridoculare.*

Pseudocentroptiloides

Comments: With the first Wisconsin records of *P. morihari* below, both species in the genus are now known from Wisconsin. Based upon claw morphology and habitat records, members of the genus likely are psammophilous.

Determination: Identification of *Pseudocentroptiloides* larvae is **Slightly Difficult** for the genus and **Moderately Difficult** for species within the genus.

Larval Keys: Waltz and McCafferty (1989); Wiersema and McCafferty (1998).

Key to the Species of *Pseudocentroptiloides*

1. Maxilla with arcuate crown setae that are subequal in length to longest setae on distal margin of maxilla (Fig. 127b); glossa obliquely truncate, asymmetrical, with most anterior extension well lateral of center (Fig. 127a); paraglossa thick and moderately truncate (Fig. 127a) . . . . . ***P. morihari***

Maxilla with straight crown setae that are much shorter than longest setae on distal margin of maxilla (Fig. 127e); glossa rounded and nearly symmetrical; paraglossa thinner, more gently arcuate throughout distal half of outer margin, and appearing more pointed at tip (Fig. 127d) . . . . . ***P. usa***

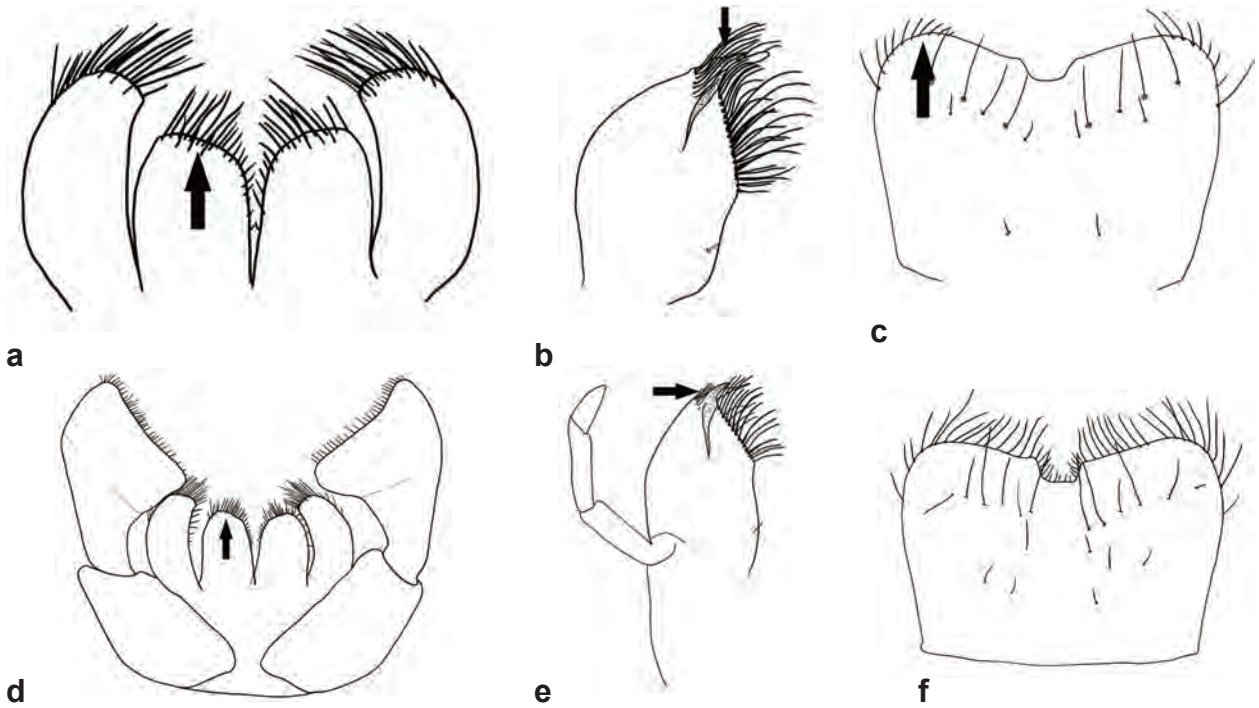


Figure 127. *Pseudocentroptiloides* (Baetidae). **a,** *P. morihari,* glossae and paraglossae (ventral); **b,** *P. morihari,* galea-lacinia (ventral); **c,** *P. morihari,* labrum (dorsal); **d,** *P. usa,* labium (ventral); **e,** *P. usa,* maxilla (ventral); **f,** *P. usa,* labrum (dorsal).

Pseudocentroptiloides morihari Wiersema & McCafferty, 1998 (Figs. 128 and 129)

Taxonomic History: *Centroptilum* sp. 2 McCafferty & Davis, 1992 (syn.).

Larval Description: Wiersema and McCafferty (1998).

Determination: Identification of *P. morihari* larvae is **Moderately Difficult**. Their small size, similarity to *P. usa*, and similarity to the much more widespread and common *Procloeon viridoculare*, all complicate identification. The holotype deposited in the Purdue University Research Collection has not been dissected, but there are slide-mounted mouthparts of another specimen in that collection taken from the same location and date as the holotype. The crown setae on the maxillae of *Pseudocentroptiloides morihari* (Fig. 127b) are more arcuate than illustrated in Wiersema and McCafferty (1998), but clearly much longer than in *P. usa* (Fig. 127e). In most specimens, the shape of the glossae and paraglossae can be seen in ventral view without dissection, though the differences in shape of these structures may be subtle. As discussed below for *P. usa*, the presence or absence of long submarginal setae on the labrum should not be used to differentiate the species.

Previous Wisconsin Records: None. The first Wisconsin and Midwest records are given below. No previously published records of *P. morihari* exist outside of Texas, where it was originally described. Other Wisconsin species from northern counties, such as *Tricorythodes robacki* (Leptohyphidae) and *Dolania americana* (Behningiidae), have equally disjunct distributions. Given the rarity of *P. morihari*, the level of difficulty of sampling sandy substrates, and its similarity with *P. usa*, it may occur in several other states.

New Wisconsin Records: BURNETT: 13L in five vials, Clam R., VI-19-1968, VI-26-1972, VI-18-1973, VI-1-1977, VI-7-1978 (UW); 2L in two vials, St. Croix R., Pansy, VI-18-1997, R. A. Lillie (THK); 6L in three vials, St. Croix R., Sand Rock Cliffs Pk., 5 mi. NW. of Grantsburg, T38NR19W Sec7, VI-17-1997 (THK); **FLORENCE:** 1L, Pine R., XI-11-1967 (UW); **MARINETTE:** 11L, Peshtigo R., 150 ft. S. of Benson Lk. Rd., 45.52624°N 88.380844°W, VII-15-2013, K. Schmude (UWS and THK); **ONEIDA:** 8L, Jennie Webber Crk., N. of Country Rd., VII-6-2009 (THK); **SAWYER:** 1L, Flambeau R., Hervas, VI-19-1997 (THK); 1L, Flambeau R., Oxbo, T39N R3W Sec14, VI-18-1997, R. A. Lillie (WiDNR); 2L, N. Fork Flambeau R., Co. Rd. W, T38NR3W Sec20, VI-18-1997 (WiDNR).

Biological Information: No previously published biological information is available for *P. morihari*. The species likely prefers sandbars, based upon morphology and characteristics of sample sites. The Wisconsin sites range from the second-order Jennie Webber Creek to the sixth-order St. Croix River, both in northern counties.

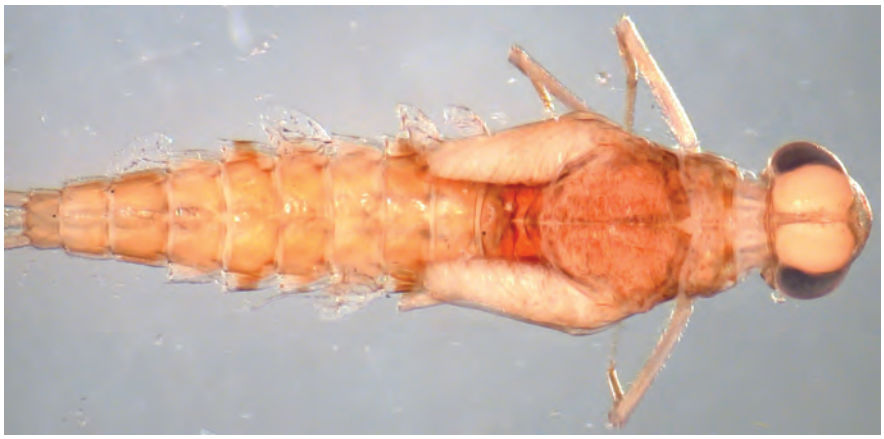


Figure 128. *Pseudocentroptiloides morihari,* larva.

Figure 129. Wisconsin records of *Pseudocentroptiloides morihari.*

Pseudocentroptiloides usa Waltz & McCafferty, 1989 (Figs. 130 and 131)

Larval Description: Waltz and McCafferty (1989).

Determination: Identification of *P. usa* larvae is **Moderately Difficult**. They are very similar to *P. morihari*, differing in number and structure of maxillary crown setae and in shape of the glossae and paraglossae. The species also can be misidentified as *Procloeon viridoculare*, which also has long claws (Fig. 111e), a widened terminal segment of the labial palpus, and similar sternal patterns (Fig. 111f). I found numerous *Pseudocentroptiloides* larvae from Wisconsin and other states with submarginal setae extending beyond the distal margin of the labrum, but otherwise matching the characteristics of *P. usa*. As described in Waltz and McCafferty (1989), the labrum of *P. usa* does not have long, dorsal setae. The holotype of this species deposited at Purdue University has the labrum slide-mounted in ventral view, making observations of the dorsal surface difficult. With careful examination of the holotype, however, I found the same dorsal setation as in Wisconsin larvae. The larva of *P. usa* has up to three pair of setae that extend beyond the distal margin of the labrum, with breakage of such setae common (Fig. 127f). *Pseudocentroptiloides morihari* has a more distinct row of submarginal setae, but of similar length (Fig. 127c). In addition, similar but scattered, shorter setae occur over the remainder of the dorsal surface of the labrum in both species. In the description of *P. morihari*, Wiersema and McCafferty (1998) considered the presence of submarginal labral setae as a distinctive feature of that species. Clearly, separation of the two *Pseudocentroptiloides* species in North America should be based primarily upon maxillary and labial characters.

Previous Wisconsin Records: McCafferty et al. (2004). I have examined all of the Wisconsin *Pseudocentroptiloides* at the Purdue University Research Collection and confirmed that they are *P. usa* and not *P. morihari*.

New County Records: MONROE: 3L, Beaver Crk., St. Rd. 21, 44.025965°N 90.31413°W, IX-24-2009, S. Provost (UWSP); **RICHLAND:** 3L, Wisconsin R., VIII-22-1975 (UW); 1L, Wisconsin R., Gotham, IX-1-1986, R. A. Lillie (UW).

Status: *Pseudocentroptiloides usa* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: No previously published biological information is available for *P. usa*. In Wisconsin, it is known from a similar diversity of stream and river sizes as *P. morihari*, but has been found in several southern counties.

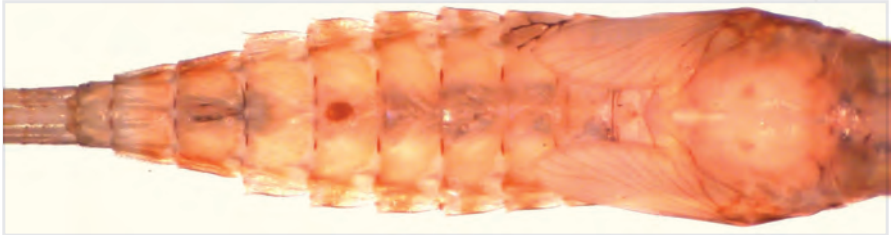


Figure 130. *Pseudocentroptiloides usa,* larva.

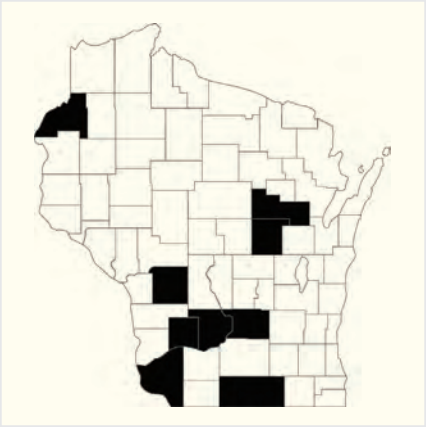


Figure 131. Wisconsin records of *Pseudocentroptiloides usa.*

9 BAETISCIDAE

Species of the Family Baetiscidae are known only from North America (Kluge 2014) and are among the most recognizable mayfly larvae. They have a large thoracic carapace over much of their dorsal surface and resemble a tank or turtle. The family currently contains only *Baetisca*.

Baetisca

Comments: Twelve species of *Baetisca* are known from North America, though only three of them are known from Wisconsin. The unmistakable, turtle-like larvae are univoltine (Hilsenhoff 1995).

Determination: Identification of *Baetisca* larvae is **Easy** at both the genus and species levels.

Larval Keys: Traver (1931b, 1935); Burks (1953); Pescador and Berner (1981); Hilsenhoff (1984).

Key to the Species of *Baetisca*

1. Thoracic carapace with lateral spines but lacking dorsal spines, and with freckles not coalesced into blotches (Fig. 132a) . . . . . ***B. lacustris***

Thoracic carapace with both dorsal and lateral spines, and usually with irregular, dark blotches (Fig. 132b) **2**

2. Thoracic carapace with thin, dark brown border along ventral margin (Fig. 132b); head with an inconspicuous frontal projection . . . . . ***B. laurentina***

Thoracic carapace without brown border along ventral margin; head with a prominent and bilobed frontal projection (Fig. 132c) . . . . . ***B. obesa***

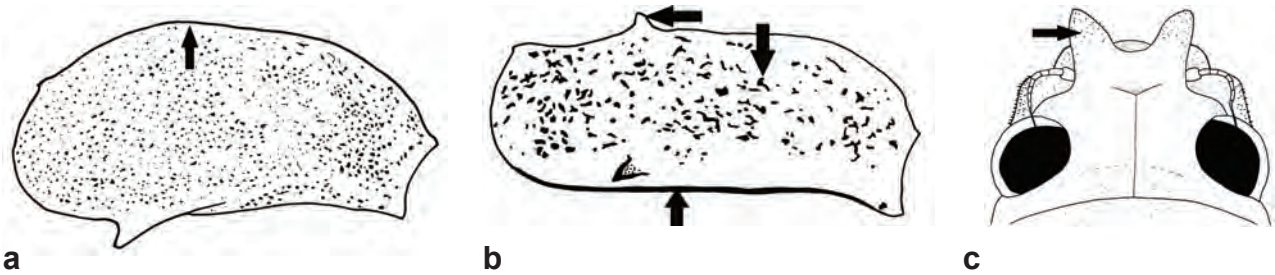


Figure 132. *Baetisca* (Baetiscidae). **a,** *B. lacustris,* carapace (lateral); **b,** *B. laurentina,* carapace (lateral); **c,** *B. obesa,* head (dorsal).

Baetisca lacustris McDunnough, 1932 (Figs. 133 and 134)

Taxonomic History: *Baetisca bajkovi* Neave, 1934 (syn.).

Larval Descriptions and Habitus: Burks (1953), as *B. bajkovi* and *B. lacustris*; Pescador and Berner (1981).

Determination: Identification of *B. lacustris* larvae is **Easy**. Characters in the key are reliable for both middle and later instars. Very young larvae of *Baetisca* should be identified carefully, as thoracic spines may not be fully developed.

Previous Wisconsin Records: Hilsenhoff (1984); Jacobs (1990); Lillie and Hilsenhoff (1992); Randolph and McCafferty (1998).

New County Records: BUFFALO: 1L, Buffalo R., Segerstrom Rd., 44.575616°N 91.54415°W, VI-5-2008, K. L. Schmude, A. Reynolds and M. Payne (UWS); **JACKSON:** 4L, Black R., Hawk Island Rd., 44.22176°N 90.87689°W, V-28-1997, W. A. Smith and R. A. Lillie (WiDNR); 2L, Black R., T19NR6W S35, V-2-1978 (MPM); **MONROE:** 2+ L, Black R., T19NR4W S6, V-11-1978 (MPM); **SHAWANO:** 1L, Red R., Butternut Rd., 44.84305°N 88.7226°W, VI-8-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS).

Biological Information: The habitats of *B. lacustris* larvae range from creeks to large rivers (Burks 1953; Hilsenhoff 1984). They generally occur along stream margins, in pools with slower current (Burks 1953; Burian and Gibbs 1991). Mature larvae occur in late spring and early summer, with emergence from May through July (Pescador and Berner 1981).

Figure 133. *Baetisca lacustris,* larva.

Figure 134. Wisconsin records of *Baetisca lacustris.*

Baetisca laurentina McDunnough, 1932 (Figs. 135 and 136)

Larval Descriptions: Burks (1953); Leonard and Leonard (1962); Pescador and Berner (1981).

Larval Habitus: Leonard and Leonard (1962); Pescador and Berner (1981); Berner and Pescador (1988).

Determination: Identification of *B. laurentina* larvae is **Easy**. Characters in the key are reliable for both middle and later instars.

Previous Wisconsin Records: Pescador and Berner (1981); Hilsenhoff (1984); DuBois (1993); Randolph and McCafferty (1998).

Biological Information: *Baetisca laurentina* is the most common member of the genus known from Wisconsin and occurs in a wide variety of streams (Burks 1953; Hilsenhoff 1984; Burian and Gibbs 1991), as wells as in ponds and backwaters (Burian and Gibbs 1991). Leonard and Leonard (1962) found the species associated most commonly with medium to large rivers in Michigan. As with other members of the genus, it is commonly encountered along stream margins.

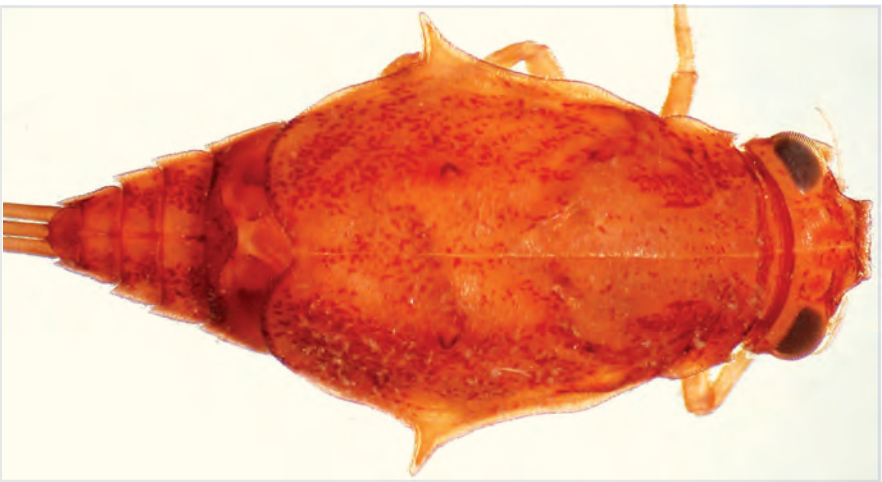


Figure 135. *Baetisca laurentina,* larva.

Figure 136. Wisconsin records of *Baetisca laurentina.*

Baetisca obesa (Say), 1839 (Figs. 137 and 138)

Taxonomic History: *Baetisca obesa* (Say), 1839 (curr. comb., Walsh 1863a); *Baetis obesa* Say, 1839 (orig.).

Larval Descriptions: Burks (1953); Leonard and Leonard (1962); Pescador and Berner (1981).

Larval Habitus: Needham (1905); Schwiebert (1973); Pescador and Berner (1981); Berner and Pescador (1988).

Determination: Identification of *B. obesa* larvae is **Easy**. Large size and obvious characters reduce the risk of misidentifications.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); Pescador and Berner (1981); Hilsenhoff (1984); Jacobs (1990); Lillie and Hilsenhoff (1992); Randolph and McCafferty (1998).

New County Records: OUTAGAMIE: 11L, Wolf R., Co. Rd. F, 44.57386°N 88.56405°W, VI-2-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **SHAWANO:** 1L, Wolf R., downstream from St. Rd. 29 bridge, 44.75441°N 88.6047°W, V-21-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 4L, Wolf R., Co. Rd. CCC boat landing, 44.696348°N 88.578892°W, VI-2-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **WAUPACA:** 1L, Embarrass R., Behnke Rd., 44.64138°N 88.69525°W, VI-8-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 6L, Wolf R., River Rd. boat landing, 44.65431°N 88.60595°W, VI-3-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Status: *Baetisca obesa* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is the least common member of the genus in Wisconsin (Hilsenhoff 1984).

Biological Information: In the state, *B. obesa* is known mostly from larger rivers (Hilsenhoff 1984; Lillie and Hilsenhoff 1992). Throughout its range, though, *B. obesa* is known from a wider variety of habitats from cool, rapid streams to large rivers (Burks 1953; Hubbard and Peters 1978; Pescador and Berner 1981; Berner and Pescador 1988).

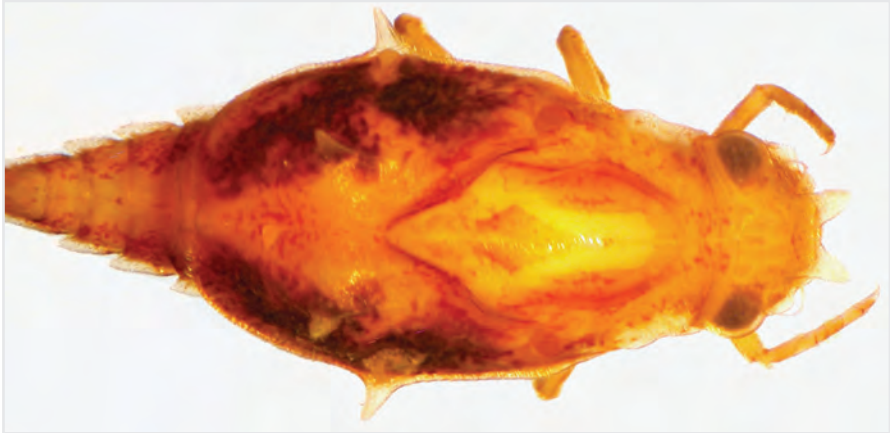


Figure 137. *Baetisca obesa,* larva.

Figure 138. Wisconsin records of *Baetisca obesa.*

10 BEHNINGIIDAE

The family Behningiidae is known from Eurasia and North America and includes only three recognized species (Kluge 2014). *Dolania* is known only from North America and is monotypic.

Dolania

Comments: Larvae of *Dolania* are some of the most unique, and rarest, mayflies in Wisconsin. The larvae are large and resemble a stonefly with patches of long setae.

Larval Keys: McCafferty (1975); Hubbard (1994).

Dolania americana Edmunds & Traver, 1959 (Figs. 139 and 140)

Larval Description: Edmunds et al. (1976).

Larval Habitus: McCafferty (1975); Edmunds et al. (1976); Berner and Pescador (1988).

Determination: Identification of *D. americana* larvae is **Easy**. *Dolania* is a monotypic genus, and the larvae are large and unlike any other mayfly in Wisconsin.

Previous Wisconsin Records: Jacobs (1990).

Status: *Dolania americana* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). The Wisconsin population is quite disjunct from the core range of the species in the southeastern United States (Randolph and McCafferty 1998). Rare in Wisconsin, the species is known from only one site on the St. Croix River (Jacobs 1990).

Biological Information: Larvae of *D. americana* prefer clean, shifting sand in cool, spring-fed rivers with moderate to high current. Larvae burrow up to 12 inches into the substrate (McCafferty 1975; Edmunds et al. 1976; Hubbard and Peters 1978).

Figure 139. *Dolania americana,* larva.

Figure 140. Wisconsin records of *Dolania americana.*

11 CAENIDAE

Five genera of Caenidae are known from Wisconsin, while a sixth (*Amercaenis*) is likely. The crawling larvae commonly are known as squaregills. Most are associated with dense vegetation, root masses, or collections of sediment. Their small size and tendency to be covered in silt and debris increases the difficulty of identifying species of caenids. A fine camel-hair brush can be used to clean specimens prior to identification.

Key to the Genera of Caenidae

1. Head with three prominent ocellar tubercles (Fig. 141a); maxillary and labial palpi two-segmented; prothoracic leg distinctly shorter than meso- and metathoracic legs **2**

Head without ocellar tubercles; maxillary and labial palpi three-segmented; prothoracic leg subequal in length to meso- and metathoracic legs **5**

2. Operculate gill with posterolateral corner evenly rounded, with curvature similar to medial edge (Fig. 141b); tergum II lacking a posteriorly directed finger-like projection just lateral of articulation with each operculate gill, or at most with a wide, flat tubercle with convergent sides **3**

Operculate gill with posterolateral corner expanded, differing significantly from curvature of medial edge (Fig. 141c); tergum II with a posteriorly directed finger-like projection just lateral of articulation with each operculate gill, this projection elongate, parallel-sided, and often projecting above the tergum in lateral view (Fig. 141d) . . ***Brachycercus***

3. Meso- and metasternum each with a medial process (Fig. 141e); median ocellar tubercle curved ventrally at apex (best observed in lateral view) . . . . . ***Susperatus prudens***

Meso- and metasternum without medial processes; medial ocellar tubercle straight or curved dorsally at apex **4**

4. Abdominal segment VI with apices of posterolateral projections strongly curved medially (Fig. 141f); first segment of labial palpus with a ventral patch of long setae (Fig. 141g); protarsus with many setae longer than twice the width of the tarsus . . . . . ***Cercobrachys***

Abdominal segment VI with apices of posterolateral projections directed posteriorly rather than medially in mature larvae (Fig. 141b) and slightly medially in immature larvae; first segment of labial palpus lacking a ventral patch of long setae, but with scattered short, spatulate setae (Fig. 141h–i); protarsus with only scattered setae longer than twice the width of the tarsus . . . . . ***Sparbarus***

5. Protibia and protarsus with ventral margins densely covered with fine, long setae (Fig. 141j); not known from Wisconsin . . . . . ***Amercaenis ridens***

Protibia and protarsus with ventral margins bearing only stout spines and short setae (Fig. 141k) . . . . . ***Caenis***

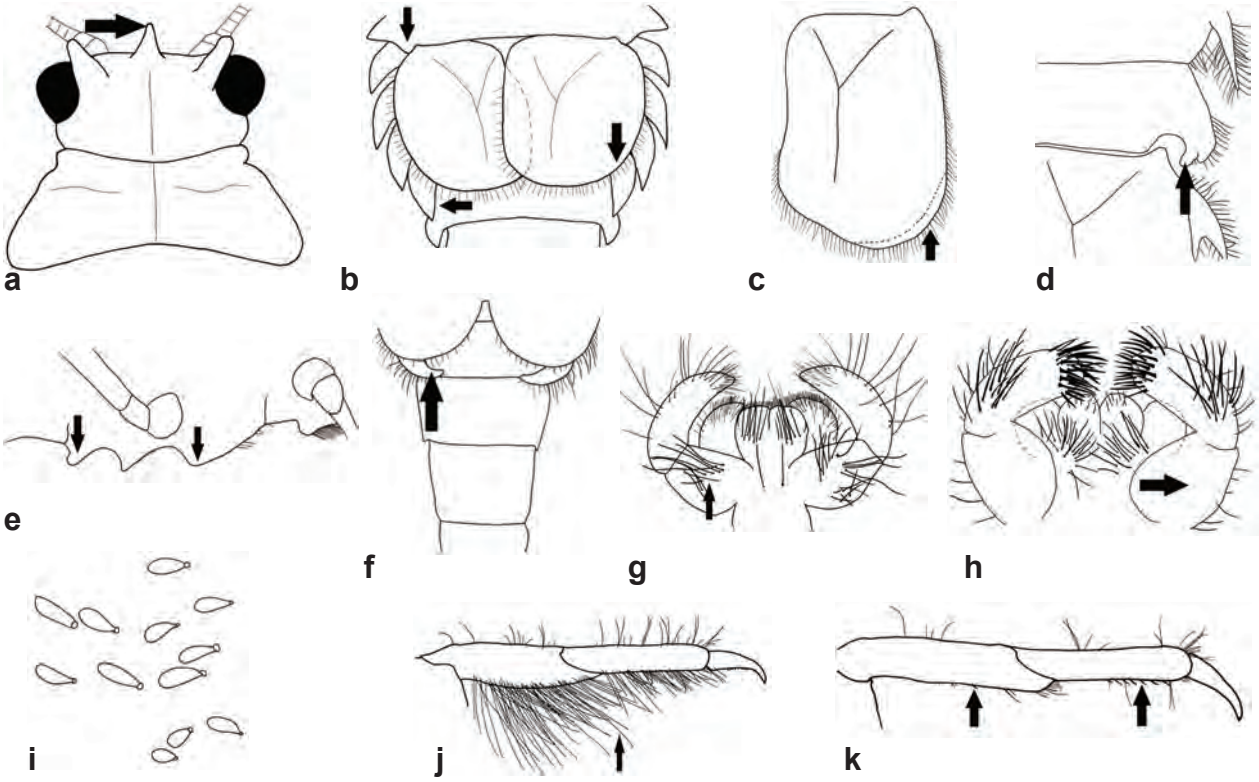


Figure 141. Caenidae. **a,** *Sparbarus lacustris,* head (dorsal); **b,** *S. lacustris,* terga II–VIII; **c,** *Brachycercus harrisella,* operculate gill; **d,** *B. harrisella,* terga I–III; **e,** *Susperatus prudens,* thoracic sterna (lateral); **f,** *Cercobrachys lilliei,* terga VI–IX; **g,** *C. lilliei,* labium (ventral); **h,** *Sparbarus lacustris,* labium (ventral); **i,** *S. lacustris,* setae from basal segment of labial palpus; **j,** *Amercaenis ridens,* front tarsus; **k,** *Caenis latipennis,* front tarsus.

Amercaenis

Comments: Larvae of *Amercaenis* strongly resemble *Caenis* and misidentifications are likely. In addition, as the genus formerly was included in *Caenis*, larvae of *Amercaenis* likely occur in unsorted batches of hard-to-identify caenids.

Determination: Identification of *Amercaenis* in Wisconsin is **Fairly Easy**. Only one species is known from the state.

Larval Key: Provonsha (1990).

Amercaenis ridens (McDunnough), 1931 (Fig. 142)

Taxonomic History: *Amercaenis ridens* (McDunnough), 1931 (curr. comb., Provonsha and McCafferty 1985); *Caenis ridens* McDunnough, 1931 (orig.).

Larval Description and Habitus: Provonsha and McCafferty (1985).

Determination: Identification of *A. ridens* larvae is **Fairly Easy**. They are more likely overlooked than misidentified. The only other species in the genus, *A. cusabo* Provonsha & McCafferty, is known only from the southeastern United States.

Previous Wisconsin Records: None. Nearest records are from several counties in Iowa (Klubertanz 1995; McCafferty et al. 2003a). The Illinois record of this species in Burks (1953) was corrected to *Caenis anceps* by Provonsha and McCafferty (1985).

It is likely that *A. ridens* will eventually be found in southern or southwestern Wisconsin.

Biological Information: *Amercaenis ridens* is known from medium to large rivers. Larvae typically cover themselves with sand when disturbed (Provonsha and McCafferty 1985).

Figure 142. *Amercaenis ridens,* larva.

Brachycercus

Comments: There currently are four recognized species of *Brachycercus*, two of which are known from Wisconsin.

Determination: Identification of *Brachycercus* larvae is **Fairly Easy** at the generic level, and **Moderately Easy** for species within the genus. Because of taxonomic changes and previously unrecognized taxonomic characters, all identifications of *Brachycercus* made prior to Sun and McCafferty (2008) should be checked for accuracy.

Larval Keys: Soldan (1986); Sun and McCafferty (2008).

Key to the Species of *Brachycercus*

1. Mesosternum with one or two medial processes projecting ventrally in lateral view (Fig. 143a) . . . . . ***B. harrisella***

Mesosternum flat, without medial processes (Fig. 143b) . . . . . ***B. ojibwe***

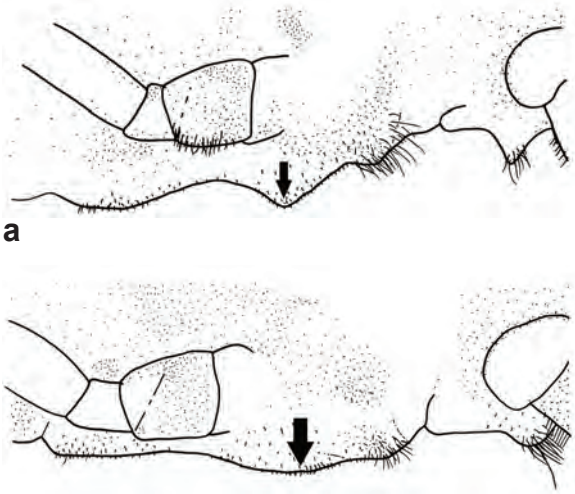


Figure 143. *Brachycercus* (Caenidae). **a,** *B. harrisella,* thoracic sterna; **b,** *B. ojibwe,* thoracic sterna.

Brachycercus harrisella Curtis, 1834 (Figs. 144 and 145)

Taxonomic History: *Brachycercus arcticus* Soldan, 1986 (syn.); *Brachycercus edmundsi* Soldan, 1986 (syn.); *Brachycercus magnus* Tshernova, 1952 (syn.); *Brachycercus pallidus* Tshernova, 1928 (syn.); *Brachycercus* sp. YUa Quan, Bae, Jung, and Lee, 2002 (syn.); *Caenis harrisella* (Curtis), 1834 (comb.); *Caenis pennata* Stephens, 1835 (syn.); *Eurycaenis harrisella* (Curtis), 1834 (comb.).

Larval Descriptions: Soldan (1986), as *B. arcticus*, *B. edmundsi*, *B. harrisella*, *B. pallidus*, and *B. magnus*; Quan et al. (2002), as *Brachycercus* YUa; Sun and McCafferty (2008).

Larval Habitus: Macan (1955); Elliott et al. (1988); Sun and McCafferty (2008).

Determination: Identification of *B. harrisella* larvae is **Moderately Easy**. The medial processes on the mesosternum (Fig. 143a) are visible in both mature and relatively early instars. These processes are most easily observed in lateral view.

Previous Wisconsin Records: Sun and McCafferty (2008).

New County Records: BUFFALO: 1L, Spring Crk., VI-27-1972 (UW); 3L, Trempealeau R., Co. Rd. P, 2 mi. N. of St. Rd. 35, VII-10-2013, K. L. Schmude (UWS); **EAU CLAIRE:** 3L, Elk Crk., Co. Line Rd., 6 mi. NW. of Eau Claire, 44°51'20"N 91°38'58"W, VII-12-2011, THK (THK); **MARQUETTE:** 1L, Neenah Crk., VI-28-1968 (UW); **POLK:** St. Croix R., Sunrise, VI-10-1996 (WiDNR); **VERNON:** 2L, Kickapoo R., VII-2-1974 (UW); **WAUPACA:** 1L, Waupaca R., VI-4-1980 (UW).

Biological Information: Despite being known from both North America and Europe, relatively little is published about the biology of *B. harrisella* (Soldan 1986). Wisconsin records of this species range from the first- to second-order Spring Creek in Buffalo County to a sixth-order reach of the St. Croix River in Polk County, indicating little selectivity of river size. In the Elk River (Eau Claire County), I have found this species in shoreline root masses and emergent vegetation with moderate amounts of silt. Larvae are sluggish and commonly covered in mud, making them difficult to locate in samples containing sediment.

Figure 144. *Brachycercus harrisella,* larva.

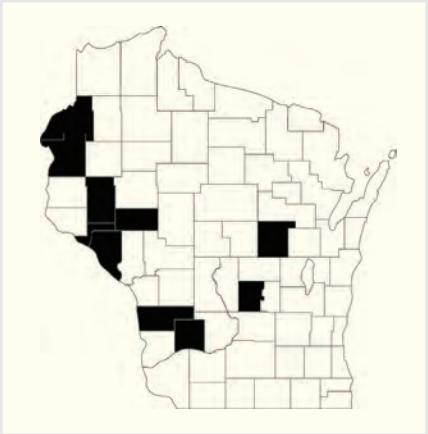


Figure 145. Wisconsin records of *Brachycercus harrisella.*

Brachycercus ojibwe Sun & McCafferty, 2008 (Figs. 146 and 147)

Larval Description and Habitus: Sun and McCafferty (2008).

Determination: Identification of *B. ojibwe* larvae is **Moderately Easy**. The lack of medial processes on the mesosternum (Fig. 143b) is distinctive in both mature and relatively early instars.

Previous Wisconsin Records: Sun and McCafferty (2008).

New County Records: BUFFALO: 1L, Trempealeau R., St. Rd. 35, VII-10-2013, K. L. Schmude (UWS); **FLORENCE:** 1L, Menominee R., Kingsford, T38NR19E S3, VI-24-1997 (WiDNR); **MARINETTE:** 1L, Eagle Crk., X-3-1968 (UW); **POLK:** 2L, McKenzie Crk., VI-6-1978 (UW); 1L, St. Croix R., Sunrise, VI-10-1996 (WiDNR); **PRICE:** 1L, S. Fork Flambeau R., VII-19-1968 (UW).

Status: *Brachycercus ojibwe* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is more widespread and common in the state, however, than *B. harrisella*.

Biological Information: *Brachycercus ojibwe* was described by Sun and McCafferty (2008) from larvae collected in Wisconsin. Because it was so recently discovered, almost nothing is known about its biology. It is likely that the biology of this species is similar to that of *B. harrisella*, as the two species have occasionally been taken together. Records listed above and those in Sun and McCafferty (2008) come from medium to large rivers throughout the state, including the Wisconsin, Chippewa, St. Croix, and Menominee Rivers. Eagle Creek in Marinette County is one of the smaller rivers for this species.

Figure 146. *Brachycercus ojibwe,* larva.

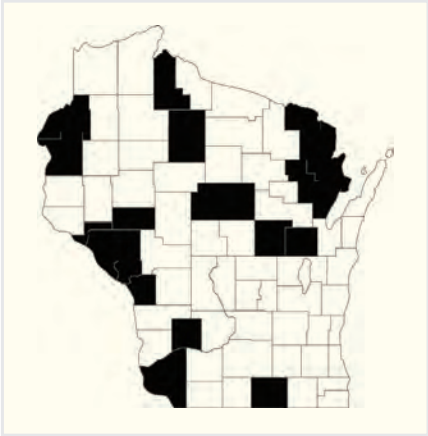


Figure 147. Wisconsin records of *Brachycercus ojibwe.*

Caenis

Comments: *Caenis* larvae generally prefer quiet or stagnant water, where rooted vegetation and debris accumulate (Edmunds et al. 1976). During field collection, patience often is required to find the small larvae crawling slowly among vegetation and other organic matter. There are 13 recognized species in North America, with eight known from Wisconsin.

Determination: Identification of *Caenis* larvae is **Moderately Easy** at the generic level, but **Slightly Difficult to Difficult** for species within the genus. Their small size and a lack of consistent markings make field identification of the species virtually impossible. A good dissecting microscope and slide mounts of legs often are required. Some specimens exhibit intermediate morphology and are extremely difficult to identify, suggesting the possibility of hybrids.

Larval Key: Provonsha (1990).

Key to the Species of *Caenis*

1. Sternum IX with notched posterior margin (Fig. 148a–b), though sometimes only slightly; profemur with a transverse row of spatulate setae in apical third of anterior surface; terga IX and X never with triads of well-formed black dots on both segments **2**

Sternum IX with rounded or truncate posterior margin (Fig. 148c–d); profemur with only scattered setae over anterior surface; terga IX and X usually with triads of black dots (Fig. 148e). **4**

2. Middle portion of each caudal filament with whorls of short setae on every second or third segment, setae much shorter than space between whorls (Fig. 148f); sternum IX with moderately notched posterior margin (Fig. 148b); operculate gill pale basally and brown apically (Fig. 152); metatarsus with four to six simple spurs along ventral margin; metatarsal claw with four to six denticles . . . . . ***C. anceps***

Middle portion of each caudal filament with long lateral setae on every segment, setae much longer than space between whorls (Fig. 148g); metatarsus with six to thirteen simple spurs along ventral margin (Fig. 148j); other characters variable **3**

3. Operculate gill of mature larva with distinct brown and white pattern, with Y-ridge forked at or slightly basad of midlength, and with five to six setae along medial branch (Fig. 148h); metatarsus with six to nine simple spurs along ventral margin (Fig. 148j); terga VII–IX often with black lateral dashes (Fig. 148i) . . . . . ***C. hilaris***

Operculate gill uniform brown, Y-ridge forked distad of midlength, and with ten to twelve setae along medial branch (Fig. 148k); metatarsus with eleven to thirteen simple spurs along ventral margin (Fig. 148l); terga VII–IX lacking black lateral dashes (Fig. 162) . . . . . ***C. tardata***

4. Tergum II with posteromedian projection that is long, straight, projecting upward, with apex rounded in lateral view, and truncate in dorsal view (Fig. 149a); pronotum with lateral margins strongly divergent anteriorly (Fig. 149e). . . ***C. youngi***

Tergum II with posteromedian projection that is of moderate length, slightly to moderately hooked, and pointed or rounded in dorsal view (Fig. 149b–c); pronotum with subparallel lateral margins (Fig. 149d) (mature larvae only—immature larvae have pronotal margins more similar to *C. youngi)* **5**

5. Sternum IX with truncate posterior margin (Fig. 148d); metafemur with inner marginal setae almost as long as outer marginal setae; metatarsus with five to seven fimbriate spurs (Fig. 149f) . . . . . ***C. latipennis***

Sternum IX with rounded posterior margin (Fig. 148c); metafemur with ventral marginal setae much shorter than dorsal marginal setae (Fig. 149i); metatarsus with five to eleven fimbriate spurs (Fig. 149g) **6**

6. Metatarsal claw with only nine to eleven denticles, usually fairly even in size or gradually increasing in size towards end of claw (Fig. 149h) . . . . . ***C. amica***

Metatarsal claw with at least sixteen denticles, with basal four to six distinctly larger than others (Fig. 149k, m). **7**

7. Metatarsus with nine to eleven fimbriate spurs (Fig. 149j); antennal scape and pedicel usually stained with dark brown (fading in alcohol); examination of a series of specimens recommended . . . . . ***C. diminuta***

Metatarsus with only six to eight fimbriate spurs (Fig. 149l), though spurs commonly break off; antennal scape and pedicel pale; examination of a series of specimens recommended . . . . . ***C. punctata***

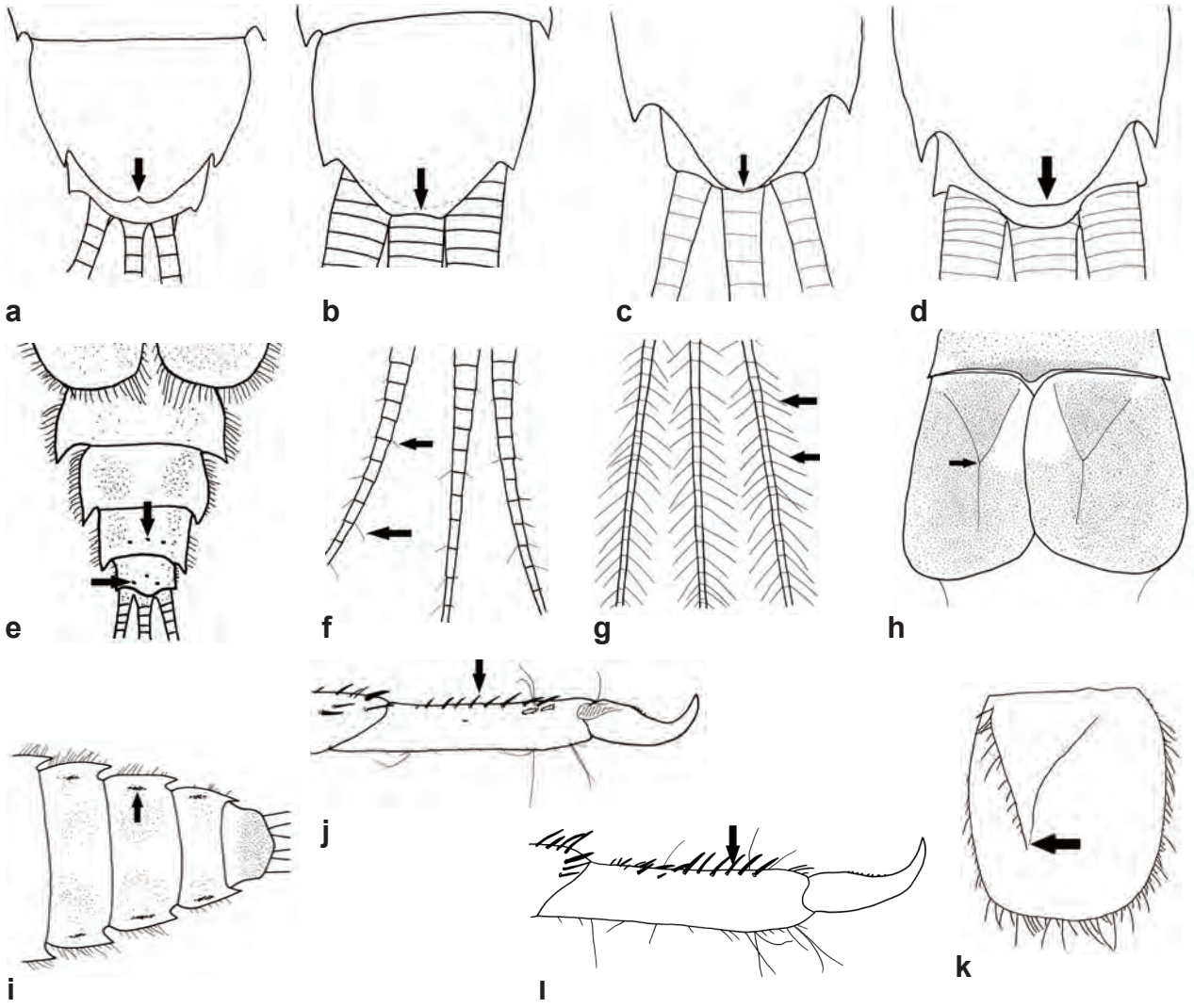


Figure 148. *Caenis* (Caenidae). **a,** *C. hilaris,* sternum IX; **b,** *C. anceps,* sternum IX; **c,** *C. amica,* sternum IX; **d,** *C. latipennis,* sternum IX; **e,** *C. latipennis,* terga VII–X; **f,** *C. anceps,* tails; **g,** *C. hilaris,* tails; **h,** *C. hilaris,* operculate gills; **i,** *C. hilaris,* terga VI–X; **j,** *C. hilaris,* hind tarsus; **k,** *C. tardata,* operculate gill; **l,** *C. tardata,* hind tarsus (posterior).

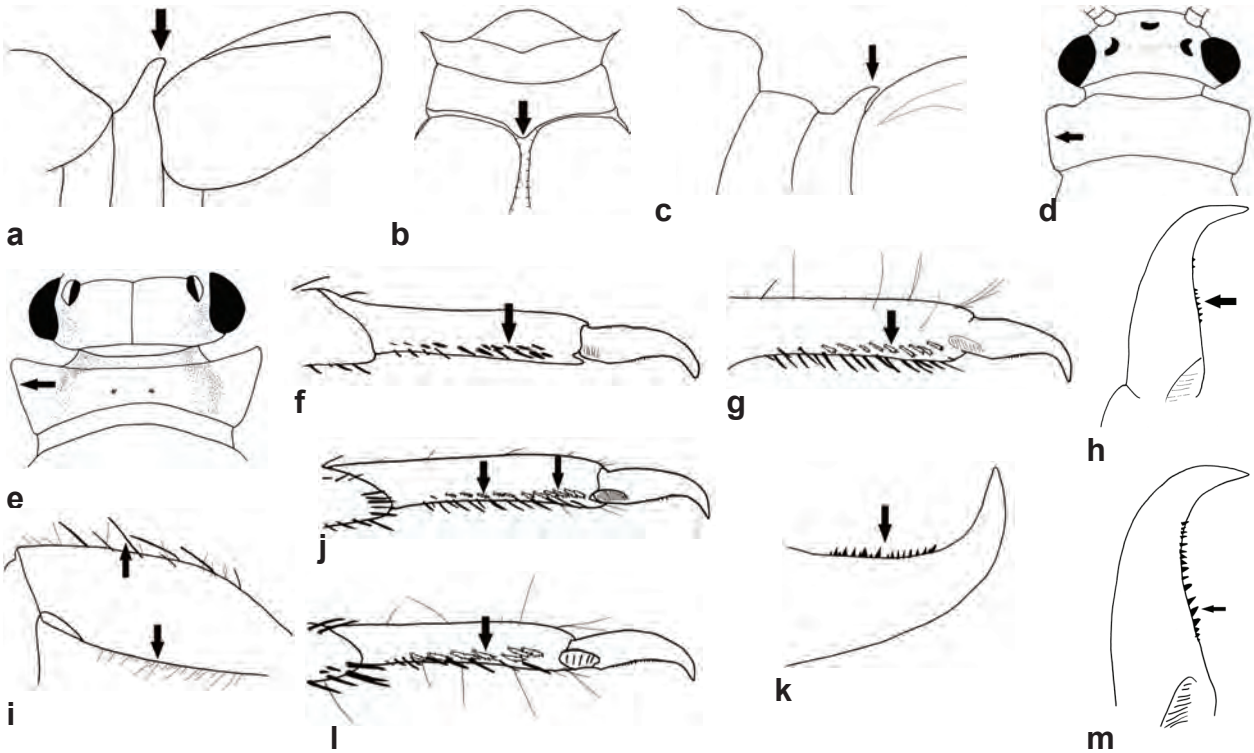


Figure 149. *Caenis* (Caenidae). **a,** *C. youngi,* terga I–III (lateral); **b,** *C. latipennis,* terga I–III (dorsal); **c,** *C. latipennis,* terga I–II (lateral); **d,** *C. latipennis,* head and pronotum; **e,** *C. youngi,* head and pronotum; **f,** *C. latipennis,* hind tarsus; **g,** *C. amica,* hind tarsus; **h,** *C. amica,* hind claw; **i,** *C. diminuta,* hind femur; **j,** *C. diminuta,* hind tarsus; **k,** *C. diminuta,* hind claw; **l,** *C. punctata,* hind tarsus; **m,** *C. punctata,* hind claw.

Caenis amica Hagen, 1861 (Figs. 150 and 151)

Taxonomic History: *Caenis simulans* McDunnough, 1931 (syn.).

Larval Description: Provonsha (1990).

Larval Habitus: Burks (1953), as *C. simulans*; Provonsha (1990).

Determination: Identification of *C. amica* larvae is **Moderately Difficult**. Each step in the key prior to *C. amica* presents its own difficulty. Examination of slide-mounted legs is required. Claw denticles in some specimens of *C. tardata* and *C. punctata* are highly worn and not visible unless properly examined under higher magnification.

Previous Wisconsin Records: Provonsha (1990); Randolph and McCafferty (1998).

New County Records: ROCK: 1L, Raccoon Crk., Beckman Mill Co. Pk., V-26-2006, THK (THK); **WAUKESHA:** 1L, Jericho Crk., bridge on Co. Rd. NN in Jericho; T5NR17E S24, V-31-2011, THK, C. Brown, and E. Wolf (THK).

Biological Information: As with most members of the genus, *C. amica* likely is more common and widely distributed than published records indicate (Randolph and McCafferty 1998).

The species is known from a wide range of habitats, and apparently tolerates pollution well (Burks 1953). In stream habitats, it occurs in depositional areas with slow or no current where silt accumulates (Burks 1953; Provonsha 1990). In particular, it prefers combinations of well-sorted fine sediment and organic material collected around aquatic or submerged plant roots (Burian and Gibbs 1991).

Figure 150. *Caenis amica,* larva.

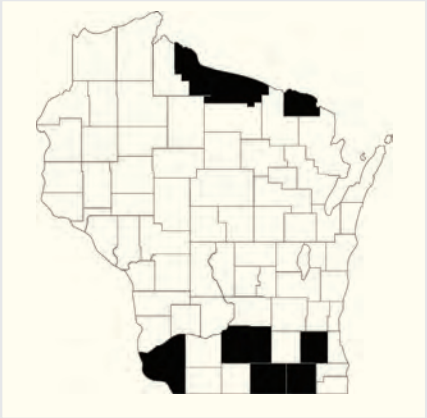


Figure 151. Wisconsin records of *Caenis amica.*

Caenis anceps Traver, 1935 (Figs. 152 and 153)

Larval Description and Habitus: Provonsha (1990).

Determination: Identification of *C. anceps* larvae is **Slightly Difficult**. The species is easier to identify than most members of the genus. In other members of the genus, the caudal filaments have long, lateral setae throughout most of their length (as in Fig. 148g). In *C. anceps*, such setae are located only on the distal third of the caudal filaments, if at all (Fig. 148f). The remaining length has whorls of setae distributed farther apart from each other than their length.

Previous Wisconsin Records: Randolph and McCafferty (1998).

New County Records: BARRON: 1L, Brill R., 29th Ave., 1.5 mi. N. of Brill, 45°37'28"N 91°40'38"W, VII-15-2011, THK (THK); **BURNETT:** 1L, St. Croix R., no date (likely Summer 1998) (WiDNR); 1L, St. Croix R., canoe landing on S. Markville Rd., 1000 ft. W. of St. Rd. 35 bridge, 46°4'26"N 92°15'3"W, VII-13-2011, THK (THK); **CLARK:** 8L, Black R., Bryan Rd., 44.501753°N 90.636741°W, VII-3-2008, K. L. Schmude, R. A. Lillie, and A. Reynolds (UWS); 3L, Black R., Co. Rd. H, 44.654145°N, 90.626645°W, VII-3-2008, K. L. Schmude, R. A. Lillie, and A. Reynolds (UWS); larvae, Black R., no date, W. J. O. (UWGB); **FLORENCE:** 11L, Menominee R., below Cowboy Lk. dam, 2 mi. W. of Iron Mountain, VI-24-1998 (WiDNR); **JACKSON:** 1L, Black R., River Rd. Canoe Launch, VII-11-2013, K. L. Schmude (UWS); **MARINETTE:** 4L, Menominee R., below Cowboy Lk. dam, 2 mi. W. of Iron Mountain, VI-24-1998 (WiDNR); 2L, Menominee R., Faithorn, T36NR22E S6, VI-20-1998 (WiDNR); 15L, Menominee R., Jones Landing, 1.5 mi. NW. of Faithorn, T37NR22E S8, VI-29-1998 (WiDNR); 5L, Pike R., VI-30-1998 (WiDNR); 5L in two vials, Menominee R., below Sturgeon Dam, 4 mi. SE. of Norway, VI-30-1998 (WiDNR); **OCONTO:** 4L in two vials, Lk. Michigan, off mouth of Oconto R., VI-6-2012 and VII-18-2012, A. Bell (UWS); **OZAUKEE:** 2M, T11NR21E S29-30, VI-7-1979, D. Hildebrandt and M. Plonczynski (MPM); **POLK:** 1L, Wolf Crk., River Rd. in Wolf Creek, 45°33'23"N 92°43'23"W, VII-13-2011, THK (THK); **PRICE:** 3L, S. Fork Flambeau R., St. Rd. 13, T39NR1E S18, VI-24-1998, R. A. Lillie (WiDNR); **ROCK:** 2L, Turtle Crk., Carvers Rock Rd., 2.5 mi. NE. of Clinton, T2NR14E S27, VIII-5-2011, THK, C. Brown, and E. Wolf (THK); **RUSK:** 4L, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998 (WiDNR); 3L (including blackwing), Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998 (WiDNR); **SAWYER:** at least 48L in three vials, Chippewa R., Town Line Rd., T37NR7W S35, VI-23-1998, R. A. Lillie (WiDNR); **ST. CROIX:** 3L, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); **WASHBURN:** 13L in two vials, Bean Brk., Hwy. 63, 2 mi. SW. of Springbrook 45°55'17"N 91°43'50"W, VII-15-2011, THK (THK); 13L, Brill R., Bridge Rd., 2.5 mi. N. of Brill, 45°38'21"N 91°40'27"W, VII-15-2011, THK (THK); 5L, Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK).

Status: *Caenis anceps* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is common in many streams in northern Wisconsin, but uncommon to rare in the south.

Biological Information: *Caenis anceps* occurs in streams with moderate current and with sand or fine gravel substrates (Hubbard and Peters 1978; Provonsha 1990). Most Wisconsin records come from third- to sixth-order streams and rivers.

Figure 152. *Caenis anceps,* larva.

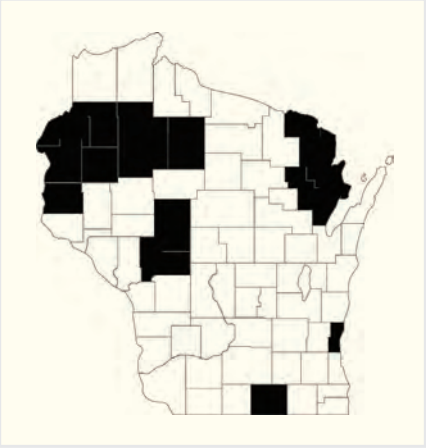


Figure 153. Wisconsin records of *Caenis anceps.*

Caenis diminuta diminuta Walker, 1853 (Figs. 154 and 155)

Taxonomic History: *Caenis diminuta* Walker, 1853 (orig.).

Larval Description: Needham and Betten (1901).

Larval Habitus: Berner and Pescador (1988).

Determination: Identification of *C. d. diminuta* larvae is **Difficult**. Each step in the key prior to this species presents its own difficulty. Preparation of slide mounts of legs and examination of fresh specimens are required. Fimbriate setae on tarsi (Fig. 149j) often are difficult to count and break easily.

Previous Wisconsin Records: Muttkowski (1918); Provonsha (1990); Lillie and Hilsenhoff (1992).

New County Records: CLARK: 9L, S. Branch Yellow R., Fair Haven Rd., site "Wiscn 11857", 44.634558°N 90.316366°W, Summer 2012, K. L. Schmude (UWS); **FOND DU LAC:** 1L, Milwaukee R., Eagle Rd., T14NR18E S15, VI-29-1978, S. Borkin and G. Johnson (MPM); **KEWAUNEE:** 3L, Silver Crk., Willow Rd., 44.607991°N 87.470315°W, Summer 2012, K. L. Schmude (UWS); **OZAUKEE:** 2L, Mud Lk., T11NR21E S31, VI-27-1978, J. Jones and G. Johnson (MPM); **RACINE:** 3L, Fox R., Fox R. Rd. Bridge, T4NR19E S10, VIII-13-1976, J. Jass (MPM); **ROCK:** 7L, Gibbs Lk., Gibbs Lk. Co. Pk., 42°47'6"N 89°10'52"W, VII-7-2011, THK, C. Brown, and E. Wolf (THK); Raccoon Crk., Beckman Mill Co. Pk., V-26-2006, THK (THK); **SAWYER:** 2L, Flambeau R., Hervas, T37NR4W S35, VI-19-1997 (WiDNR); **WALWORTH:** 8L, Rice Lk., E. shore, T4NR15E S26, V-30-1978, S. Borkin (MPM); **WAUKESHA:** 2L, Jericho Crk, Twp. Rd. X, 2.5 mi. N. of Jericho, NE. corner of T5N, V-31-2011, THK, C. Brown, and E. Wolf (THK); **WINNEBAGO:** 25A and 2Ex., N. shore of Lk. Butte des Morts, VI-3-1982, G. Drecktrah (UWO); 10L (including blackwing), Lk. Poygan, VI-4-1979, M. Brosseau (UWO); **WOOD:** 9L, S. Branch Yellow R., Fair Haven Rd., site "Wiscn 11857", 44.634558°N 90.316366°W, Summer 2012, K. L. Schmude (UWS).

Status: *Caenis diminuta* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It likely is more widespread in the state than published records indicate because of the difficulty of identification.

Biological Information: *Caenis diminuta* is known from a wide range of habitats, including wetlands and pools, but generally prefers areas with slow or no current where silt accumulates around emergent vegetation (Needham and Betten 1901; Hubbard and Peters 1978; Berner and Pescador 1988; Provonsha 1990; Burian and Gibbs 1991). It is tolerant of a wide range of environmental conditions and water quality (Berner and Pescador 1988).

Figure 154. *Caenis diminuta,* larva.

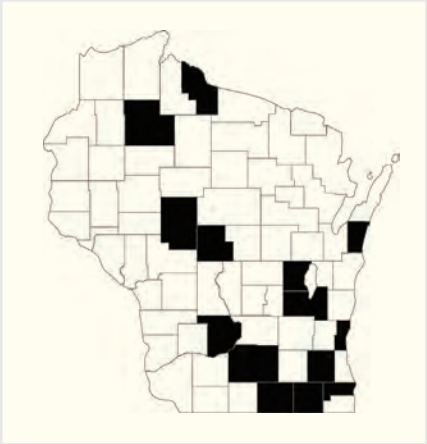


Figure 155. Wisconsin records of *Caenis diminuta.*

Caenis hilaris (Say), 1839 (Figs. 156 and 157)

Taxonomic History: *Caenis hilaris* (Say), 1839 (curr. comb., Walker 1853); *Ephemera hilaris* Say, 1839 (orig.).

Larval Description and Habitus: Provonsha (1990).

Determination: Identification of *C. hilaris* larvae is **Slightly to Moderately Difficult**. Those specimens with distinct lateral dashes on abdominal terga VII–IX (Fig. 148i) and patterning on operculate gills (Fig. 148h) are distinctive. Unfortunately, many specimens lack these distinctive markings and require slide mounts of metatarsi. Some specimens are morphologically intermediate between *C. hilaris* and *C. tardata* and cannot be identified reliably.

Previous Wisconsin Records: Provonsha (1990); Lillie and Hilsenhoff (1992).

New County Records: BUFFALO: 1L, Chippewa R., St. Rd. 35, E. side of river, VII-10-2013, K. L. Schmude (UWS); **BURNETT:** 1L, St. Croix R., Sand Rock Cliffs, T38NR19W S7, 5 mi. NW. of Grantsburg, VI-17-1997 (WiDNR); **DANE:** 1L, W. Branch Sugar R., Co. Rd. PB, 1.6 mi. NW. of Belleville, 42°52'45"N 89°33'32"W, VIII-8-2011, THK, E. Wolf, and C. Brown (THK); **PRICE:** S. Fork Flambeau R., St. Rd. 13, T39NR1E S18, VI-24-1998 (WiDNR); **RUSK:** numerous L, Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998, R. A. Lillie (WiDNR); 1L, N. Fork Chippewa R., Hwy. 8, ½ mi. E. of Bruce, 45°27'8"N 91°15'37"W, VII-15-2011, THK (THK); **SAUK:** 1L, Otter Crk., St. Rd. 60, 2.5 mi. W. of Sauk City, 43°16'16"N 89°47'5"W, VII-26-2011, THK (THK); **SAWYER:** Chippewa R., Town Line Rd., T37NR7W S35, VI-23-1998, R. A. Lillie (WiDNR); **ST. CROIX:** 2L, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); **WASHBURN:** 1L, Spring Crk., Hamilton Rd., 0.9 mi. NW. of Springbrook, 45°57'27"N 91°42'11"W, VII-15-2011, THK (THK).

Status: *Caenis hilaris* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b), though the records above indicate that it occurs widely throughout the state.

Biological Information: *Caenis hilaris* prefers moderate to large rivers (Burks 1953; Provonsha 1990; Webb et al. 2004), though it is known from smaller, third- to fourth-order creeks as shown in the records above from Otter Creek (Sauk Co.) and Spring Creek (Washburn Co.). It has been reported from eddies or backwaters as well as in river channels (Burks 1953; Hubbard and Peters 1978; Provonsha 1990), though Berner and Pescador (1988) in Florida observed that the species avoids swift current. Substrates ranging from vegetation to clean, fine sand, to poorly sorted gravel and detritus were reported by Berner and Pescador (1988) and Provonsha (1990).

Figure 156. *Caenis hilaris,* larva.

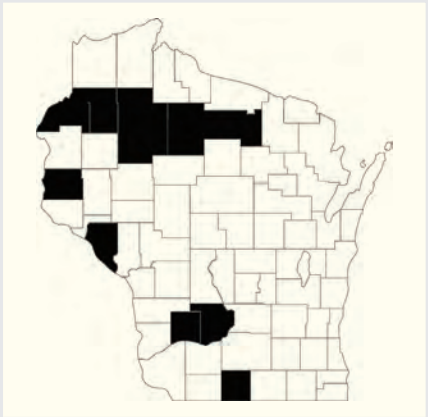


Figure 157. Wisconsin records of *Caenis hilaris.*

Caenis latipennis Banks, 1907 (Figs. 158 and 159)

Taxonomic History: *Caenis delicata* Traver, 1935 (syn.); *Caenis forcipata* McDunnough, 1931 (syn.); *Caenis gigas* Burks, 1953 (syn.); *Caenis jocosa* McDunnough, 1931 (syn.).

Larval Description: Provonsha (1990).

Larval Habitus: Provonsha (1990).

Determination: Identification of *C. latipennis* larvae is **Slightly Difficult**. With practice, the truncate posterior margin of sternum IX (Fig. 148d) can be recognized quite rapidly. In many specimens, debris blocks a clear view of the ninth sternum. A fine brush easily removes such debris. In *Caenis*, at the base of the caudal filaments and beneath (dorsal of) the ninth sternum, is a variously developed transverse ridge that can be quite visible through the sternal plate. The shape of this ridge is similar to the ninth sternum of *C. latipennis,* potentially resulting in erroneous identification of other species as *C. latipennis*. Though many larvae of *C. latipennis* have pale freckles over the thoracic notum, such freckles can be present in many other species of *Caenis* and is not a reliable character. The posteromedian projection on tergum II varies considerably in height above the tergum and overall shape in lateral view (Fig. 149c), with some young larvae weakly suggestive of *C. youngi*.

Previous Wisconsin Records: Provonsha (1990); Randolph and McCafferty (1998).

New County Records: ASHLAND: 1L, N. Fork Flambeau R., Holt's Landing, T41NR1E S21, VI-19-1997 (WiDNR); **BARRON:** 2L, Brill R., 29th Ave., 1.5 mi. N. of Brill, 45°37'28"N 91°40'38"W, VII-15-2011, THK (THK); **BAYFIELD:** 2L, Namekagon R., IV-20-1986, THK (THK); 1F, 0.5 mi. W. of Pigeon Lk. Field Station, VI-26-1975, G. Drecktrah (UWO); **BROWN:** Town of Scott, Volk's Landing, VI-27-2007, J. Lee (UWGB); **CHIPPEWA:** 1L, Chippewa R., Cornell, T31NR7W S24, VI-19-1997 (WiDNR); **CLARK:** 2L, Cunningham Crk., St. Rd. 73, site "Blackr 2819", 44.531259°N 90.597912°W, K. L. Schmude (UWS); **DANE:** 1M, Lk. Waubesa, VII-12-1996, THK (THK); **DOOR:** 1L, Ahnapee R., below Forestville Dam, V-22-2010, THK (THK); **DOUGLAS:** 1L, Amnicon R., S. Amnicon R. Rd., site "Lksup 1406", 46.690863°N 91.857244°W, Summer 2012, K. L. Schmude (UWS); **FLORENCE:** 1L, Menominee R., Florence, VI-26-1996 (WiDNR); **GRANT:** 1L (with Ex.), Wisconsin R., Dead Lk. St. Nat. Area, 1 mi. N. of Woodman, T7NR4W S12, VII-25-2011, THK (THK); 1L, Wisconsin R., Woodman, 3–4 ft. moderate flow with sand, VI-6-1986, R. A. Lillie (UW); **JACKSON:** 2L, Black R., St. Rd. 71, VII-11-2013, K. L. Schmude (UWS); **OCONTO:** 1L, Lk. Michigan, off mouth of Oconto R., VI-6-2012, A. Bell (UWS); **OUTAGAMIE:** 1L, Shiocton, V-12-1994, C. Taylor (UWO); **RACINE:** 2L, Fox R., Fox R. Rd. Bridge, T4NR19E S10, VIII-13-1976, J. Jass (MPM); **RUSK:** 3L in two vials, Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998, R. A. Lillie (WiDNR); 3L, Flambeau R., Washington, T33NR7W S22, VI-28-1998, R. A. Lillie (WiDNR); 2L, N. Fork Main Crk., V-21-1969 (UW); **SAUK:** 2L, Wisconsin R., Prairie Du Sac Dam, 0–1 ft. moderate flow gravel bar riffle, V-30-1986, R. A. Lillie (UW); 1L, Wisconsin R., Spring Green, 3 ft. slow current sandbar drop-off, VII-14-1985, R. A. Lillie (UW); **SAWYER:** 3L in two vials, Flambeau R., Hervas, T37NR4W S35, VI-19-1997 (WiDNR); 12L in two vials, Flambeau R., Oxbo Rd., T39NR3W S14, VI-18-1997 (WiDNR); **ST. CROIX:** 14L, Eau Galle R., Co. Rd. N, 3 mi. S. of Woodville, 44°54'18"N 92°15'53"W, VII-12-2011, THK (THK).

Biological Information: *Caenis latipennis* is the most ubiquitous species in the genus known from Wisconsin. It is known from a wide range of current rates and substrates (Ferro and Sites 2007), especially where silt accumulates around emergent vegetation, and is fairly pollution tolerant (Provonsha 1990).

Figure 158. *Caenis latipennis,* larva.

Figure 159. Wisconsin records of *Caenis latipennis.*

Caenis punctata McDunnough, 1931 (Figs. 160 and 161)

Larval Description: Provonsha (1990).

Determination: Identification of *C. punctata* larvae is **Difficult**. Each step in the key prior to this species presents its own difficulty. Preparation of slide mounts of legs and examination of fresh specimens are required. Fimbriate setae on tarsi (Fig. 149l) are often difficult to count and break easily.

Previous Wisconsin Records: Provonsha (1990); Lillie and Hilsenhoff (1992).

New County Records: ASHLAND: 1L, N. Fork Flambeau R., Holt's Landing, T41NR1E S21, VI-19-1997 (WiDNR); **DOUGLAS:** 1L, Amnicon R., S. Amnicon R. Rd., site "Lksup 1406", 46.690863°N 91.857244°W, Summer 2012, K. L. Schmude (UWS); **RUSK:** 1L, Little Soft Maple Crk., Kief Rd., site "Chipr 7645", 45.448368°N 91.379094°W, Summer 2012, K. L. Schmude (UWS).

Status: *Caenis punctata* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: Provonsha (1990) described the substrate of *C. punctata* as sand or fine gravel in waters with little to no current.

Figure 160. *Caenis punctata,* larva.

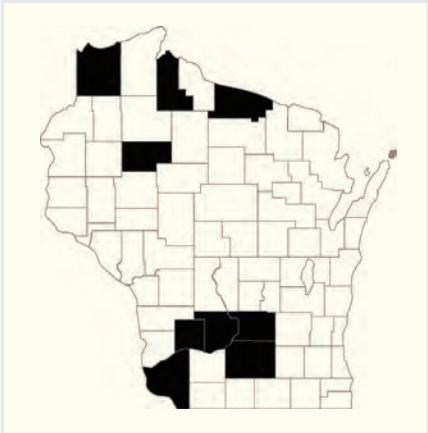


Figure 161. Wisconsin records of *Caenis punctata.*

Caenis tardata McDunnough, 1931 (Figs. 162 and 163)

Larval Description: Provonsha (1990).

Determination: Identification of *C. tardata* larvae is **Moderately Difficult**. Their operculate gills are more uniformly brown (Fig. 162) than in *C. hilaris* and *C. anceps*. Preparation of slide mounts of metatarsi usually is required for species confirmation. Some specimens are intermediate between *C. hilaris* and *C. tardata* and cannot be identified reliably.

Previous Wisconsin Records: Lillie and Hilsenhoff (1992).

New County Records: BUFFALO: 7L, Chippewa R., St. Rd. 35, E. side of river, VII-10-2013, K. L. Schmude (UWS); **BURNETT:** 1L, Wood R., St. Rd. 70, ½ mi. SW. of Grantsburg, 45°46'23"N 92°42'28"W, VII-13-2011, THK (THK); **DANE:** 2L, Wisconsin R., wood log and sticks, Mazomanie boat landing, VI-22-1985, R. A. Lillie (UW); **DUNN:** 1L, Chippewa R., Spring Brk. Landing, VII-9-2013, K. L. Schmude (UWS); **PEPIN:** 2L, Chippewa R., St. Rd. 35, W. side, VII-10-2013, K. L. Schmude (UWS); **RUSK:** 9+ L in two vials (including blackwing), Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998, R. A. Lillie (WiDNR); **SAUK:** 18L in two vials, Wisconsin R., 0–3 ft., stagnant sandbar pools, Spring Green, VII-14-1985, R. A. Lillie (UW); **WASHBURN:** 1L, Brill R., Bridge Rd., 2.5 mi. N. of Brill, 45°38'21"N 91°40'27"W, VII-15-2011, THK (THK).

Status: *Caenis tardata* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is one of the least commonly encountered members of the genus.

Biological Information: Provonsha (1990) described the habitat of *C. tardata* as fine sand and mixed gravel substrates in moderate to large rivers.

Figure 162. *Caenis tardata,* larva.

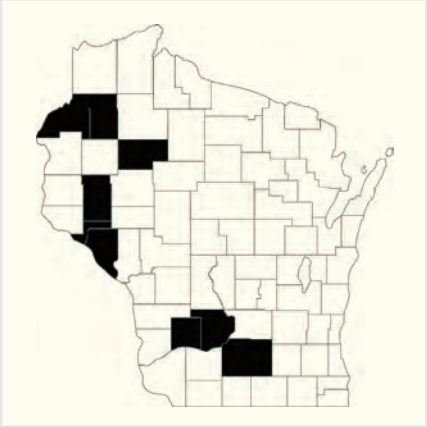


Figure 163. Wisconsin records of *Caenis tardata.*

Caenis youngi Roemhild, 1984 (Figs. 164 and 165)

Larval Description: Roemhild (1984); Provonsha (1990).

Larval Habitus: Roemhild (1984); Sun and McCafferty (2008).

Determination: Identification of *C. youngi* larvae is **Slightly Difficult**. Some earlier instars of *C. latipennis* have a disproportionately long and erect medial spine on the second abdominal tergum, suggestive of *C. youngi*. The widely divergent lateral margins of the pronotum typical in *C. youngi* (Fig. 149e) can occur to a more limited sense in related species, especially in young larvae.

Previous Wisconsin Records: Lillie and Hilsenhoff (1992); DuBois (1993); Randolph and McCafferty (1998).

New County Records: BAYFIELD: 1L, Lk. Anodanta outflow, VII-18-1979, D. Volk (UWO); 3L in two vials, Namekagon R., VII-19-1979, R. Larson (UWO & THK); 1L, unnamed crk., Washington Ave., site "Lksup 712", 46.787085°N 91.384085°W, Summer 2012, K. L. Schmude (UWS).

Status: *Caenis youngi* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is as uncommonly encountered as *C. tardata*, which has a similar known distribution in the state.

Biological Information: Provonsha (1990) described the habitat of *C. youngi* as sandy substrates in waters with little or no current.

Figure 164. *Caenis youngi,* larva.

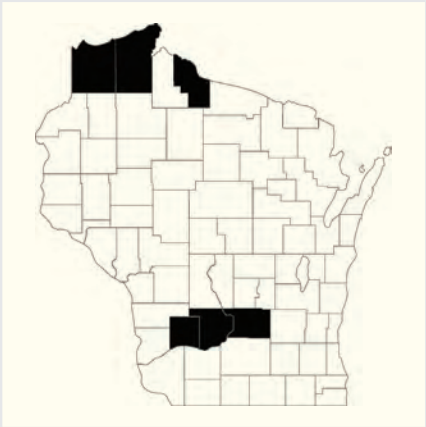


Figure 165. Wisconsin records of *Caenis youngi.*

Cercobrachys

Comments: Sun and McCafferty (2008) made a substantial revision of *Cercobrachys* and other caenid genera with ocellar tubercles. There currently are seven North American species in the genus, with four of them known from Wisconsin.

Determination: Identification of *Cercobrachys* larvae is **Fairly Easy** for the genus and **Slightly Difficult** for the species within the genus. Most specimens of *Cercobrachys* are paler than those of *Brachycercus* and *Sparbarus*.

Larval Keys: Soldan (1986); Sun and McCafferty (2008). The key below was modified from Sun and McCafferty (2008).

Key to the Species of *Cercobrachys*

1. Galea-lacinia elongate (length greater than twice the basal width), with distinctly arcuate medial margin (Fig. 166a); protarsus with both short and long setae, with short setae being less than twice the width of protarsus (Fig. 166b) **2**

Galea-lacinia relatively short and compact (length less than twice the basal width), with a slightly curved medial margin (Fig. 166d); protarsus lacking short setae (Fig. 166c). **3**

2. Median ocellar tubercle acutely pointed (Fig. 166e); abdominal tergum VI with posterolateral projection projecting diagonally across tergum VII (as in Fig. 141f) . . . . . ***C. etowah***

Median ocellar tubercle bluntly pointed (Fig. 166f); abdominal tergum VI with posterolateral projection strongly curved and projecting horizontally across anterior edge of tergum VII (Fig. 166g) . . . . . ***C. fox***

3. Operculate gill with fringe of setae on posteromedial edge that are much longer than setae on posterolateral edge (Fig. 166h) . . . . . ***C. lilliei***

Operculate gill with fringe of setae on posteromedial edge that are similar in length to setae on posterolateral edge . . . . . ***C. winnebago***

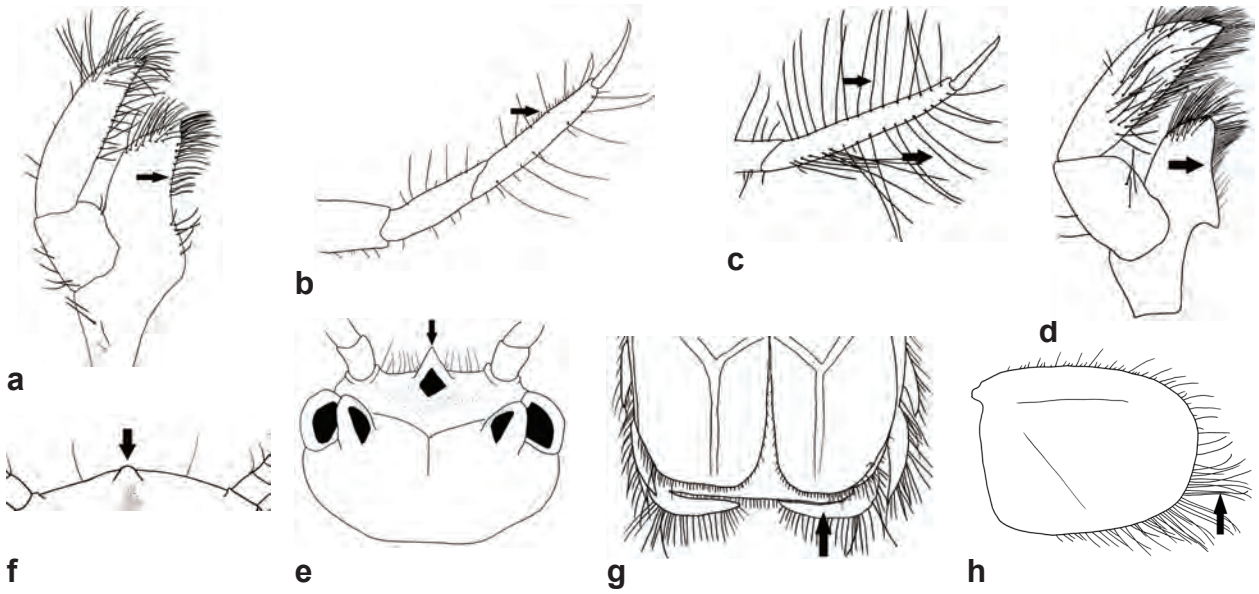


Figure 166. *Cercobrachys* (Caenidae). **a,** *C. etowah,* maxilla (ventral); **b,** *C. etowah,* front tarsus; **c,** *C. lilliei,* front tarsus; **d,** *C. lilliei,* maxilla (ventral); **e,** *C. etowah,* frons (tangential); **f,** *C. fox,* head (dorsal); **g,** *C. fox,* terga IV–VII and operculate gills; **h,** *C. lilliei,* operculate gill.

Cercobrachys etowah Soldan, 1986 (Figs. 167 and 168)

Larval Descriptions: Soldan (1986); Sun and McCafferty (2008).

Larval Habitus: Sun and McCafferty (2008).

Determination: Identification of *C. etowah* larvae is **Slightly Difficult**. Mixed-length setae of the protarsi (Fig. 166b) are easily seen in both mature and moderately mature larvae.

Previous Wisconsin Records: Sun and McCafferty (2008).

New County Records: RUSK: Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998 (WiDNR).

Biological Information: There is very little published information regarding the biology of *C. etowah*. Berner and Pescador (1988) gave anecdotal information about habitat characteristics of a site in Florida where the species was taken. The limited number of Wisconsin records come from fifth- to sixth-order segments of fairly large rivers.

Figure 167. *Cercobrachys etowah,* young larva.

Figure 168. Wisconsin records of *Cercobrachys etowah.*

Cercobrachys fox Sun & McCafferty, 2008 (Figs. 169 and 170)

Larval Description and Habitus: Sun and McCafferty (2008).

Determination: Identification of *C. fox* larvae is **Slightly Difficult**. Mixed-length setae of protarsi are easily seen in both mature and moderately mature larvae.

Previous Wisconsin Records: Sun and McCafferty (2008).

Status: *Cercobrachys fox* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: There is no previous analysis of the habitat associations for *C. fox*. The limited number of Wisconsin records come from fifth- to seventh-order segments of fairly large rivers, including the Black, Trempealeau, Sugar, and Wisconsin Rivers (Sun and McCafferty 2008).

Figure 169. *Cercobrachys fox,* larva.

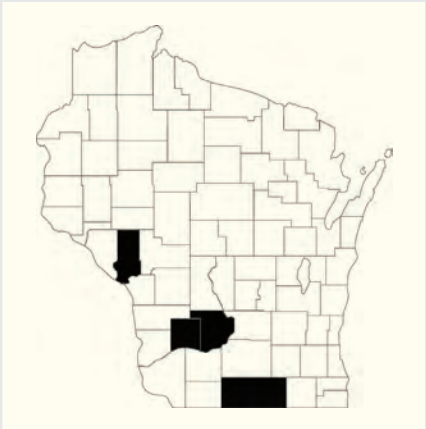


Figure 170. Wisconsin records of *Cercobrachys fox.*

Cercobrachys lilliei Sun & McCafferty, 2008 (Figs. 171 and 172)

Larval Description and Habitus: Sun and McCafferty (2008).

Determination: Identification of *C. lilliei* larvae is **Slightly Difficult**. Their small size makes examination and dissection of mouthparts challenging. Setae on operculate gills often are obscured by debris and surface biota.

Previous Wisconsin Records: Sun and McCafferty (2008). The type locality is in Wisconsin.

New County Records: BUFFALO: 2L, Trempealeau R., Co. Rd. P, 2 mi. N. of St. Rd. 35, VII-10-2013, K. L. Schmude (UWS); **BURNETT:** 1L, St. Croix R., Sand Rock Cliffs, 5 mi. NW. of Grantsburg, T38NR19W S7, VI-24-1998, R. A. Lillie (WiDNR).

Status: *Cercobrachys lilliei* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: None. There is no previous analysis of the habitat associations for *C. lilliei*. The limited number of Wisconsin records come from sixth- to eighth-order segments of fairly large rivers, including the Black, Chippewa, Trempealeau, Sugar, and Wisconsin Rivers (Sun and McCafferty 2008).

Figure 171. *Cercobrachys lilliei,* larva (partially emerged).

Figure 172. Wisconsin records of *Cercobrachys lilliei.*

Cercobrachys winnebago Sun & McCafferty, 2008 (Fig. 173)

Larval Description and Habitus: Sun and McCafferty (2008).

Determination: Identification of *C. winnebago* larvae is **Slightly Difficult**. Their small size makes examination and dissection of mouthparts challenging. Setae on operculate gills often are obscured by debris and surface biota.

Previous Wisconsin Records: Sun and McCafferty (2008).

Status: *Cercobrachys winnebago* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is known in Wisconsin only from the lower segments of the Sugar River in Green and Rock Counties.

Biological Information: There is no previous analysis of the habitat associations for *C. winnebago*. Sites along the Sugar River in Green and Rock Counties near the Illinois border, which have produced the only Wisconsin records of this species, are in a sixth-order segment of the river with a combination of silt and scattered sandy substrates.

Figure 173. Wisconsin records of *Cercobrachys winnebago.*

Sparbarus

Comments: There are seven recognized species of *Sparbarus* in North America. Three of them are known from Wisconsin.

Determination: Identification of *Sparbarus* larvae is **Fairly Easy** for the genus, and **Moderately to Fairly Easy** for species within the genus. The short, spatulate setae on the basal segment of the labial palpi (Fig. 141i) are not illustrated in either Sun and McCafferty (2008) or Soldan (1986). These setae can be difficult to see, however, because of the amount of debris generally on the mouthparts.

Larval Keys: Soldan (1986) and Burian et al. (1997), both as *Brachycercus*; Sun and McCafferty (2008).

Key to the Species of *Sparbarus*

1. Median ocellar tubercle at least twice the length of lateral tubercles (Fig. 174a) . . . . . ***S. nasutus***

Median ocellar tubercle subequal to or shorter than lateral tubercles (Fig. 141a). **2**

2. Tergum II of mature larvae with well-developed, apically acute lateral projection (Fig. 141b); length of median ocellar tubercle 1.5–2 times its basal width (Fig. 141a). . . . . ***S. lacustris***

Tergum II of mature larvae with weakly developed lateral projection, roughly forming a 90° angle at tip (Fig. 174c); length of median ocellar tubercle subequal to its basal width (Fig. 174b) . . . . . ***S. maculatus***

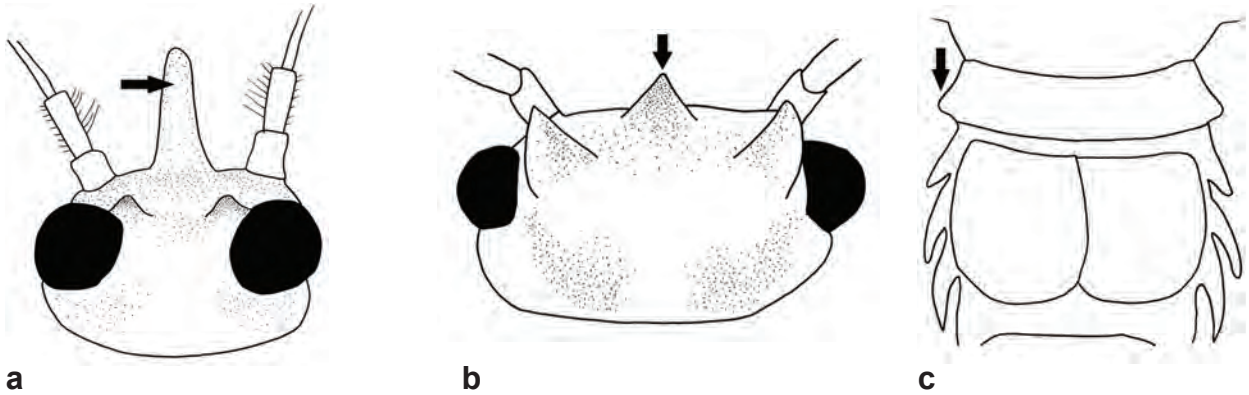


Figure 174. *Sparbarus* (Caenidae). **a,** *S. nasutus,* head (dorsal); **b,** *S. maculatus,* head (dorsal); **c,** *S. maculatus,* terga II–VI.

Sparbarus lacustris (Needham), 1918 (Figs. 175 and 176)

Taxonomic History: *Brachycercus idei* (Lestage), 1931 (syn.); *Brachycercus lacustris* (Needham), 1918 (comb.); *Brachycercus pallidus* (Ide), 1930 (syn.); *Caenis lacustris* Needham, 1918 (orig.); *Eurycaenis idei* Lestage, 1931 (syn.); *Eurycaenis lacustris* (Needham), 1918 (comb.); *Eurycaenis pallida* Ide, 1930 (syn.); *Sparbarus lacustris* (Needham), 1918 (curr. comb., Sun and McCafferty 2008).

Larval Descriptions: Ide (1930a), as *Eurycaenis pallida*; Traver (1935), as *Brachycercus lacustris*; Sun and McCafferty (2008). Descriptions and illustrations of this species in Leonard and Leonard (1962), Soldan (1986), and Burian et al. (1997) were in error and applicable to other species (Sun and McCafferty 2008).

Larval Habitus: Burks (1953), as *Brachycercus lacustris*; Sun and McCafferty (2008).

Determination: Identification of *S. lacustris* larvae is **Fairly Easy**. They are most easily confused with *S. maculatus*, especially when immature. As larvae of *S. lacustris* mature, the lateral projections of the second abdominal segment become increasingly acute.

Previous Wisconsin Records: Randolph and McCafferty (1998), as *Brachycercus lacustris* and *Cercobrachys* sp. 1; Sun and McCafferty (2008).

New County Records: BARRON: 5L (including blackwing), Brill R., 29th Ave., 1.5 mi. N. of Brill, 45°37'28"N 91°40'38"W, VII-15-2011, THK (THK); **OCONTO:** 1L, Lk. Michigan, off mouth of Oconto R., VI-6-2012, A. Bell (UWS); **POLK:** 4A, St. Croix Falls, VII-13-2011, THK (THK); **RUSK:** 3L, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998, R. A. Lillie (WiDNR); 3L, Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998 (WiDNR); **WALWORTH:** 4L and 1A in three vials, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VII-20-2000, VIII-4-2000, and VIII-4-2009, THK (THK); **WASHBURN:** 6L (exuviae), Namekagon R., Stinnett Landing on Stinnett Landing Rd., 45°59'9"N 91°35'34"W, VII-15-2011, THK (THK).

Status: *Sparbarus lacustris* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Though it is uncommon in the state, the new county records given above show it is widely distributed.

Biological Information: Because of numerous misidentifications, biological information for *S. lacustris* is difficult to obtain from historical literature. Wisconsin records restricted to those from Sun and McCafferty (2008) and herein are from third-order (Turtle Crk., Walworth Co.) to seventh-order (Wisconsin R., Grant Co.) rivers. Adults are known from 13 July (Polk Co.) and 4 August (Walworth Co.).

Figure 175. *Sparbarus lacustris,* larva.

Figure 176. Wisconsin records of *Sparbarus lacustris.*

Sparbarus maculatus (Berner), 1946 (Figs. 177 and 178)

Taxonomic History: *Brachycercus maculatus* Berner, 1946 (orig.); *Brachycercus pini* Soldan, 1986 (syn.); *Sparbarus maculatus* (Berner), 1946 (curr. comb., Sun and McCafferty 2008).

Larval Descriptions: Soldan (1986), as *Brachycercus lacustris*, *B. maculatus*, and *B. pini*; Sun and McCafferty (2008).

Larval Habitus: Sun and McCafferty (2008).

Determination: Identification of *S. maculatus* larvae is **Fairly Easy**. They are most easily confused with *S. lacustris*, especially when immature.

Previous Wisconsin Records: Sun and McCafferty (2008).

Status: *Sparbarus maculatus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is the rarest member of the genus in the state, known only from the St. Croix, Wolf, and Nemadji Rivers. Though the species is known in Wisconsin only from northern counties, it has been reported from a wide geographic area from Ontario to Florida, with Wisconsin being on the northwestern edge of its range (Sun and McCafferty 2008).

Biological Information: Burian et al. (1997) found *S. maculatus* along the shoreline just above a hydroelectric dam, in a substrate of sand and silt.

Figure 177. *Sparbarus maculatus,* larva.

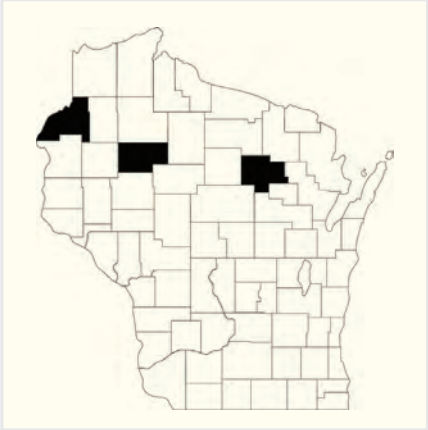


Figure 178. Wisconsin records of *Sparbarus maculatus.*

Sparbarus nasutus (Soldan), 1986 (Figs. 179 and 180)

Taxonomic History: *Brachycercus nasutus* Soldan, 1986 (orig.); *Sparbarus nasutus* (Soldan), 1986 (curr. comb., Sun and McCafferty 2008).

Larval Descriptions: Soldan (1986); Sun and McCafferty (2008).

Larval Habitus: Sun and McCafferty (2008).

Determination: Identification of *S. nasutus* larvae is **Moderately Easy**. The species is the easiest member of the genus in Wisconsin to identify. The extremely long medial ocellar tubercle (Fig. 174a) is distinctive on both mature and immature specimens.

Previous Wisconsin Records: Lillie and Hilsenhoff (1992), as *Brachycercus nasatus*; Sun and McCafferty (2008).

New County Records: OCONTO: 1L, Lk. Michigan, off mouth of Oconto R., VII-18-2012, A. Bell (UWS).

Status: *Sparbarus nasutus* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: Berner and Pescador (1988) reported *S. nasutus* from a sandbar in shallow water in Florida. Otherwise, no detail about the biology of the species has been published. Wisconsin records from Sun and McCafferty (2008) and that given above are from large, fifth- to seventh-order rivers.

Figure 179. *Sparbarus nasutus,* larva.

Figure 180. Wisconsin records of *Sparbarus nasutus.*

Susperatus

Comments: There are three North American species of *Susperatus*. Only one species occurs in the Midwest.

Determination: Identification of *Susperatus* larvae in Wisconsin is **Moderately Easy**.

Larval Key: Sun and McCafferty (2008).

Susperatus prudens (McDunnough), 1931 (Figs. 181 and 182)

Taxonomic History: *Brachycercus prudens* (McDunnough), 1931 (comb.); *Eurycaenis prudens* McDunnough, 1931 (orig.); *Susperatus prudens* (McDunnough), 1931 (curr. comb., Sun and McCafferty 2008).

Larval Descriptions: Soldan (1986); Sun and McCafferty (2008).

Larval Habitus: Sun and McCafferty (2008).

Determination: Identification of *S. prudens* larvae is **Moderately Easy**. The species is the only member of the genus in Wisconsin. Any specimens identified as this species prior to Sun and McCafferty (2008) should be re-examined, as misidentifications are likely.

Previous Wisconsin Records: Lillie and Hilsenhoff (1992) and Randolph and McCafferty (1998), both as *Brachycercus prudens*.

Status: *Susperatus prudens* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: Biological information has not been previously reported for *S. prudens*. It is known from the Wisconsin River (Lillie and Hilsenhoff 1992), as well as several medium to small rivers (Randolph and McCafferty 1998).

Figure 181. *Susperatus prudens,* larva.

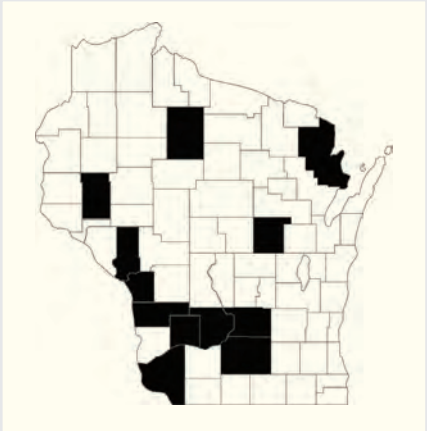


Figure 182. Wisconsin records of *Susperatus prudens.*

12 EPHEMERELLIDAE

The Family Ephemerellidae is highly diverse, with seven Wisconsin genera and equally as many elsewhere in North America. The family has the third greatest species diversity in the state after the Baetidae and the Heptageniidae. Many of the Wisconsin species are sensitive to environmental degradation and occur only in the state's best trout streams. Species diversity of ephemerellids encountered during sampling is much greater in the northern counties. A few, such as various *Eurylophella*, commonly occur in ponds and lakes, also mostly in the northern half of the state.

Key to the Genera of Ephemerellidae

1. Tergum III with lamellate gills (Fig. 183d) **2**

Tergum III without lamellate gills. **5**

2. Profemur with conspicuous tubercles along ventral margin (Fig. 183a). . . . . ***Drunella***

Profemur without tubercles along ventral margin **3**

3. Caudal filaments with long lateral setae at and between each segment just beyond midlength of filament (less so in very young specimens) (Fig. 183b); maxillary palpus well developed and clearly three-segmented . . . . . ***Ephemerella***

Caudal filaments with whorls of short spines at each segment, spines of similar length and abundance throughout filament, and intersegmental spaces generally without spines or setae (Fig. 183c); maxillary palpus usually reduced in size and/or segmentation, or absent **4**

4. Terga with paired, submedian tubercles (Fig. 183d); maxillary palpus present, although sometimes reduced to one or two segments (Fig. 183e) . . . . . ***Serratella***

Terga without paired, submedian tubercles (Fig. 237); maxillary palpus absent (Fig. 183f) . . . . . ***Teloganopsis deficiens***

5. Gill IV not operculate, apical half of gills V–VI visible from above, with gill IV not reaching posterior margin of tergum VII (Fig. 183g) . . . . . ***Attenella***

Gill IV operculate, largely covering those on segments V–VII, only about one-third of any following gill visible; gill IV nearly reaching posterior margin of tergum VII (Fig. 183l). **6**

6. Claws without denticles (Fig. 183k); maxillae with palpi (Fig. 183i). . . . . ***Dannella***

Claws with denticles (Fig. 183h); maxillae without palpi (Fig. 183j). ***7***

7. Terga I–VII with paired, median tubercles (Fig. 183l). . . . . ***Eurylophella***

Terga V–VII only with paired, median tubercles . . . . . ***Dentatella coxalis***

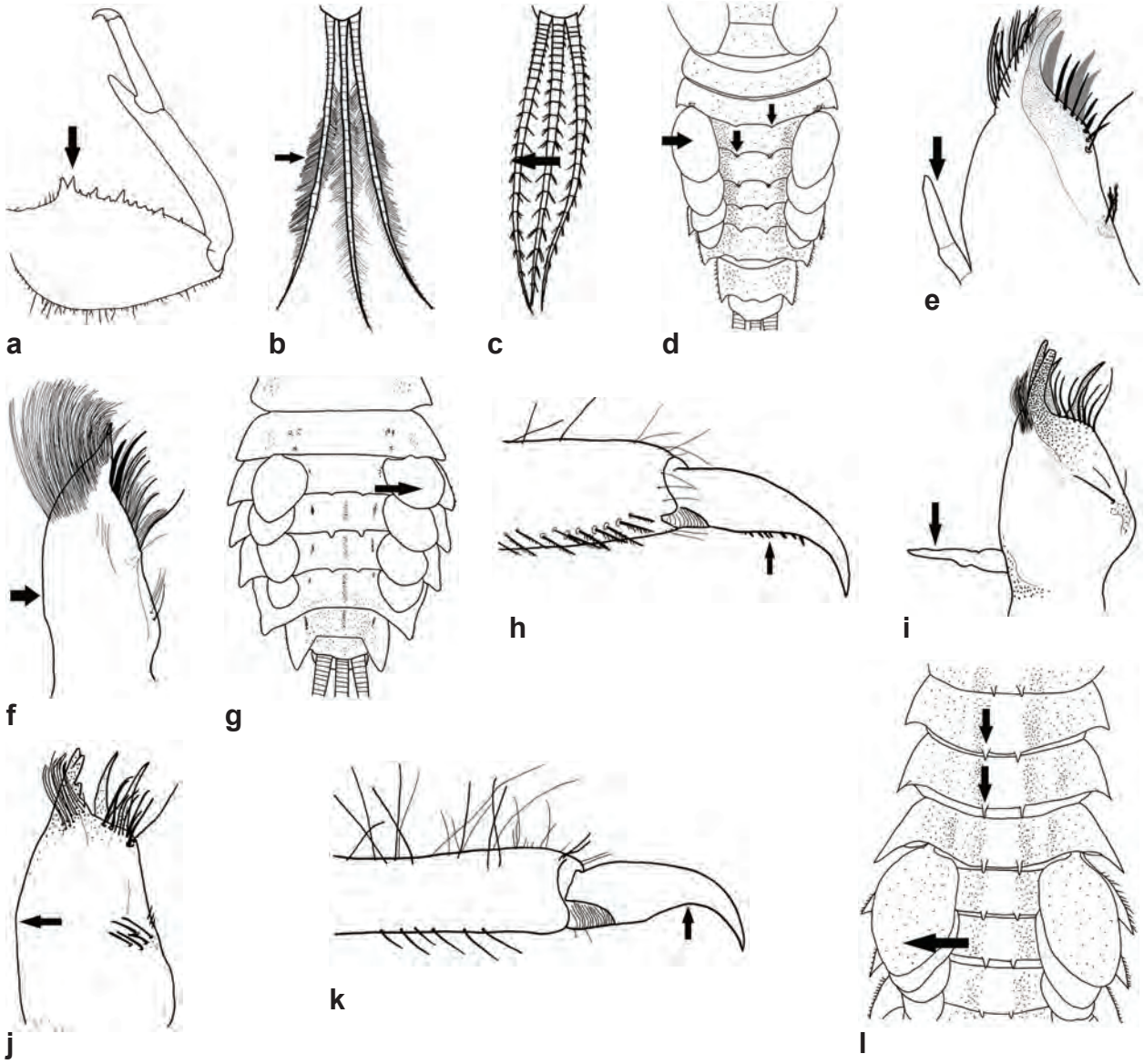


Figure 183. Ephemerellidae. **a,** *Drunella cornutella,* front leg; **b,** *Ephemerella subvaria,* tails; **c,** *Teloganopsis deficiens,* tails; **d,** *Serratella serratoides,* terga; **e,** *S. serratoides,* maxilla (ventral); **f,** *T. deficiens,* maxilla (ventral); **g,** *Attenella attenuata,* terga; **h,** *Eurylophella temporalis,* hind claw; **i,** *Dannella lita,* maxilla; **j,** *E. temporalis,* maxilla; **k,** *D. lita,* hind tarsus; **l,** *E. temporalis,* terga I–VII.

Attenella

Comments: There are four North American species of *Attenella*, though only one is known from Wisconsin.

Determination: Identification of *Attenella* larvae is **Moderately Easy** for the genus, and **Fairly Easy** for species within the genus.

Larval Keys: Burks (1953) and Allen and Edmunds (1961), both as *Ephemerella*.

Key to the Species of *Attenella*

1. Prothorax with well-developed paired submedian tubercles; females and some males with paired occipital tubercles (Fig. 184a); abdominal sterna with pale margins . . . . . ***A. attenuata***

Prothorax with obscure, small paired submedian tubercles; occipital tubercles lacking; each sternum IV–IX with a brown transverse band extending from lateral margin (Fig. 184b); not known from Wisconsin . . . . . ***A. margarita***

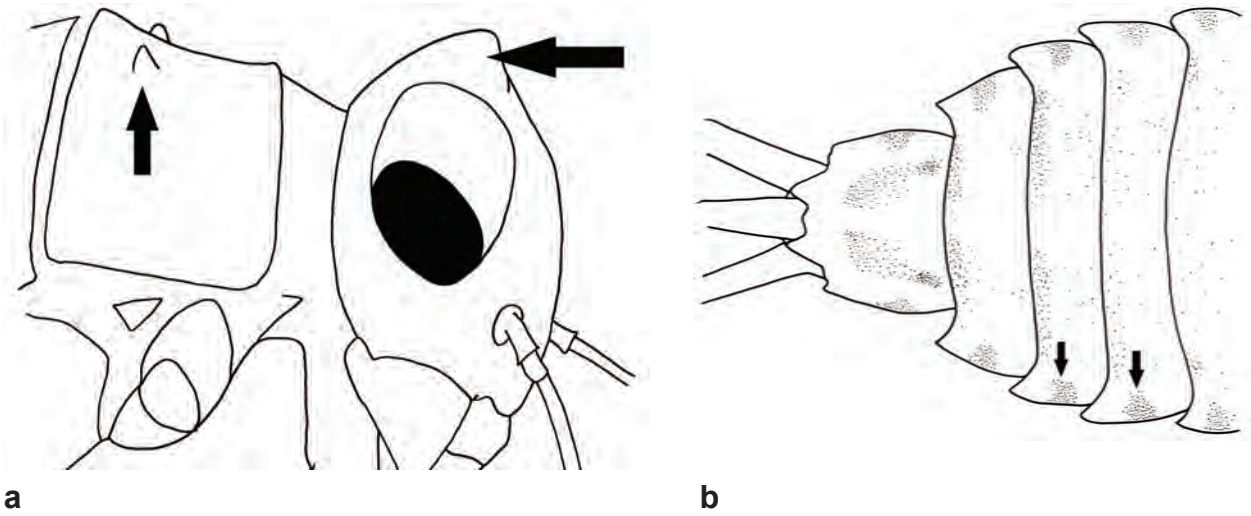


Figure 184. *Attenella* (Ephemerellidae). **a,** *A. attenuata,* pronotum and head (lateral); **b,** *A. margarita,* sterna V–IX.

Attenella attenuata (McDunnough), 1925 (Figs. 185 and 186)

Taxonomic History: *Attenella attenuata* (McDunnough), 1925 (curr. comb., Allen 1980); *Ephemerella attenuata* McDunnough, 1925 (orig.); *Ephemerella hirsuta* Berner, 1946 (syn.).

Larval Descriptions: Traver (1935), Burks (1953), and Allen and Edmunds (1961), all as *Ephemerella attenuata*.

Larval Habitus: Allen and Edmunds (1961) and Edmunds et al. (1976), both as *Ephemerella attenuata*; Berner and Pescador (1988).

Determination: Identification of *A. attenuata* larvae is **Fairly Easy**. Most specimens have large occipital and pronotal tubercles that are best observed in lateral view (Fig. 184a).

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Ephemerella attenuata*; Jacobs (1990); Randolph and McCafferty (1998).

New County Records: CLARK: 1L, Black R., Co. Rd. H, 44.654145°N 90.626645°W, VII-3-2008, K. L. Schmude, R. A. Lillie, and A. Reynolds (UWS); **JACKSON:** 7L, Black R., Mason Boat Launch, Old Hwy. 54, VII-11-2013, K. L. Schmude (UWS); **MARATHON:** 55L, unnamed crk., River Rd., 44.73936°N 89.29898°W VI-7-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **ONEIDA:** 1L, Wisconsin R., Riverview Rd., 45.75251°N 89.55511°W, VI-7-1994, K. L. Schmude (UWS); **PEPIN:** 2L, Chippewa R., Ella Boat Landing, VII-9-2013, K. L. Schmude (UWS); **PRICE:** 1L, Flambeau R., St. Rd. 70, 45.8404°N 90.66077°W, VI-14-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **SAWYER:** 3L, Flambeau R., Hervas, T37NR4W S35, VI-19-1997 (WiDNR); 2L, Flambeau R., Oxbo Rd., T39NR3W S14, VI-18-1997 (WiDNR); **SHAWANO:** 1L, Embarrass R., St. Rd. 22, 44.69191°N 88.70084°W, VI-6-1999, K. L. Schmude and C. Brennan (UWS); **WASHBURN:** 1L (blackwing), Brill R., Bridge Rd., 2.5 mi. N. of Brill, 45°38'21"N 91°40'27"W, VII-15-2011, THK (THK).

Biological Information: Larvae of *A. attenuata* occur in unpolluted rivers and streams with strong current (Hubbard and Peters 1978). In Wisconsin, this species is known from a wide range of river sizes. Burian and Gibbs (1991) described the substrate for the species as sediment, gravel, and coarse organic matter in runs and pools, particularly in pockets of slower current downstream of rubble.

Figure 185. *Attenella attenuata,* larva.

Figure 186. Wisconsin records of *Attenella attenuata.*

Attenella margarita (Needham), 1927 (Fig. 187)

Taxonomic History: *Attenella margarita* (Needham), 1927 (curr. comb., Allen 1980); *Ephemerella margarita* Needham, 1927 (orig.).

Larval Descriptions: Traver (1935) and Allen and Edmunds (1961), both as *Ephemerella margarita.*

Determination: Identification of *A. margarita* larvae is **Fairly Easy**. Young specimens identified as *A. margarita* should be examined carefully, as occipital and pronotal tubercles in *A. attenuata* may not yet be fully developed.

Previous Wisconsin Records: None. The nearest record of *A. margarita* is from the Upper Peninsula of Michigan (Yanoviak and McCafferty 1996). The species is expected in Wisconsin, especially in the northern tier of counties.

Biological Information: The known habitat of *A. margarita* ranges from margins of medium-sized streams with moderate current to large, sluggish rivers (Allen and Edmunds 1961).

Figure 187. *Attenella margarita,* larva.

Dannella

Comments: There are only three North American species of *Dannella*, with two known from Wisconsin. The third species, *D. provonshai* (McCafferty), is an eastern species.

Determination: Identification of *Dannella* larvae is **Slightly Difficult** for the genus and **Fairly Easy** for the species within the genus.

Larval Keys: Traver (1935), Burks (1953), and Allen and Edmunds (1962a), all as *Ephemerella*; McCafferty (1977a).

Key to the Species of *Dannella*

1. Tergum III with well-developed and acute posterolateral processes; tergum IX with posterolateral processes at least as long as mid-dorsal length of that segment, and with medial margins distinctly divergent from lateral margins of segment X (Fig. 188a) . . . . . ***D. lita***

Tergum III without posterolateral processes; posterolateral processes of tergum IX shorter, being shorter than mid-dorsal length of segment X, with medial margins nearly paralleling lateral margins of segment X (Fig. 188b) . . . . . ***D. simplex***

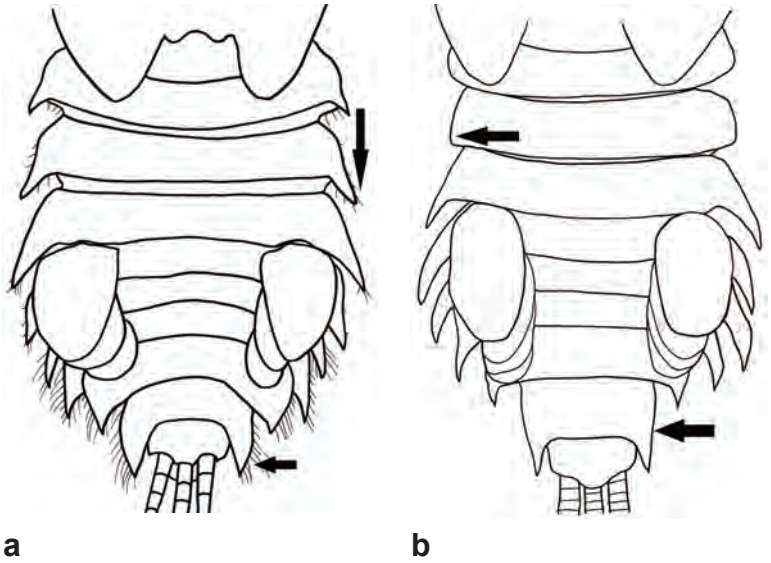


Figure 188. *Dannella* (Ephemerellidae). **a,** *D. lita,* terga; **b,** *D. simplex,* terga.

Dannella lita (Burks), 1949 (Figs. 189 and 190)

Taxonomic History: *Dannella lita* (Burks), 1949 (curr. comb., Allen 1980); *Ephemerella lita* Burks, 1949 (orig.); *Timpanoga lita* (Burks), 1949 (comb.).

Larval Descriptions: Burks (1949, 1953) and Allen and Edmunds (1962a), all as *Ephemerella lita*.

Determination: Identification of *D. lita* larvae is **Fairly Easy**. Identifications are most reliable with mature larvae.

Previous Wisconsin Records: Klubertanz and Hess (2001), as *Timpanoga lita*.

New County Records: GRANT: 1L, Tributary of Platte R., Bridge on Co. Rd. O, 1 mi. E. of Tennyson, T3NR2W S31, VI-3-2011, THK, E. Wolf, and C. Brown (THK); **POLK:** 3L, St. Croix R., Nevers Landing near Wolf Creek, Summer 1996 (WiDNR, THK); **ROCK:** 1L, Turtle Crk., Carver's Rock Rd., VI-1-2005, THK (THK); 24L in two vials, Turtle Crk., Lather's Rd., 1 mi. WSW. of Shopiere, T2NR13E S9, V-25-2000, THK (THK) and VI-6-2011, THK, C. Brown, and E. Wolf (THK); 32L in two vials, Turtle Crk., Smith Rd. near Tiffany, T2NR13E S35 VI-6-2011, THK, C. Brown, and E. Wolf (THK); Turtle Crk., Sweet Allyn Pk. on Belding Rd. in Shopiere, T1NR13E S3, VI-6-2011, THK, C. Brown, and E. Wolf (THK); **SHAWANO:** 2L, Embarrass R., Hayman Falls Ln., 44.74853°N 88.84183°W, V-26-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 1L, Wolf R., Co. Rd. CCC, 44.696348°N 88.578892°W, VI-2-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **WAUPACA:** 2L, Embarrass R., Old Hwy. 156 (7th Str.), 44.61996°N 88.70151°W, VI-8-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 2L, S. Branch Little Wolf R., Military Rd., 44.37621°N 88.97928°W, VI-5-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 2L, Waupaca R., Reek Rd., 44.32682°N 88.98114°W, VI-5-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Status: *Dannella lita* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List, as *Timpanoga lita* (Anonymous 2014b). It is less commonly encountered than *D. simplex*, though is fairly common in southern rivers such as Turtle Creek and the Sugar River.

Biological Information: Very little biological information has been published for *D. lita*. Burks (1953) described its habitat as moderate sized streams with fairly rapid current. In Wisconsin, it is known from third- to sixth-order rivers.

Figure 189. *Dannella lita,* larva.

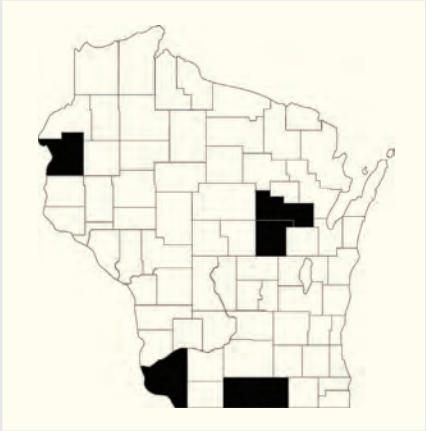


Figure 190. Wisconsin records of *Dannella lita.*

Dannella simplex (McDunnough), 1925 (Figs. 191 and 192)

Taxonomic History: *Dannella simplex* (McDunnough), 1925 (curr. comb., Allen 1980); *Ephemerella simplex* McDunnough, 1925 (orig.); *Timpanoga simplex* (McDunnough), 1925 (comb.).

Larval Descriptions: Traver (1935), Burks (1953), and Allen and Edmunds (1962a), all as *Ephemerella simplex*; Leonard and Leonard (1962).

Larval Habitus: Allen and Edmunds (1962a) and Leonard and Leonard (1962), both as *Ephemerella simplex*; Berner and Pescador (1988).

Determination: Identification of *D. simplex* larvae is **Fairly Easy**. Identifications are most reliable with mature larvae.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Ephemerella simplex*; Randolph and McCafferty (1998), as *Timpanoga simplex*.

New County Records: EAU CLAIRE: 3L (including blackwing), Elk Crk., County Line Rd., 6 mi. NW. of Eau Claire, 44°51'20"N 91°38'58"W, VII-12-2011, THK (THK); **PIERCE:** 2L, Rush R., Wayside Pk., St. Rd. 29, 44.847783°N 92.402052°W, VI-25-2008, K. L. Schmude and A. Reynolds (UWS); **PORTAGE:** 34L, Flume Crk., Co. Rd. T, 44.597845°N 89.26691°W, VI-7-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **SAWYER:** 2L, Price Crk., Price Crk. Rd., 45.68544°N 90.70384°W, VI-15-2000, K. L. Schmude, C. Brennan, J. Denninger, and K. Mielke (UWS); **SHAWANO:** 3L, Middle Branch Embarrass R., Co. Rd. J, 44.80852°N 89.01844°W, V-27-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS).

Biological Information: Burks (1953) described the habitat of *D. simplex* as being moderate-sized rivers with fairly rapid current, as he did for *D. lita*. In the next decade, Allen and Edmunds (1962a) commented that the biology of *D. simplex* was not well known. Hubbard and Peters (1978) concluded that the species was most common in unpolluted streams with good oxygen levels. Burian and Gibbs (1991) described its substrate as biofilms on well sorted sediment with gravel and coarse organic matter. Wisconsin records are from second- to fifth-order segments of streams and rivers.

Figure 191. *Dannella simplex,* larva.

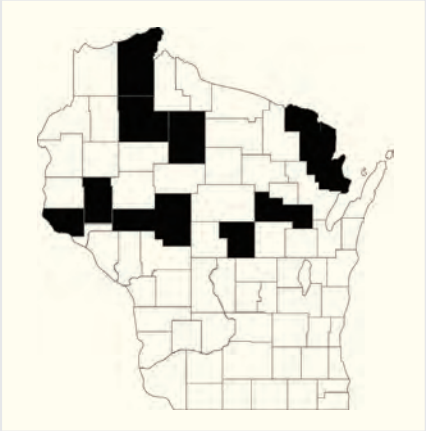


Figure 192. Wisconsin records of *Dannella simplex.*

Dentatella

Comments: Prior to McCafferty et al. (2003b), the one species currently in *Dentatella* was placed in *Eurylophella*.

Determination: Identification of *Dentatella* larvae in Wisconsin is **Fairly Easy**.

Dentatella coxalis (McDunnough), 1926

Taxonomic History: *Dannella bartoni* (Allen), 1977 (syn.); *Dentatella bartoni* (Allen), 1977 (syn.); *Dentatella coxalis* (McDunnough), 1926 (curr. comb., McCafferty et al. 2003b); *Dentatella danutae* McCafferty, 2000 (syn.); *Ephemerella bartoni* Allen, 1977 (syn.); *Ephemerella coxalis* McDunnough, 1926 (orig.); *Eurylophella bartoni* (Allen), 1977 (syn.); *Eurylophella coxalis* (McDunnough), 1926 (comb.).

Larval Descriptions: Allen (1977b), as *Ephemerella bartoni;* Burian (2002).

Larval Habitus: Burian (2002).

Determination: Identification of *D. coxalis* larvae is **Fairly Easy**. Generic determination of this species requires careful examination of claws and maxillae with a dissecting microscope or with slide mounts.

Previous Wisconsin Records: None. The nearest record of this Atlantic species is from Grand Traverse County in Lower Michigan. It is not expected in Wisconsin.

Biological Information: Burian (2002) found larvae of *D. coxalis* in relatively shallow water of streams with small cobble to boulder substrates heavily covered with biofilm.

Drunella

Comments: There are twelve species of *Drunella* in North America, but only two known from Wisconsin. *D. cornutella* is reported from the state for the first time herein. Two additional species are reasonably possible in the state. All records of the genus in the state are from premier waters in the northernmost counties.

Determination: Identification of *Drunella* larvae is **Easy** for the genus, but **Fairly Easy to Slightly Difficult** for species within the genus. Their large size and distinct profemora are easily visible in the field.

Larval Keys: Traver (1932b, 1935) and Burks (1953), all as *Ephemerella*; Allen and Edmunds (1962b); Funk et al. (2008).

Key to the Species of *Drunella*

1. Abdomen with paired dorsal tubercles (Fig. 193b); head with a broad frontal shelf (Fig. 193a); not known from Wisconsin . . . . . ***D. walkeri***

Abdomen without paired dorsal tubercles; head without a broad frontal shelf (Fig. 193c–e). **2**

2. Frontoclypeal projections consisting of flattened extensions of the frontoclypeus, in the same plane as the frontoclypeus, and about as long as wide (Fig. 193c); each femur with few or no long, fine setae on posterior margin (Fig. 193f); not known from Wisconsin . . . . . ***D. lata***

Frontoclypeal projections conical and usually incurved, at a plane dorsal of the clypeus, and about twice as long as wide (Fig. 193d–e); each femur with dense row of long, fine setae on posterior margin (Fig. 193g) **3**

3. Total body length of mature larvae usually at least 8 mm (commonly >9 mm); meso- and metatibiae of mature larvae longer than 1.6 mm; median ocellar tubercle of mature larvae relatively sharp, projecting slightly beyond the apices of the frontoclypeal projections when viewed in tangential, dorsal view (Fig. 193d). . . . . ***D. cornuta***

Total body length of mature larvae usually less than 8 mm (commonly <7.5 mm); meso- and metatibiae of mature larvae shorter than 1.6 mm; median ocellar tubercle of mature larvae relatively short and slightly blunt, ending short of the apices of the frontoclypeal projections when viewed in tangential, dorsal view (Fig. 193e) . . . . . ***D. cornutella***

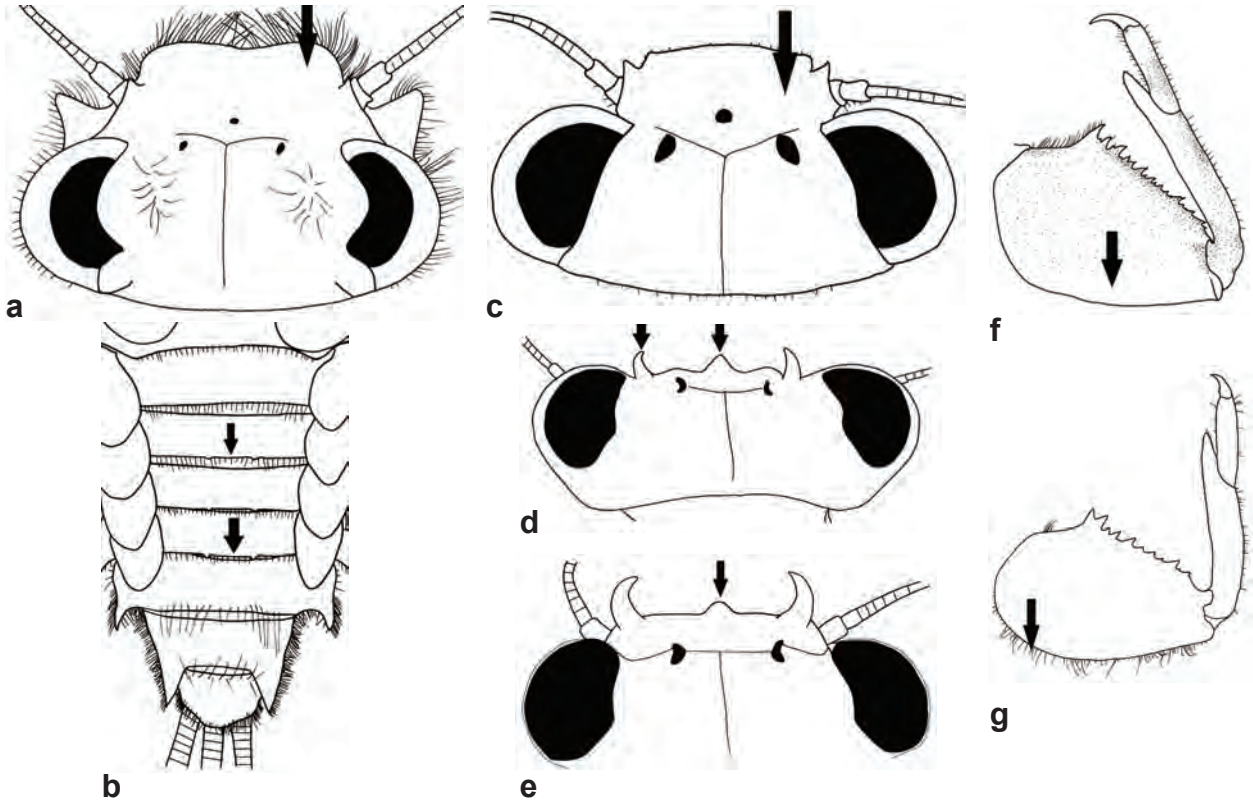


Figure 193. *Drunella* (Ephemerellidae). **a,** *D. walkeri,* head (dorsal); **b,** *D. walkeri,* terga; **c,** *D. lata,* head (dorsal); **d,** *D. cornuta,* head (dorsal); **e,** *D. cornutella,* head (dorsal); **f,** *D. lata,* front leg; **g,** *D. cornuta,* front leg.

Drunella cornuta (Morgan), 1911 (Figs. 194 and 195)

Taxonomic History: *Drunella cornuta* (Morgan), 1911 (curr. comb., Allen 1980); *Ephemerella cornuta* Morgan, 1911 (orig.); *Ephemerella depressa* Ide, 1930 (syn.). Jacobus & McCafferty (2004) placed *Drunella cornuta* as a junior synonym of *D. lata*. This taxonomic assignment was reversed by Funk et al. (2008).

Larval Descriptions: Ide (1930a), as *Ephemerella depressa*; Traver (1935), Allen and Edmunds (1962b), and Leonard and Leonard (1962), all as *E. cornuta*; Funk et al. (2008).

Larval Habitus: Ide (1930a), as *Ephemerella depressa*; Leonard and Leonard (1962), *E. cornuta.*

Determination: Identification of *D. cornuta* larvae is **Slightly Difficult**. Mature larvae are required for reliable identification.

Previous Wisconsin Records: Hilsenhoff et al. (1972) and Shapas and Hilsenhoff (1976), both as *Ephemerella cornuta*; Randolph and McCafferty (1998).

Status: *Drunella cornuta* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is known only from the northernmost counties.

Biological Information: *Drunella cornuta* was considered an indicator of excellent water quality in Wisconsin (Hilsenhoff 1982). Hubbard and Peters (1978) associated it with well-oxygenated streams with high current flow. In contrast, Funk et al. (2008) found it in a greater variety of habitats than other species in the genus, including first-order spring streams and large rivers such as the Delaware River. It most commonly occurs in shallow, swift riffles and outlets of pools with coarse organic matter, large gravel, and rubble (Leonard and Leonard 1962; Burian and Gibbs 1991). Ide (1930a) reported it, as *Ephemerella depressa*, on moss-covered stones in riffle areas.

Figure 194. *Drunella cornuta,* larva.

Figure 195. Wisconsin records of *Drunella cornuta.*

Drunella cornutella (McDunnough), 1931 (Figs. 196 and 197)

Taxonomic History: *Drunella cornutella* (McDunnough), 1931 (curr. comb., Allen 1980); *Ephemerella cornutella* McDunnough, 1931 (orig.). Jacobus & McCafferty (2004) placed *Drunella cornutella* as a junior synonym of *D. lata*. This taxonomic assignment was reversed by Funk et al. (2008).

Larval Descriptions: Traver (1935), Burks (1953), and Allen and Edmunds (1962b), all as *Ephemerella cornutella*; Funk et al. (2008).

Determination: Identification of *D. cornutella* larvae is **Difficult**. Mature larvae and specimens of *D. cornuta* available for comparison are required for reliable identification of *D. cornutella*.

Previous Wisconsin Records: None, with the first Wisconsin record given below. Hilsenhoff (1995) indicated *D. cornutella* was in the state but gave no detail. Records of the species have been published from the Upper Peninsula of Michigan (Allen and Edmunds 1962b; Yanoviak and McCafferty 1996).

New State Record: ASHLAND: 5L (including blackwing) in two vials, Morgan Crk., T45NR4W S30, VII-15-1979, G. Drecktrah, vials 091611D (UWO) and 091611E (THK).

Biological Information: Hilsenhoff (1982) considered *D. cornutella* an indicator of excellent water quality. The species is most common in third- to fifth-order streams with swift current and gravel or rubble substrates (Hubbard and Peters 1978; Burian and Gibbs 1991; Funk et al. 2008). The blackwing larvae reported above from July are in agreement with Burian and Gibbs (1991), who reported emergence of adults during July in Maine.

Figure 196. *Drunella cornutella,* larva.

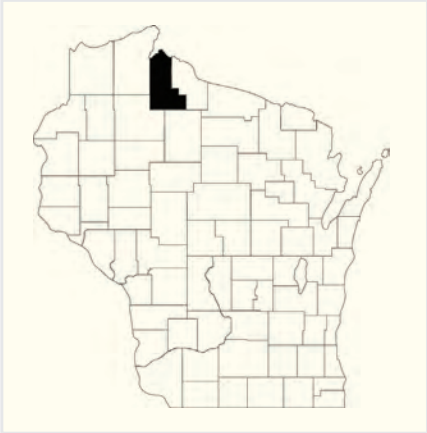


Figure 197. Wisconsin records of *Drunella cornutella.*

Drunella lata (Morgan), 1911 (Fig. 198)

Taxonomic History: *Drunella lata* (Morgan), 1911 (curr. comb., Allen 1980); *Drunella longicornis* (Traver), 1932 (syn.); *Ephemerella inflata* McDunnough, 1926 (syn.); *Ephemerella lata* Morgan, 1911 (orig.); *Ephemerella longicornis* Traver, 1932 (syn.).

Larval Descriptions: Traver (1932b), as *Ephemerella longicornis*; Traver (1935), as *E. lata* and *E. longicornis*; Burks (1953), as *E. lata*; Allen and Edmunds (1962b), as *E. lata* and *E. longicornis*; Leonard and Leonard (1962), as *E. lata*; Jacobus and McCafferty (2004); Funk et al. (2008).

Larval Habitus: Leonard and Leonard (1962), as *Ephemerella lata*.

Determination: Identification of *D. lata* larvae is **Slightly Difficult**. Jacobus and McCafferty (2004) concluded that the taxon was part of a highly variable single species including *D. lata*, *longicornis*, *cornuta*, and *cornutella*. Funk et al. (2008) subsequently found genetic and morphological differences between *D. lata*, *cornuta*, and *cornutella* and elevated those taxa back to species status but did not address the validity of *D. longicornis*. In the traditional concept of *D. lata* (Allen and Edmunds 1962), the frontoclypeal projections are small, flattened, and in the same plane as the remainder of the clypeus. The apical tibial projection is blunt. Larvae of this form are known from Appalachia as well as Great Lakes states east to Michigan. In southern Appalachian and New York populations previously known as *D. longicornis*, the frontoclypeal projections are very long, each nearly half as wide as the clypeus. The apical tibial projection is sharp and slightly curved. As this form is not known from the Midwest, it is presumed that any potential *D. lata* specimens in Wisconsin would be the former type (*sensu* Allen and Edmunds 1962).

Previous Wisconsin Records: None. Nearest records are from Lower Michigan. Hilsenhoff (1995) believed *D. lata* eventually will be found in Wisconsin.

Biological Information: Hilsenhoff (1982) considered *D. lata* an indicator of excellent water quality. It prefers larger streams than *D. cornuta* and *D. cornutella* (Funk et al. 2008). Its known substrates include sediment and gravel located behind large rubble and boulders in riffles (Burian and Gibbs 1991).

Figure 198. *Drunella lata,* larva.

Drunella walkeri (Eaton), 1884 (Fig. 199)

Taxonomic History: *Baetis fuscata* Walker, 1853 (hom.: *B. fuscata* Stephens, 1835); *Drunella walkeri* (Eaton), 1884 (curr. comb., Allen 1980); *Drunella wayah* (Traver), 1932 (syn.); *Ephemerella bispina* Needham, 1905 (syn.); *Ephemerella fuscata* (Walker), 1853 (hom. comb.); *Ephemerella walkeri* Eaton, 1884 (renam.); *Ephemerella wayah* Traver, 1932 (syn.).

Larval Descriptions: Traver (1932b), as *Ephemerella wayah*; Traver (1935), as *E. fuscata* and *E. wayah*; Burks (1953), as *E. walkeri*; Allen and Edmunds (1962b), as *E. walkeri* and *E. wayah*; Leonard and Leonard (1962), as *E. walkeri*; Jacobus and McCafferty (2004).

Larval Habitus: Leonard and Leonard (1962), as *Ephemerella walkeri*.

Determination: Identification of *D. walkeri* larvae is **Fairly Easy**. They are distinctive and easier to identify than other members of the genus. Jacobus and McCafferty (2004) noted that larvae of this species appear more flattened than other members of the genus.

Previous Wisconsin Records: None. Nearest records are from Lower Michigan and northern Indiana (Randolph and McCafferty 1998; Jacobus and McCafferty 2008). It is possible but unlikely in Wisconsin, considering that this distinctive species would not likely escape detection.

Biological Information: *Drunella walkeri* was considered an indicator of excellent water quality by Hilsenhoff (1982). It has been reported from streams with coarse organic matter under rubble and large gravel in swift, shallow riffles, or in areas of lesser current where leafy debris accumulates (Leonard and Leonard 1962; Burian and Gibbs 1991).

Figure 199. *Drunella walkeri,* larva.

Ephemerella

Comments: There currently are 21 recognized species of *Ephemerella* in North America. Six species are regular in Wisconsin, while historical records of two additional species currently are in question.

Determination: Identification of *Ephemerella* larvae is **Moderately Easy** for the genus, but **Fairly Easy to Very Difficult** for species within the genus. Some specimens of *Ephemerella* exhibit intermediate morphology and cannot reliably be identified, suggesting the possibility of hybrids.

Larval Keys: Traver (1932b, 1935); Burks (1953); Allen and Edmunds (1965); Allen (1968); Hilsenhoff (1982).

Key to the Species of *Ephemerella*

1. Terga IV–VII (at least) with large, paired submedian tubercles along the posterior margin of each segment which are clearly visible in lateral view rising above the terga (Fig. 200b, f, h); terga I, II, and IX with tubercles lesser and variously developed, but usually discernible on at least two of those segments **2**

Terga IV–VII with small, relatively flat protuberances which are difficult to discern in lateral view or do not clearly rise above the terga (Fig. 200a), or without any form of submedian tubercles or protuberances; terga I, II, and usually IX without discernible tubercles or protuberances **5**

2. Terga II–VIII bearing tubercles armed with many stout spicules (Fig. 200b), and sometimes such spicules also on terga I and IX; total body length of mature larvae usually longer than 11 mm; all legs relatively long; metathoracic leg more than 1.5 times longer than prothoracic leg, with metatibia much longer than metatarsus (Fig. 200c) . . . . . ***E. aurivillii***

Terga II–VIII bearing tubercles with few, if any, stout spicules (Fig. 200d), and such spicules never present on both segments I and IX; total body length of mature larvae usually less than 11 mm; all legs relatively short; metathoracic leg less than 1.5 times longer than prothoracic leg, with metatibia only slightly longer than metatarsus (Fig. 200e) **3**

3. Terga I–VIII with paired submedian tubercles along posterior margins, sometimes barely discernible on segment I (Fig. 200f); profemur with scattered hairs, but fewer than 10 spines on anterior surface, and with a dark band at both the proximal and distal end; each tarsus slightly swollen at end, with a dark terminal band (Fig. 200g) . . . . . ***E. needhami***

Terga II–IX or III–VIII with paired submedian tubercles along posterior margins (Fig. 200h); profemur with numerous short, thick spines along anterior surface, and without distinct dark bands as described above; each tarsus not swollen at end, with margins nearly parallel, and with or without a darkened terminal band **4**

4. Terga II–VIII or II–IX with well-developed paired submedian tubercles on posterior margins (Fig. 200h); head usually with small submedian occipital tubercles (Fig. 200j); profemur of mature larvae with limited number of spine-like setae on distal third of anterior surface, with few spines near ventral margin (Fig. 200i) . . . . . ***E. subvaria***

Terga III–VIII with moderately developed paired submedian tubercles along posterior margins, and with barely discernible protuberances on segments II and IX; head at most with small submedian occipital bumps (Fig. 200k); profemur of mature larvae with numerous setae of varying structure on distal half of anterior surface, sometimes limited to blunt setae but often with several long, spine-like setae (Fig. 201a) . . . . . ***E. invaria (rotunda)*** (in part)

5. Profemur of **mature** larvae usually with numerous blunt and/or spine-like setae on distal half of anterior surface, often forming a wide band across entire femur from dorsal to ventral edge (Fig. 201a); head of female larvae usually with small but distinct submedian occipital bumps visible in posterior view (less frequent in males); terga with submedian protuberances, if present, that are finely pointed (Fig. 200a); examination of a series of mature specimens may be required . . . . . ***E. invaria*** (in part)

Profemur of **mature** larvae usually with only scattered blunt setae on distal half of anterior surface (Fig. 201b); head lacking occipital bumps; terga with or without variously formed submedian protuberances—if present, protuberances usually rounded or blunt; examination of a series of mature specimens may be required **6**

6. Protarsal claw relatively robust, with curvature along posterior margin occurring more abruptly in distal third of claw (Fig. 201c), and more darkly pigmented at tip; terga with lateral margins bearing numerous small, stout setae but never serrate; common in Wisconsin . . . . . ***E. excrucians***

Protarsal claw relatively gracile, with curvature gradual over distal half of its length, and with dark pigment diffuse or absent (Fig. 201e); terga with or without serrate lateral margins, but also with numerous small, stout setae as above; all previous reports from Wisconsin suspect 7

7. Terga with serrate lateral margins having few scattered, stout setae (Fig. 201d); terga with few or no spicules over surfaces; examination of a series of and/or reared material essential for reliable identification . . . . . ***E. catawba***

Terga without serrate lateral margins but having regularly spaced, stout setae that give the appearance of serration; terga with scattered small spicules over surfaces; examination of a series of and/or reared material essential for reliable identification . . . . . ***E. dorothea dorothea***

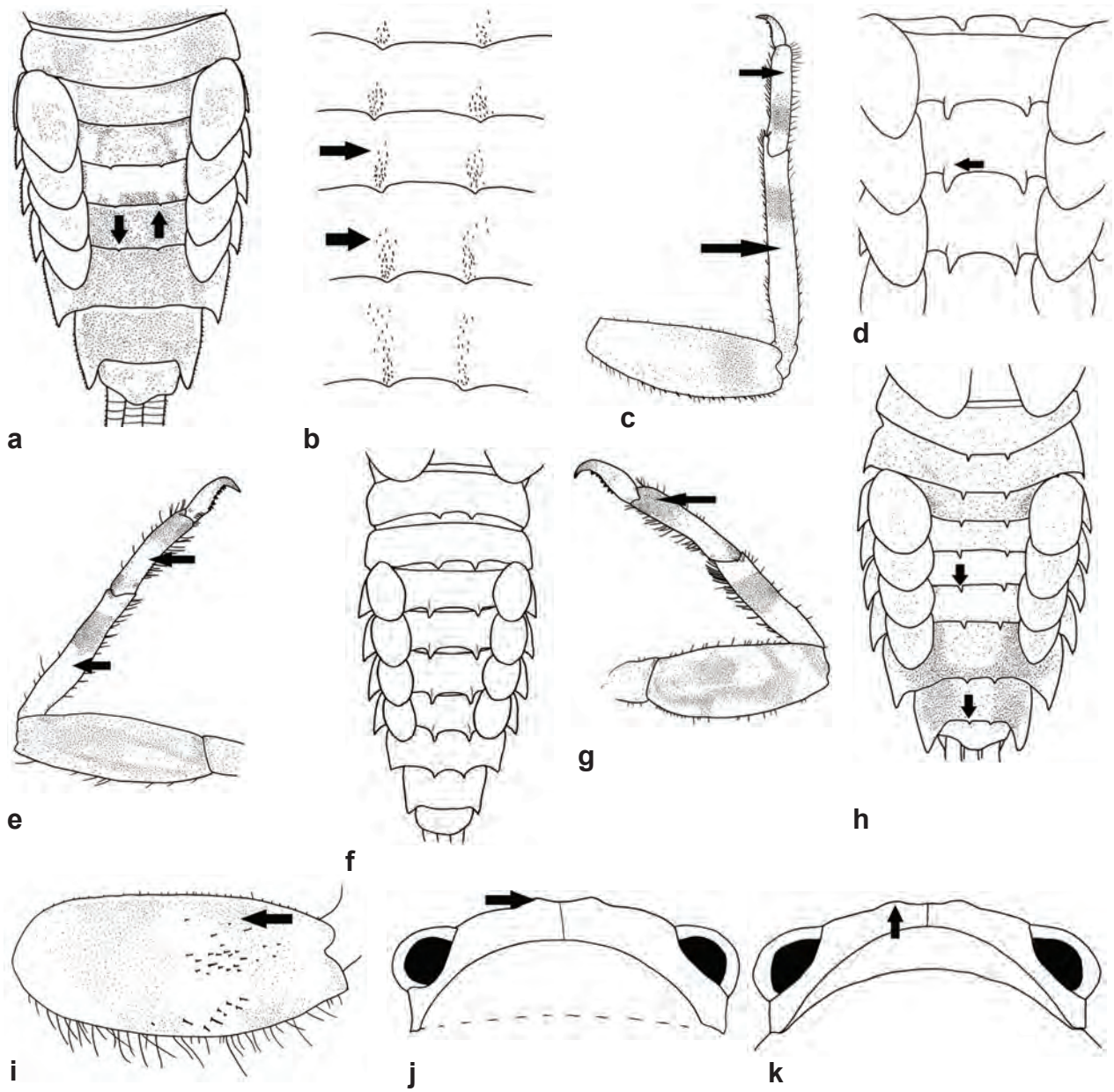


Figure 200. *Ephemerella* (Ephemerellidae). **a,** *E. invaria,* terga; **b,** *E. aurivillii,* tubercles on terga III–VII; **c,** *E. aurivillii,* hind leg (anterior); **d,** *E. needhami,* terga III–VI; **e,** *E. needhami,* hind leg (anterior); **f,** *E. needhami,* terga; **g,** *E. needhami,* front leg (anterior); **h,** *E. subvaria,* tubercles on terga III–VII; **i,** *E. subvaria,* front femur (anterior); **j,** *E. subvaria,* occiput (tangential); **k,** *E. invaria,* occiput, female (tangential).

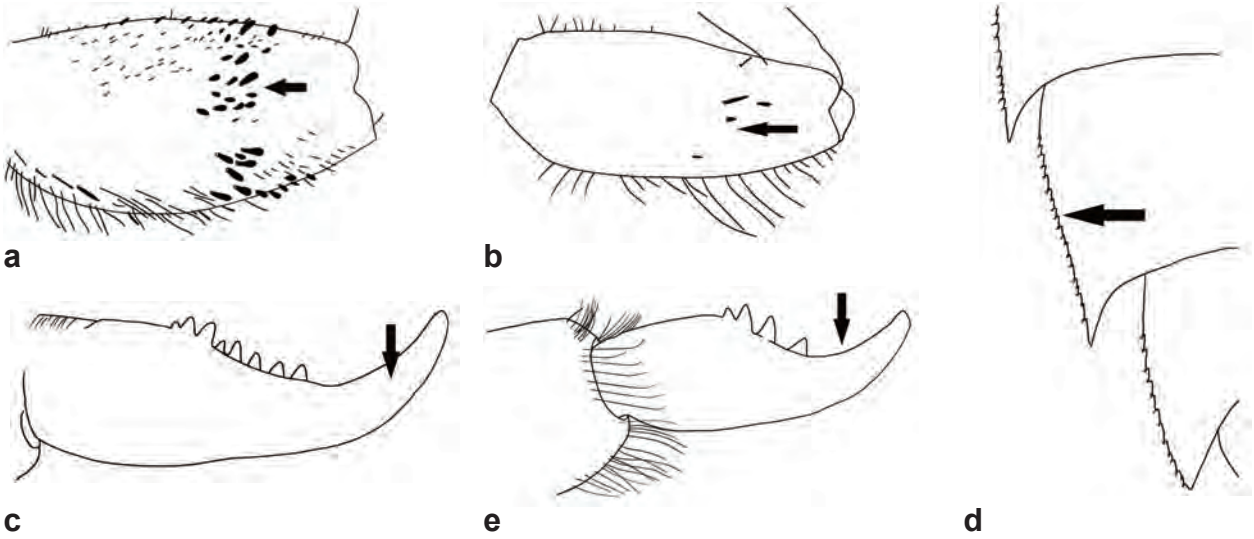


Figure 201. *Ephemerella* (Ephemerellidae). **a,** *E. invaria,* front femur (anterior); **b,** *E. excrucians,* front femur (anterior); **c,** *E. excrucians,* front claw; **d,** *E. catawba,* lateral margins of terga VII–IX; **e,** *E. catawba,* front claw.

Ephemerella aurivillii (Bengtsson), 1908 (Figs. 202 and 203)

Taxonomic History: *Chitonophora aurivillii* Bengtsson, 1908 (orig.); *Cincticostella ezoensis* (Gose), 1980 (syn.); *Ephemerella aroni* Eaton, 1908 (syn.); *Ephemerella aronii* Eaton, 1908 (syn.); *Ephemerella aurivillii* (Bengtsson), 1908 (curr. comb., McDunnough 1931b); *Ephemerella aurivilliusi* (Bengtsson), 1908 (spell.); *Ephemerella concinnata* Traver, 1934 (syn.); *Ephemerella ezoensis* Gose, 1980 (syn.); *Ephemerella* nN Imanishi, 1940 (syn.); *Ephemerella norda* McDunnough, 1924 (syn.); *Ephemerella taeniata* Tshernova, 1952 (syn.).

Larval Descriptions: Traver (1934), as *E. concinnata*; Traver (1935); Burks (1953); Allen and Edmunds (1965).

Determination: Identification of *E. aurivillii* larvae is **Slightly Difficult**, though easier with practice. Long legs and heavily spiculated, paired abdominal tubercles (Fig. 200b) are useful in the field and under low magnification. Mature or nearly mature larvae are recommended, however, for reliable identification.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976); DuBois (1993); Lillie (1995), misidentified as *E. inermis* Eaton; Randolph and McCafferty (1998).

New County Records: ASHLAND: 4L, Morgan Crk., T45NR4W S30, V-11-1985, THK (THK); **FLORENCE:** 1M, Pine R., coll. V-3-1970, emerged V-18-1970 (UW).

Biological Information: Little is published about the biology of *E. aurivillii*. The species was considered an indicator of excellent water quality by Hilsenhoff (1982). Burian and Gibbs (1991) reported it from poorly sorted gravel and rubble in riffles of cool, swift streams. In Wisconsin, it is known from a wide range of waters, from the second-order Billy Creek (Ashland Co.) to the much larger, sixth-order St. Croix River (Burnett Co.).

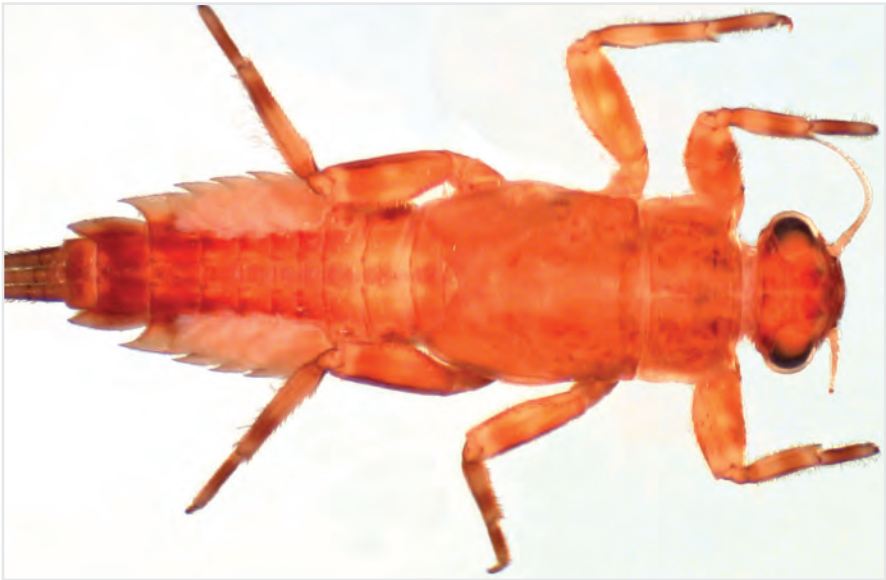


Figure 202. *Ephemerella aurivillii,* larva.

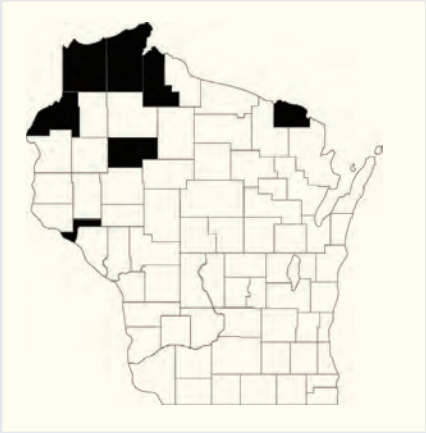


Figure 203. Wisconsin records of *Ephemerella aurivillii.*

Ephemerella catawba Traver, 1932 (Figs. 204 and 205)

Larval Descriptions: Traver (1932b, 1935); Allen and Edmunds (1965).

Determination: Identification of *E. catawba* larvae is **Very Difficult**. They look very similar to larvae of *E. excrucians* and misidentifications are common (Jacobus and McCafferty 2003).

Previous Wisconsin Records: Shapas and Hilsenhoff (1976). Jacobus and McCafferty (2003) questioned all Upper Midwest records of *E. catawba* on the basis that adults are known only from Appalachia, and that numerous specimens from the Midwest labeled as *E. catawba* are incorrectly identified *E. excrucians*. Unfortunately, I have not examined the specimens from Shapas and Hilsenhoff (1976) and the records remain unverified.

Biological Information: *Ephemerella catawba* larvae usually are associated with moss on rocks in rapid water (Traver 1935).

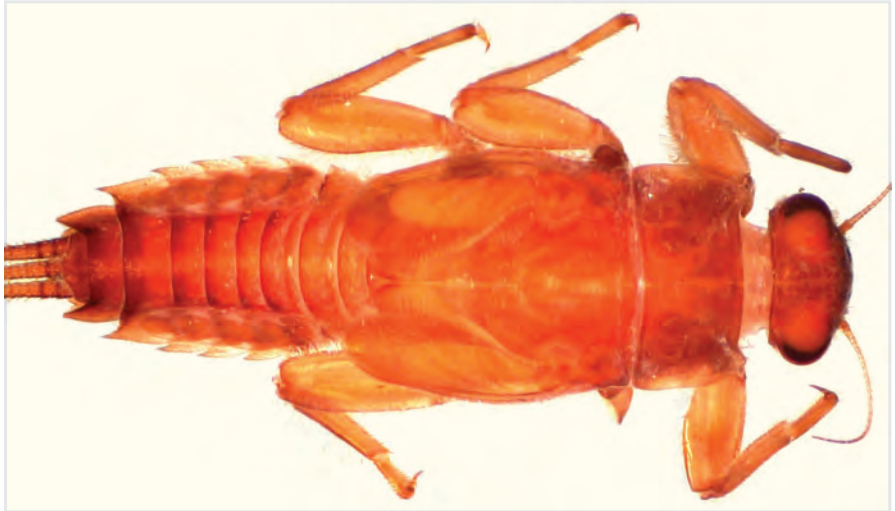


Figure 204. *Ephemerella catawba,* larva.

Figure 205. Wisconsin records of *Ephemerella catawba.*

Ephemerella dorothea dorothea Needham, 1908 (Figs. 206 and 207)

Taxonomic History: *Ephemerella dorothea* Needham, 1908 (orig.).

Larval Descriptions: Traver (1935); Burks (1953); Leonard and Leonard (1962); Allen and Edmunds (1965); Jacobus and McCafferty (2003).

Determination: Identification of *E. d. dorothea* larvae is **Very Difficult**. They look very similar to larvae of *E. excrucians* and misidentifications are common (Jacobus and McCafferty 2003).

Previous Wisconsin Records: Randolph and McCafferty (1998). Jacobus and McCafferty (2003) questioned all Upper Midwest records of *E. dorothea* on the basis that adults of the species are known only from Appalachia, and that numerous specimens from the Midwest labeled as *E. dorothea* were misidentified *E. excrucians*. No formal correction of the Wisconsin specimens reported in Randolph and McCafferty (1998) has been published, and I have not examined those specimens.

Biological Information: Because of the confusion with *E. excrucians*, references to the biology of *E. dorothea* in the Midwest should be interpreted with caution. Hilsenhoff (1982) considered *E. dorothea* an indicator of excellent water quality. Burks (1953) considered it a species of fairly large rivers, whereas Burian and Gibbs (1991) believed it more typical of first- to third-order streams. In such streams, they associated it with erosional habitats with poorly sorted sediment, gravel, and clumps of coarse organic matter.

Figure 206. *Ephemerella dorothea dorothea,* larva.

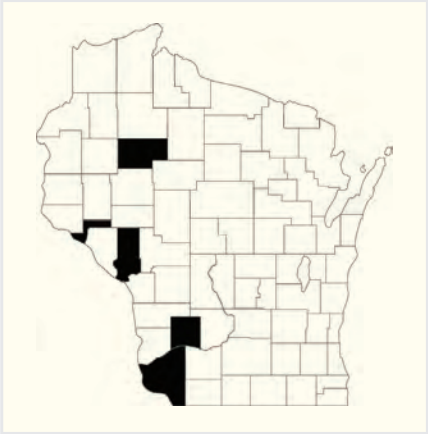


Figure 207. Wisconsin records of *Ephemerella dorothea dorothea.*

Ephemerella excrucians Walsh, 1862 (Figs. 208 and 209)

Taxonomic History: *Ephemerella argo* Burks, 1947 (syn.); *Ephemerella crenula* Allen and Edmunds, 1965 (syn.); *Ephemerella excrucians* Walsh, 1862 (spell.); *Ephemerella inermis* Eaton, 1884 (syn.); *Ephemerella lacustris* Allen and Edmunds, 1965 (syn.); *Ephemerella ora* Burks, 1949 (syn.); *Ephemerella rama* Allen, 1968 (syn.); *Ephemerella rossi* Allen and Edmunds, 1965 (syn.); *Ephemerella semiflava* McDunnough, 1926 (syn.).

Larval Descriptions: Needham and Betten (1901), as *E. excrucians*; Traver (1935), as *E. inermis*; Burks (1949), as *E. argo*; Leonard (1949), as *E. excrucians*; Burks (1953), as *E. argo* and *E. excrucians*; Leonard and Leonard (1962), as *E. excrucians*; Allen and Edmunds (1965), as *E. argo*, *E. crenula*, *E. excrucians*, *E. inermis*, *E. lacustris*, and *E. rossi*; Jacobus and McCafferty (2003).

Larval Habitus: Leonard (1949), as *E. excrucians*; Allen and Edmunds (1965), as *E. inermis;* Schwiebert (1973), as *E. excrucians* and *E. inermis*; Edmunds et al. (1976).

Determination: Identification of *E. excrucians* larvae is **Slightly Difficult**. Jacobus and McCafferty (2003) noted, however, that larvae are variable in color and structure, including tail patterns, abdominal coloration, and size of the abdominal tubercles. Larvae are very similar to *E. dorothea*, *E. catawba*, and some *E. invaria*.

Previous Wisconsin Records: Randolph and McCafferty (1998), as *E. inermis*. Jacobus and McCafferty (2003) suspected that larvae identified as *E. catawba* in Shapas and Hilsenhoff (1976) were misidentified *E. excrucians*. Jacobus and McCafferty (2003) also suspected that Wisconsin and other Upper Midwest records of *E. dorothea* were misidentified *E. excrucians.* Larvae reported as *E. inermis* by Lillie (1995) were corrected to *E. aurivillii* by Randolph and McCafferty (1998).

New County Records: BAYFIELD: 2L in two vials (including blackwing), Marengo R., Forest Rd. 198, IV-30-1998 and V-26-2006, G. Drecktrah (THK and UWO); **POLK:** 1L, Wolf Crk., River Rd. in Wolf Creek, 45°33'23"N 92°43'23"W, VII-13-2011, THK (THK); **PORTAGE:** 12L, Tomorrow R., 8.5 mi. S. of Amherst, V-8-2001, M. Reif (UWO); 2L (including blackwing), Waupaca R., Hwy. 10 wayside, V-27-1988, G. Drecktrah (UWO); **RUSK:** 3L, Devil's Crk., Fire Lane Rd., site "Chipr 6355", 45.528878°N 91.401712°W, Summer 2012, K. L. Schmude (UWS).

Status: *Ephemerella excrucians* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). The species may be far more widely distributed in the state than indicated by published records because of the difficulty of identification.

Biological Information: Burks (1953) suggested that *E. excrucians* (as both *E. argo* and *E. ora*) was a large river species. The few records listed above, however, are from third- and fourth-order streams. Leonard and Leonard (1962) reported it from relatively shallow portions, just 14 inches deep, of gravel-bottom streams.

Figure 208. *Ephemerella excrucians,* larva.

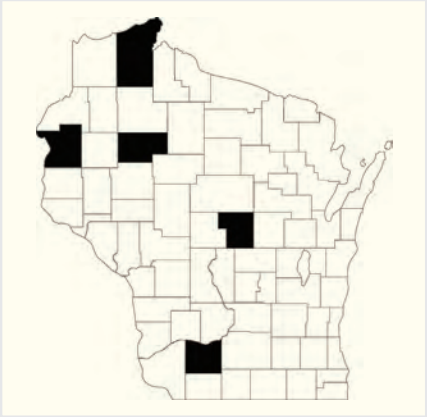


Figure 209. Wisconsin records of *Ephemerella excrucians.*

Ephemerella invaria (Walker), 1853 (Figs. 210 and 211)

Taxonomic History: *Baetis invaria* Walker, 1853 (orig.); *Chitonophora vernalis* (Banks), 1914 (syn.); *Ephemerella choctawhatchee* Berner, 1946 (syn.); *Ephemerella femenina* Needham, 1924 (syn. spell.); *Ephemerella feminina* Needham, 1924 (syn.); *Ephemerella floripara* McCafferty, 1985 (syn.); *Ephemerella fratercula* Needham, 1925 (syn.); *Ephemerella inconstans* Traver, 1932 (syn.); *Ephemerella invaria* (Walker), 1853 (curr. comb., Eaton 1871); *Ephemerella rotunda* Morgan, 1911 (syn.); *Ephemerella simila* Allen and Edmunds, 1965 (syn.); *Ephemerella vernalis* Banks, 1914 (syn.).

Larval Descriptions: Traver (1932b), as *E. inconstans*; Traver (1935), as *E. invaria*, *E. rotunda*, and *E. vernalis*; Burks (1953) and Leonard and Leonard (1962), both as *E. invaria* and *E. rotunda*; Allen and Edmunds (1965), as *E. choctawhatchee*, *E. inconstans*, *E. invaria*, *E. rotunda*, and *E. simila*; Schwiebert (1973), as *E. invaria* and *E. rotunda*; Jacobus and McCafferty (2003).

Larval Habitus: Leonard and Leonard (1962) and Schwiebert (1973), both as *E. invaria* and *E. rotunda*.

Determination: Determination of *E. invaria* larvae is **Moderately Difficult**. Variation in sharpness of the abdominal tubercles and coloration exists in the species (Jacobus and McCafferty 2003). Young larvae are difficult to reliably identify. Most Wisconsin specimens have extremely small, paired dorsal tubercles on the abdominal terga (Fig. 200a), or such tubercles are absent. Such specimens are very similar to *E. excrucians*.

Previous Wisconsin Records: Allen and Edmunds (1965), as *E. invaria* and *E. rotunda*; Hilsenhoff et al. (1972), as *E. invaria* and *E. rotunda*; Shapas and Hilsenhoff (1976), as *E. rotunda*; DuBois (1993); Lillie and Isenring (1996); Randolph and McCafferty (1998), as *E. invaria* and *rotunda*.

New County Records: ASHLAND: 65L in three vials (including blackwing), Brunsweiler R., Forest Rd. 189, V-4-1985, V-2-1992, and V-26-2006, G. Drecktrah (UWO); **BUFFALO:** 1M, Spring Crk., coll. V-31-1972, emerg. VI-20-1972 (UW); **CHIPPEWA:** 5L, Spring Crk., Co. Rd. Z, site "Chipr 11307", 45.17021°N 91.246757°W, Summer 2012, K. L. Schmude (THK); **LINCOLN:** 1L, Big Hay Meadow Crk., 1st Ave., site "Wiscn 3776", 45.307597°N 89.465643°W, Summer 2012, K. L. Schmude (UWS); **MARQUETTE:** 1L, Chaffee Crk., next to Hwy. 51, V-2-1981, T. Ziebell (UWO); **PORTAGE:** 2L (including blackwing), Waupaca R., Hwy. 10 wayside, V-27-1988, G. Drecktrah (UWO); **RICHLAND:** 1M, Elk Crk., V-23-1972 (UW).

Biological Information: Burks (1953) associated *E. invaria* with rapid, moderate-size rivers, though Leonard and Leonard (1962) found it tolerant of a variety of river sizes. More specifically, Burian and Gibbs (1991) found it in poorly sorted materials consisting of gravel, rubble, and coarse organic matter covered with filamentous green algae in riffles and transitional runs.

Figure 210. *Ephemerella invaria,* larva.

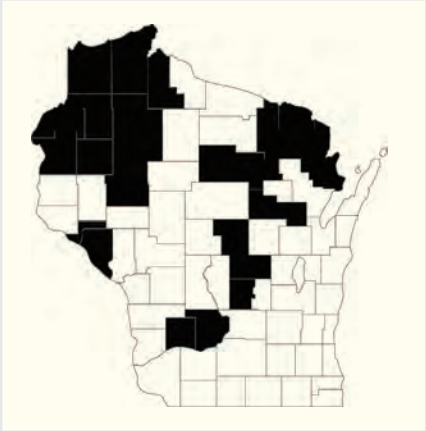


Figure 211. Wisconsin records of *Ephemerella invaria.*

Ephemerella needhami McDunnough, 1925 (Figs. 212 and 213)

Larval Descriptions: Traver (1935); Burks (1953); Leonard and Leonard (1962); Allen and Edmunds (1965).

Larval Habitus: Leonard and Leonard (1962); Schwiebert (1973).

Determination: Identification of *E. needhami* larvae is **Slightly Difficult**. They have paired abdominal tubercles that are distinctly larger than in larvae of *E. aurivillii* and lack dense patches of spicules (Fig. 200d). In the field, the pale mid-dorsal stripe of larger larvae is useful. Moderately immature larvae can be reliably identified. In many larvae of *E. needhami*, the whorls of setae beyond the midlength of the caudal filaments are shorter and sparser than in other *Ephemerella*, suggestive of *Serratella*. I have found such misidentifications in various collections.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); Peckarsky (1980); Dubois (1993); Hilsenhoff (1996); Lillie and Isenring (1996); Randolph and McCafferty (1998).

Biological Information: *Ephemerella needhami* is the most widely distributed member of the genus. It is most common in cool, rapid creeks and small rivers (Burks 1953). As with *E. invaria*, this species commonly is associated with mats of filamentous algae and films of periphyton on large gravel and rubble (Burian and Gibbs 1991). McShaffrey and McCafferty (1991) found it associated with *Cladophora* filamentous algae in streams, while Leonard and Leonard (1962) found it associated with *Potamogeton*.

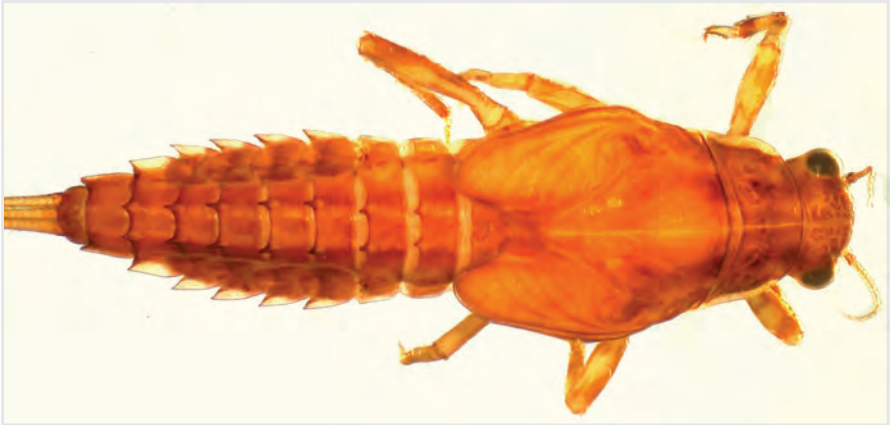


Figure 212. *Ephemerella needhami,* larva.

Figure 213. Wisconsin records of *Ephemerella needhami.*

Ephemerella subvaria McDunnough, 1931 (Figs. 214 and 215)

Larval Descriptions: Ide (1935b); Traver (1935); Burks (1953); Leonard and Leonard (1962); Allen and Edmunds (1965).

Larval Habitus: Leonard and Leonard (1962).

Determination: Identification of *E. subvaria* larvae is **Slightly Difficult**. The larvae are more consistent in structure and coloration than larvae of *E. invaria* and *E. excrucians*. Wisconsin specimens have abdominal tubercles (Fig. 200h) intermediate in size between the minute ones typical of *E. invaria* (Fig. 200a) and the much larger and more robust ones of *E. needhami* (Fig. 200d).

Previous Wisconsin Records: Allen and Edmunds (1965); Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); Peckarsky (1980); Narf (1985); DuBois (1993); Hilsenhoff (1996); Lillie and Isenring (1996); Randolph and McCafferty (1998).

New County Records: SHEBOYGAN: 4L, Pigeon R., 1 mi. N. of Sheboygan, IV-7-1990, M. Graff (UWO).

Biological Information: DuBois (1993) found larvae of *E. subvaria* in a wide range of biotic areas in the Brule River drainage system of Douglas County, Wisconsin. Leonard and Leonard (1962) and Burian and Gibbs (1991) associated it with clean gravel and rubble substrates in swift riffles and transitional runs.

Figure 214. *Ephemerella subvaria,* larva.

Figure 215. Wisconsin records of *Ephemerella subvaria.*

Eurylophella

Comments: There are fifteen North American species of *Eurylophella*. Five are known from Wisconsin. An additional four species are included in the key because they are possible in the state.

Determination: Identification of *Eurylophella* larvae is **Moderately Easy** for the genus and **Fairly Easy to Slightly Difficult** for species within the genus. Identification of species requires careful lifting of the dorsal lamella of gill IV and viewing the ventral lobe in lateral view, which can be done without removing the gill.

Larval Keys: Traver (1932b, 1935) and Burks (1953), both as *Ephemerella*; Hilsenhoff (1982); Funk and Sweeney (1994).

Key to the Species of *Eurylophella*

1. Gill IV with dorsal subdivisions of ventral lamella well developed, subequal to ventral subdivisions (Fig. 216a); terga II–VII with rows of paired submedian tubercles appearing evenly convergent throughout that range of segments (Figs. 216b, 229) **2**

Gill IV with dorsal subdivisions of ventral lamella reduced (no more than five) or absent (Figs. 216h, 217d); terga II–VII with rows of paired submedian tubercles appearing subparallel (Figs. 217c, 218), or with those on anterior segments closer together (Figs. 216k, 217e) **3**

2. Occipital tubercles small in both sexes, sometimes barely perceptible in males (Fig. 216c); total body length of full-grown larvae 6.5–8 mm; terga I–III with submedian tubercles, often pointed, relatively straight, and not significantly larger than those of segment V–VII when observed in lateral view (Fig. 216d); not known from Wisconsin . . . . ***E. prudentalis***

Occipital tubercles usually large in both sexes (Fig. 216e); total body length of full-grown larvae 8–12 mm; terga I–III with submedian tubercles thick, arched, and much larger than those of segment V–VII when observed in lateral view (Fig. 216f) . . . . . ***E. temporalis***

3. Posterolateral projections of tergum IX with inner margins sinuate, with outer margins gently convex to nearly parallel, and with well-developed submedian tubercles (Fig. 216g); submedian tubercles on terga I–IV long, thin, and arched in lateral view . . . . . ***E. funeralis***

Posterolateral projections of tergum IX variously shaped, but not with all of the conditions described above (Figs. 216i, 217a); submedian tubercles on terga I–IV generally blunt, rounded in lateral view, but if narrow then not arched in lateral view **4**

4. Gill IV with ventral lamella bearing two to five small, dorsal lobes (Fig. 217d); terga I–II with submedian tubercles both separated by more than half the distance separating those on segment VI (Fig. 217c) **5**

Gill IV with ventral lamella bearing up to two minute, dorsal lobes (Fig. 216h); terga I–II with submedian tubercles close together, with those on segment I less than half of the distance of those on segment VI (Fig. 216k) **6**

5. Total body length of full-grown larvae 6.4–8 mm; occipital tubercles always well developed (Fig. 217b); abdominal segment III with posterolateral projections shorter than distance between dorsal tubercles on that segment (Fig. 217c) . . . . . ***E. aestiva***

Total body length of full-grown larvae 8.7–11.2 mm; occipital tubercles sometimes small (Fig. 217f); abdominal segment III with posterolateral projections subequal to or longer than distance between dorsal tubercles on that segment (Fig. 217e) . . . . . ***E. lutulenta***

6. Occipital tubercles distinct and well developed in both sexes (Fig. 217g); total body length of full-grown larva 6.8–9.2 mm; not known from Wisconsin . . . . . ***E. verisimilis***

Occipital tubercles small and inconspicuous in males, small but distinct in females (Fig. 216j); total body length of full-grown larvae 5.1–8.9 mm **7**

7. Tergum V with space between submedian tubercles distinctly greater than on tergum IV, so that rows of tubercles appear to diverge abruptly from IV to V (Fig. 216k); terga V–VII with tubercles less than three-quarters the length of the tubercle on tergum IV, sometimes barely visible above terga in lateral view; tubercle IV noticeably less erect than tubercle III in lateral view (Fig. 216l); common. . . . . ***E. bicolor***

Tergum V with space between submedian tubercles similar to that on IV (Fig. 217h); terga V–VII with tubercles at least three-quarters the length of the tubercle on tergum IV in lateral view, sometimes tubercle V reaching nearly the same height and similar in shape to tubercle IV; tubercle IV similar in overall shape to tubercle III in lateral view (Fig. 217i); not known from Wisconsin **8**

8. Terga I–IV with submedian tubercles appearing broadly rounded in lateral view; posterolateral projection on abdominal segment II minute; emerges in summer; not known from Wisconsin . . . . . ***E. minimella***

Terga I–IV with submedian tubercles appearing narrowly rounded in lateral view (Fig. 217i); posterolateral projection on abdominal segment II small but distinct (Fig. 217j); emerges in spring; not known from Wisconsin . . ***E. macdunnoughi***

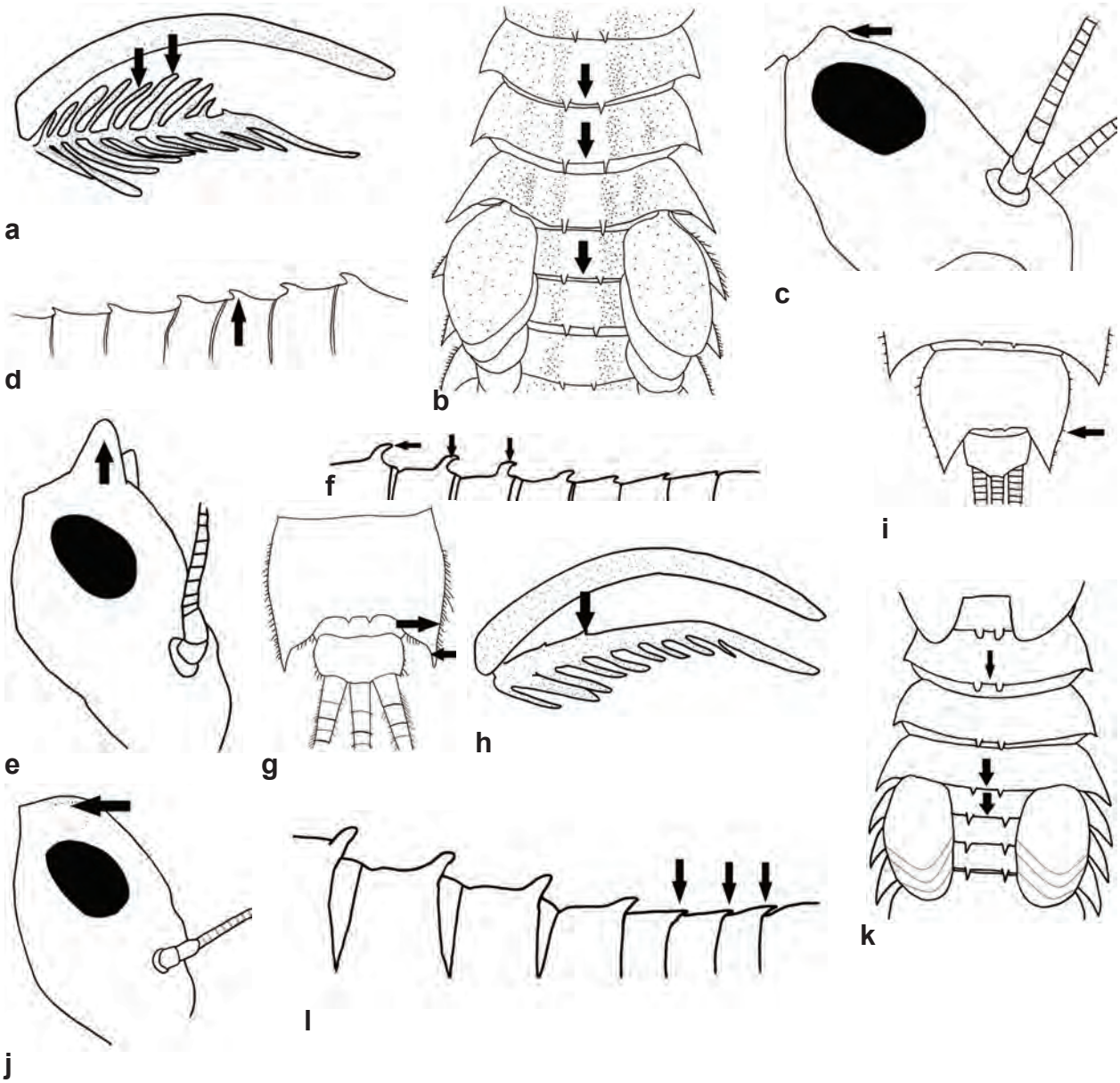


Figure 216. *Eurylophella* (Ephemerellidae). **a,** *E. temporalis,* gill IV (medial); **b,** *E. temporalis,* terga I–VII; **c,** *E. prudentalis,* head (lateral); **d,** *E. prudentalis,* terga I–VII (lateral); **e,** *E. temporalis,* head (lateral); **f,** *E. temporalis,* terga I–VIII (lateral); **g,** *E. funeralis,* terga IX–X; **h,** *E. bicolor,* gill IV (medial); **i,** *E. bicolor,* terga VIII–X; **j,** *E. bicolor,* head (lateral); **k,** *E. bicolor,* terga I–VII; **l,** *E. bicolor,* terga I–VIII (lateral).

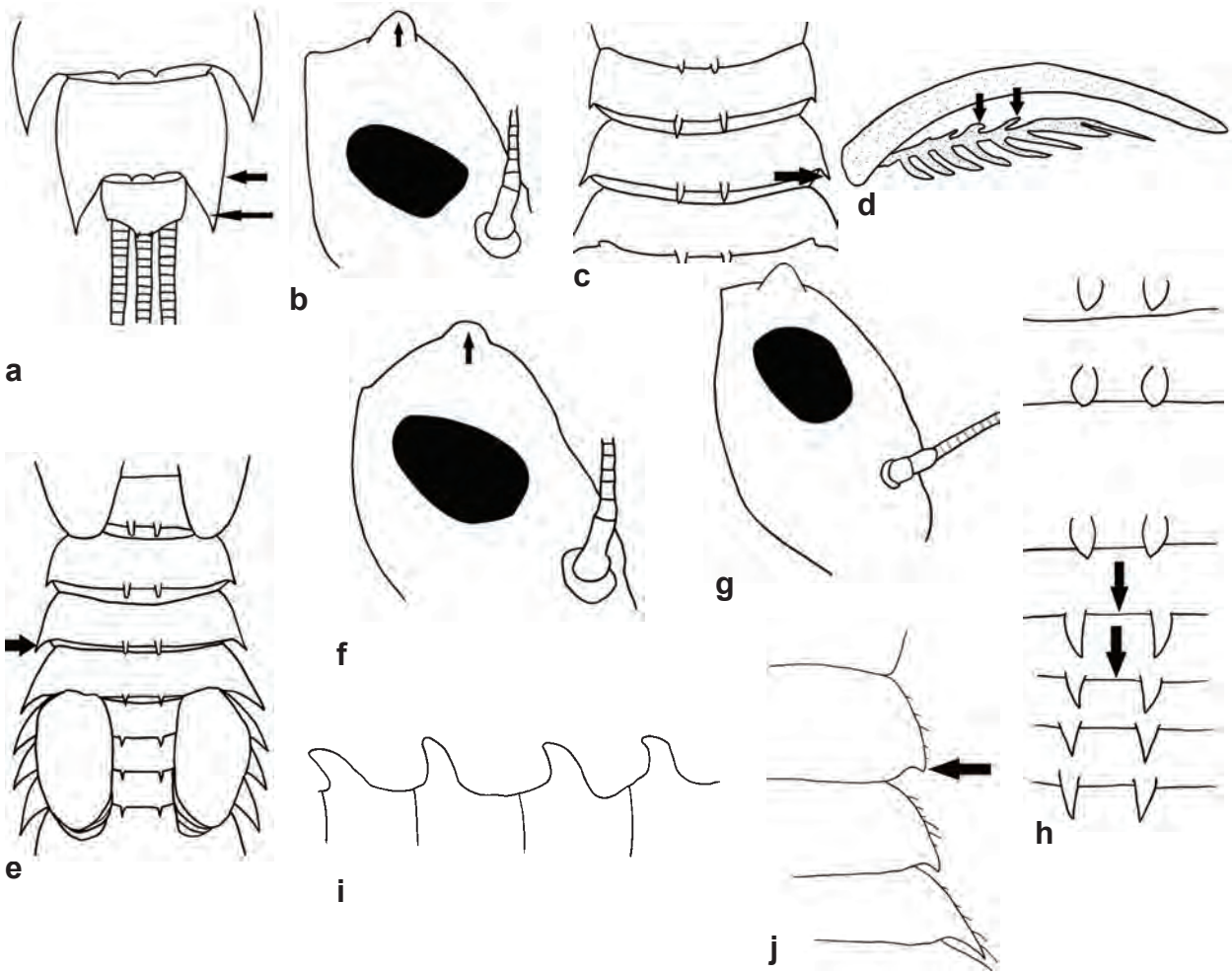


Figure 217. *Eurylophella* (Ephemerellidae). **a,** *E. aestiva,* terga VIII–X; **b,** *E. aestiva,* head (lateral); **c,** *E. aestiva,* terga I–IV; **d,** *E. aestiva,* gill IV (medial); **e,** *E. lutulenta,* terga I–VIII; **f,** *E. lutulenta,* head (lateral); **g,** *E. verisimilis,* head (lateral); **h,** *E. macdunnoughi,* abdominal tubercles; **i,** *E. macdunnoughi,* terga I–IV (lateral); **j,** *E. macdunnoughi,* sterna I–IV.

Eurylophella aestiva (McDunnough), 1931 (Figs. 218 and 219)

Taxonomic History: *Ephemerella aestiva* McDunnough, 1931 (orig.); *Eurylophella aestiva* (McDunnough), 1931 (curr. comb., Allen 1980).

Larval Descriptions: Traver (1935) and Burks (1953), both as *Ephemerella aestiva*; Funk and Sweeney (1994).

Larval Habitus: Funk and Sweeney (1994).

Determination: Identification of *Eurylophella aestiva* larvae is **Slightly Difficult**. With practice, they can be separated from the bicolor group by the characters in the key. Young larvae may not be separable, however, from *E. lutulenta*.

Previous Wisconsin Records: Randolph and McCafferty (1998).

Status: *Eurylophella aestiva* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is the least frequently encountered member of the genus known from the state.

Biological Information: The habitat of *E. aestiva* apparently ranges from first- and second-order streams (Burian and Gibbs 1991) to medium-sized streams and even large rivers (Funk and Sweeney 1994). It lives in depositional habitats with fine sediment, gravel, and organic matter (Burian and Gibbs 1991). It is the last *Eurylophella* to emerge, typically with larvae not appearing again until late spring or early summer (Funk and Sweeney 1994).

Figure 218. *Eurylophella aestiva,* larva.

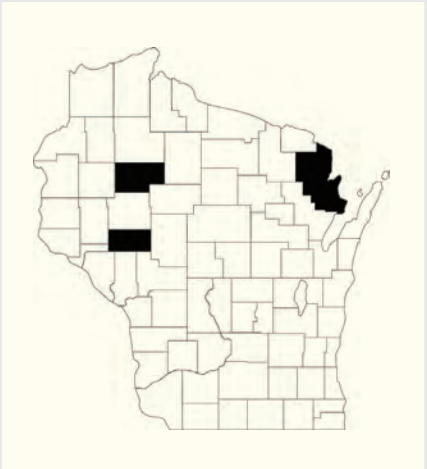


Figure 219. Wisconsin records of *Eurylophella aestiva.*

Eurylophella bicolor (Clemens), 1913 (Figs. 220–222)

Taxonomic History: *Ephemerella bicolor* Clemens, 1913 (orig.); *Eurylophella bicolor* (Clemens), 1913 (curr. comb., Allen 1980).

Larval Descriptions: Clemens (1915c), Traver (1935), and Burks (1953), all as *Ephemerella bicolor*; Funk and Sweeney (1994).

Larval Habitus: Clemens (1913) and Edmunds et al. (1976), both as *Ephemerella bicolor*; Funk and Sweeney (1994).

Determination: Identification of *Eurylophella bicolor* larvae is **Slightly Difficult**. This is the only member of the bicolor species group that is known from Wisconsin. Larvae of *E. bicolor* are highly variable in coloration and pattern (Fig. 221). Specimens should be examined carefully, though, to enable detection of other members of the group. Young larvae usually have more erect submedian tubercles on the abdomen than mature larvae, possibly creating confusion in the key.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Randolph and McCafferty (1998).

New County Records: BARRON: 3L, Spring Crk., 23rd Ave., site "Chipr 6325", 45.537268°N 91.544923°W, Summer 2012, K. L. Schmude (UWS); **BAYFIELD:** 7L, Iron R., N. River Loop Rd., site "Lksup 936", 46.765383°N 91.487359°W, Summer 2012, K. L. Schmude (UWS); **CHIPPEWA:** 2L in two vials (including blackwing), Chippewa R., Cornell, T31NR7W S24, VI-19-1997 (WiDNR); **DOUGLAS:** 2L, Amnicon R., S. Amnicon R. Rd., site "Lksup 1406", 46.690863°N 91.857244°W, Summer 2012, K. L. Schmude (UWS); **MARINETTE:** 13L (including blackwing), Menominee R., Faithorn, T36NR22E S6, VI-24-1997 (WiDNR); 6L, Menominee R., Jones Landing, 1.5 mi. NW. of Faithorn, T37NR22E S8, VI-24-1997, R. A. Lillie (WiDNR); 25L, Menominee R., Saler Landing, T38NR22E S17, Summer 1996, (WiDNR); 1L, Pike R., VI-23-1997, R. A. Lillie (WiDNR); **PRICE:** 2L, Sailor Crk., Old 13 Rd., site "Chipr 3517", 45.853512°N 90.412508°W, Summer 2012, K. L. Schmude (UWS); **SAWYER:** 28L in two vials (including blackwing), Flambeau R., Hervas, T37NR4W S35, VI-19-1997 (WiDNR).

Biological Information: *Eurylophella bicolor* is known from a variety of habitats, including small streams to large rivers, ponds, and lakes (Burian and Gibbs 1991; Funk and Sweeney 1994). It is most abundant close to shore (Burian and Gibbs 1991). It is more restricted to northern waters in the state than *E. temporalis*.

Figure 220. *Eurylophella bicolor,* larva.

Figure 221. *Eurylophella bicolor,* larvae.

Figure 222. Wisconsin records of *Eurylophella bicolor.*

Eurylophella funeralis (McDunnough), 1925 (Figs. 223 and 224)

Taxonomic History: *Ephemerella funeralis* McDunnough, 1925 (orig.); *Eurylophella funeralis* (McDunnough), 1925 (curr. comb., Allen 1980).

Larval Descriptions: Traver (1935) and Burks (1953), both as *Ephemerella funeralis*; Funk and Sweeney (1994).

Larval Habitus: Funk and Sweeney (1994).

Determination: Identification of *Eurylophella funeralis* larvae is **Fairly Easy**. The species is the most easily recognized member of the genus (Funk and Sweeney 1994).

Previous Wisconsin Records: Allen and Edmunds (1963b), as *Ephemerella funeralis*; Peckarsky (1980); Funk and Sweeney (1994).

New County Records: FOREST: 2L, Kufner Crk., Kufner Rd., site "Pesht 700", 45.495849°N 88.556889°W, Summer 2012, K. L. Schmude (UWS); **IRON:** 2L, unnamed crk., Casey Sag Rd., site "Badri 2453", 46.36095°N 90.465515°W, Summer 2012, K. L. Schmude (UWS); **JACKSON:** 3L, unnamed crk., trail off Dodge Rd., site "Blckr 5918", 44.198728°N 90.77925°W, Summer 2012, K. L. Schmude (THK).

Biological Information: *Eurylophella funeralis* was considered an indicator of excellent water quality in Wisconsin by Hilsenhoff (1982). Of the species in the genus, it is the one most likely in first-order streams (Funk and Sweeney 1994), though it can occur in third-order streams (Burian and Gibbs 1991; Funk and Sweeney 1994). It prefers poorly sorted and loosely collected sediment, gravel, rubble, and clumps of organic matter (Burian and Gibbs 1991).

Figure 223. *Eurylophella funeralis,* larva.

Figure 224. Wisconsin records of *Eurylophella funeralis.*

Eurylophella lutulenta (Clemens), 1913 (Figs. 225 and 226)

Taxonomic History: *Ephemerella lineata* Clemens, 1913 (syn.); *Ephemerella lutulenta* Clemens, 1913 (orig.); *Eurylophella lutulenta* (Clemens), 1913 (curr. comb., Allen 1980).

Larval Descriptions: Clemens (1913, 1915c), as *Ephemerella lineata* and *E. lutulenta*; Traver (1935) and Burks (1953), both as *E. lutulenta*; Funk and Sweeney (1994).

Larval Habitus: Clemens (1913), as *Ephemerella lineata*; Funk and Sweeney (1994).

Determination: Identification of *Eurylophella lutulenta* larvae is **Slightly Difficult**. Identifications of mature larvae are most reliable, as young larvae may not be separable from *E. aestiva*.

Previous Wisconsin Records: Traver (1935) and Allen and Edmunds (1963b), both as *Ephemerella lutulenta*; Randolph and McCafferty (1998).

New County Records: WINNEBAGO: 2L in two vials, Rush Crk., T18NR14E S36, IV-23-2001, A. Dubay (UWO).

Biological Information: The large larvae of *Eurylophella lutulenta* are most likely found in small, shallow lakes (Burks 1953; Funk and Sweeney 1994). Emergence occurs earlier in spring than for other *Eurylophella*, with nearly mature larvae already present in fall (Funk and Sweeney 1994).

Figure 225. *Eurylophella lutulenta,* larva.

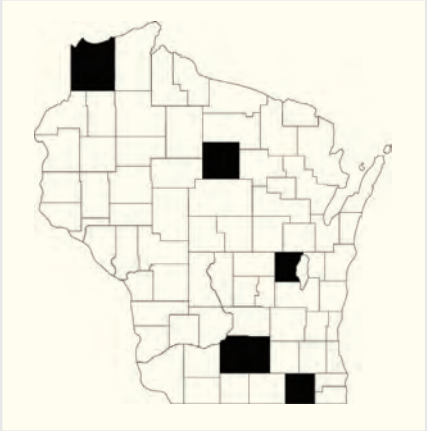


Figure 226. Wisconsin records of *Eurylophella lutulenta.*

Eurylophella macdunnoughi Funk, 1994 (Fig. 227)

Larval Description and Habitus: Funk and Sweeney (1994).

Determination: Identification of *E. macdunnoughi* larvae is **Slightly Difficult**. Larvae that are at least moderately mature are recommended for reliable species identification.

Previous Wisconsin Records: None. There is one record of *E. macdunnoughi* from Lower Michigan (Randolph and McCafferty 1998). With a range mostly limited to the Appalachian Plateau, it is not expected in Wisconsin.

Biological Information: Relatively little is known about *E. macdunnoughi*. It usually is reported from habitats ranging from large streams to large rivers (Funk and Sweeney 1994).

Figure 227. *Eurylophella macdunnoughi,* larva.

Eurylophella minimella (McDunnough), 1931

Taxonomic History: *Ephemerella minimella* McDunnough, 1931 (orig.); *Eurylophella minimella* (McDunnough), 1931 (curr. comb., Allen 1980).

Larval Descriptions: Traver (1935) and Burks (1953), both as *Ephemerella minimella*; Funk and Sweeney (1994).

Larval Habitus: Funk and Sweeney (1994).

Determination: Identification of *Eurylophella minimella* larvae is **Slightly Difficult**. Larvae of *E. minimella* have more erect submedian tubercles on abdominal terga V–VII than larvae of *E. bicolor*. Immature larvae have thinner, more erect tubercles than mature larvae.

Previous Wisconsin Records: None. Nearest records are from Lower Michigan (Allen and Edmunds 1963b) and northeastern Minnesota (Lager et al. 1982). It is expected in Wisconsin.

Biological Information: *Eurylophella minimella* is known from well-oxygenated, medium-sized streams as well as lakes (Hubbard and Peters 1978; Funk and Sweeney 1994). It usually is associated with erosional zones with well-sorted coarse sediment and organic matter, such as in outflow downstream from a pool or in transitional runs and riffles (Funk and Sweeney 1994).

Eurylophella prudentalis (McDunnough), 1931 (Fig. 228)

Taxonomic History: *Ephemerella prudentalis* McDunnough, 1931 (orig.); *Eurylophella prudentalis* (McDunnough), 1931 (curr. comb., Allen 1980).

Larval Descriptions: Traver (1935) and Burks (1953), both as *Ephemerella prudentalis*; Funk and Sweeney (1994).

Larval Habitus: Funk and Sweeney (1994).

Determination: Identification of *Eurylophella prudentalis* larvae is **Fairly Easy**. They are most similar to larvae of *E. temporalis*, with both species having gill IV with dorsal subdivisions of ventral lamella well developed (Fig. 216a).

Previous Wisconsin Records: None. Nearest published records of *E. prudentalis* are from Kentucky (Randolph and McCafferty 1998). The species was reported from Minnesota in an unpublished PhD dissertation by Daggy (1941), as noted in Lager et al. (1982). Daggy did not, however, include the species in his later, published survey (1945) of Minnesota mayflies. Randolph and McCafferty suggested that it would be expected in northern Wisconsin and the Upper Peninsula of Michigan based upon Minnesota records of Funk and Sweeney (1994). Actually, no mention of *E. prudentalis* in the Upper Midwest is made by Funk and Sweeney (1994), and the only known record in the region remains that of Daggy's (1941) dissertation. The species, therefore, is confirmed only from Appalachia and should be considered unlikely in Wisconsin and the Upper Peninsula without confirmed, published records.

Biological Information: *Eurylophella prudentalis* is known from shorelines of both lotic (Funk and Sweeney 1994) and lentic (Burian and Gibbs 1991) habitats. It tends not to be associated with strong currents. The substrate usually is well-sorted sediment with fine and coarse organic matter (Burian and Gibbs 1991).

Figure 228. *Eurylophella prudentalis,* larva.

Eurylophella temporalis (McDunnough), 1924 (Figs. 229 and 230)

Taxonomic History: *Ephemerella temporalis* McDunnough, 1924 (orig.); *Eurylophella temporalis* (McDunnough), 1924 (curr. comb., Allen 1980).

Larval Descriptions: Traver (1935), Burks (1953) and Leonard and Leonard (1962), all as *Ephemerella temporalis*; Funk and Sweeney (1994).

Larval Habitus: Berner and Pescador (1988); Funk and Sweeney (1994).

Determination: Identification of *Eurylophella temporalis* larvae is **Fairly Easy**. It is the only common species of Wisconsin *Eurylophella* with gill IV having well developed dorsal subdivisions of the ventral lamella (Fig. 216a).

Previous Wisconsin Records: Allen and Edmunds (1963b), as *Ephemerella temporalis*; DuBois (1993); Hilsenhoff (1996); Lillie and Isenring (1996); Randolph and McCafferty (1998).

New County Records: BAYFIELD: 25+L Namekagon R., Forest Rd. 211, IV-20-1986, THK (THK); 1L, Lk. Owen outlet, T44NR7W S10, V-6-1995, G. Drecktrah (UWO); 1L, Lk. Owen, V-7-2004, A. Carvajal (UWO).

Biological Information: In terms of water quality, Hilsenhoff (1982) considered *Eurylophella temporalis* the least sensitive member of the genus in Wisconsin. It is known from a wide variety of lentic and lotic habitats, usually located in relatively shallow water with low current (Burks 1953; Burian and Gibbs 1991; Funk and Sweeney 1994).

Figure 229. *Eurylophella temporalis,* larva.

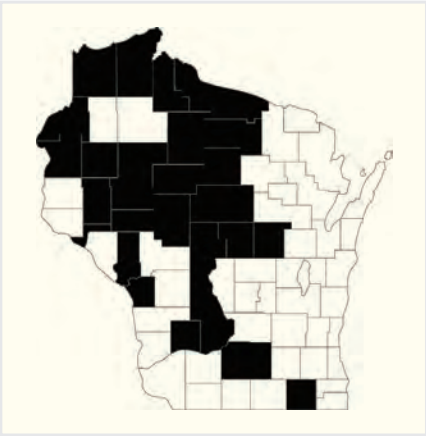


Figure 230. Wisconsin records of *Eurylophella temporalis.*

Eurylophella verisimilis (McDunnough), 1930 (Fig. 231)

Taxonomic History: *Ephemerella verisimilis* McDunnough, 1930 (orig.); *Eurylophella verisimilis* (McDunnough), 1930 (curr. comb., Allen 1980); *Eurylophella versimilis* (McDunnough), 1930 (spell. comb.).

Larval Descriptions: Traver (1935) and Burks (1953), both as *Ephemerella verisimilis*; Funk and Sweeney (1994).

Larval Habitus: Funk and Sweeney (1994).

Determination: Identification of *Eurylophella verisimilis* larvae is **Slightly Difficult**. The occipital tubercles are much more distinct in larvae of *E. verisimilis* than in other members of the *bicolor* group (Fig. 217g; also Figs. 66–67 in Funk and Sweeney 1994).

Previous Wisconsin Records: None. Nearest records of *E. verisimilis* are from the Upper Peninsula of Michigan (Yanoviak and McCafferty 1996; Randolph and McCafferty 1998) and northeastern Minnesota (Lager et al. 1982). It is expected in northern Wisconsin.

Biological Information: *Eurylophella verisimilis* is a mayfly of small- to medium-sized streams, but not lakes (Burian and Gibbs 1991; Funk and Sweeney 1994). It lives on well-sorted, fine sediment and organic debris along stream margins (Burian and Gibbs 1991).

Figure 231. *Eurylophella verisimilis,* larva.

Serratella

Comments: There are five North American species of *Serratella*. Published Wisconsin records exist for only one species, *S. serrata*, and only from northern waters.

Determination: Identification of *Serratella* larvae is **Moderately Easy** for the genus and **Slightly Difficult** for species within the genus.

Larval Keys: Traver (1935) and Burks (1953), both as *Ephemerella*; Allen and Edmunds (1963a); Hilsenhoff (1982).

Key to the Species of *Serratella*

1. Maxillary palpus one-segmented (Fig. 232a); not known from Wisconsin . . . . . ***S. frisoni***

Maxillary palpus of similar length, but clearly three-segmented **2**

2. Pronotum with paired, submedian tubercles; head, thorax, and legs with long hair-like setae (Fig. 234); vertex of head roughened and covered with scattered fine spicules; claws with three to five denticles; each abdominal sternum with or without a set of four dots . . . . . ***S. serrata***

Pronotum without paired, submedian tubercles; head, thorax, and legs lacking long hair-like setae (Fig. 236); vertex of head variable; claws with five to eight denticles; each abdominal sternum with a set of four black dots (Fig. 232b); not known from Wisconsin . . . . . ***S. serratoides***

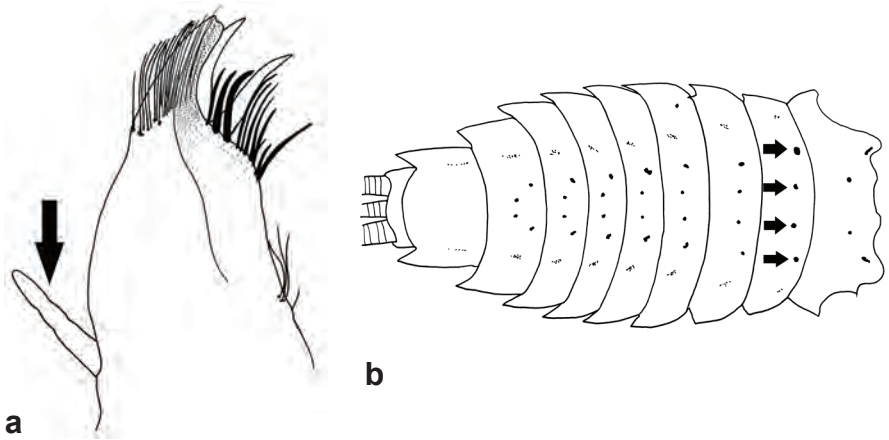


Figure 232. *Serratella* (Ephemerellidae). **a,** *S. frisoni,* maxilla (ventral); **b,** *S. serratoides,* abdominal sterna.

Serratella frisoni (McDunnough), 1927 (Fig. 233)

Taxonomic History: *Ephemerella frisoni* McDunnough, 1927 (orig.); *Serratella frisoni* (McDunnough), 1927 (curr. comb., Allen 1980).

Larval Descriptions: Burks (1953) and Allen and Edmunds (1963a), both as *Ephemerella frisoni*.

Larval Habitus: Burks (1953), as *Ephemerella frisoni*.

Determination: Identification of *S. frisoni* larvae is **Slightly Difficult**. The one-segmented maxillary palpi (Fig. 232a) are small, often covered in debris, and must be slide-mounted. Young larvae of *Ephemerella needhami*, which have shorter lateral setae on caudal filaments than most *Ephemerella*, frequently are misidentified as *S. frisoni*.

Previous Wisconsin Records: None. Nearest records are from east-central Illinois (McDunnough 1927; Burks 1953; Allen and Edmunds 1963a). It is unlikely in Wisconsin.

Biological Information: *Serratella frisoni* almost always is reported from creeks, small streams, and small rivers with swift current (Burks 1953; Berner and Allen 1961; Allen and Edmunds 1963a). It commonly crawls on vegetation downstream from rocks or logs that provide shelter from the strong current (Berner and Allen 1961).

Figure 233. *Serratella frisoni,* larva.

Serratella serrata (Morgan), 1911 (Figs. 234 and 235)

Taxonomic history: *Ephemerella carolina* Berner and Allen, 1961 (syn.); *Ephemerella serrata* Morgan, 1911 (orig.); *Ephemerella sordida* McDunnough, 1925 (syn.); *Ephemerella spiculosa* Berner and Allen, 1961 (syn.); *Serratella carolina* (Berner and Allen), 1961 (syn.); *Serratella serrata* (Morgan), 1911 (curr. comb., Allen 1980); *Serratella sordida* (McDunnough), 1925 (syn.); *Serratella spiculosa* (Berner and Allen), 1961 (syn.).

Larval Descriptions: Traver (1935) and Burks (1953), both as *Ephemerella serrata* and *E. sordida*; Berner and Allen (1961), as *E. carolina* and *E. spiculosa*; Allen and Edmunds (1963a), as *E. carolina*, *E. serrata*, *E. sordida*, and *E. spiculosa*; Jacobus and McCafferty (2000); Jacobus and McCafferty (2003).

Determination: Identification of *S. serrata* larvae is **Slightly Difficult**. Their appearance and coloration are variable (Jacobus and McCafferty 2000). The maxillae are small, often covered with debris, and require dissection for adequate examination. Fortunately, the long setae on the thorax and legs (Fig. 234) are quite distinct and allow separation of *S. serrata* from both *S. serratoides* and *S. frisoni*.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Ephemerella sordida*; Randolph and McCafferty (1998), as *S. sordida*.

New County Records: BURNETT: 1L (blackwing), St. Croix R., VI-24-1998 (WiDNR); 1L, St. Croix R., T42NR14W S16, VI-18-1997 (WiDNR); 2L, St. Croix R., St. Rd. 77, T41NR17W S25, VI-17-1997 (WiDNR); **RUSK:** 1L, Flambeau R., Washington, T33NR7W S22, VI-19-1997 (WiDNR).

Status: Given its sensitivity to water quality and scattered populations in the state, *S. serrata* should be a good candidate for conservation measures.

Biological Information: Hilsenhoff (1982) considered *S. serrata* an indicator of excellent water quality in Wisconsin. It is known from moderate-sized to large rivers with swift current (Berner and Allen 1961; Allen and Edmunds 1963a; Burian and Gibbs 1991; Jacobus and McCafferty 2003). Larvae seek crevices in logs and rocks that protect them from the current (Allen and Edmunds 1963a; Burian and Gibbs 1991).

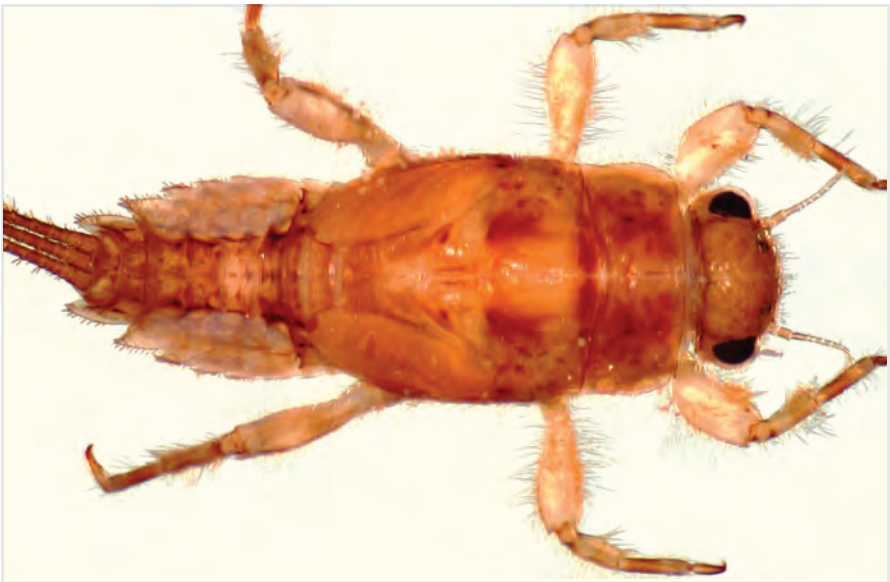


Figure 234. *Serratella serrata,* larva.

Figure 235. Wisconsin records of *Serratella serrata.*

Serratella serratoides (McDunnough), 1931 (Fig. 236)

Taxonomic History: *Ephemerella serratoides* McDunnough, 1931 (orig.); *Serratella serratoides* (McDunnough), 1931 (curr. comb., Allen 1980).

Larval Descriptions: Burks (1953) and Allen and Edmunds (1963a), both as *Ephemerella serratoides*.

Larval Habitus: Traver (1935), as *Ephemerella serratoides*.

Determination: Identification of *S. serratoides* larvae is **Slightly Difficult**. The maxillae often are covered with debris and should be cleaned with a brush. Larvae lack the long setae on the thorax and legs that occur in *S. serrata*, but have just as many relatively short setae.

Previous Wisconsin Records: None. The nearest record of *S. serratoides* is from the Upper Peninsula of Michigan (Yanoviak and McCafferty 1996), as well as Indiana (Randolph and McCafferty 1998). It is likely in Wisconsin, especially in northern counties rich in ephemerellid diversity. It likely has been overlooked.

Biological Information: As with *S. serrata*, *S. serratoides* occurs in streams with swift current. Larvae crawl on moss-covered rocks, particularly downstream of larger rocks that break up the current (Allen and Edmunds 1961; Berner and Allen 1961; Burian and Gibbs 1991).

Figure 236. *Serratella serratoides,* larva.

Teloganopsis

Comments: *Teloganopsis* contains only one species, which formerly was placed in *Serratella*.

Determination: Identification of *Teloganopsis* larvae is **Moderately Easy**. They are most similar to larvae of *Serratella*.

Larval Keys: Traver (1932b), Burks (1953), and Allen and Edmunds (1963a), all as *Ephemerella*; Hilsenhoff (1982), as *Serratella*.

Teloganopsis deficiens (Morgan), 1911 (Figs. 237 and 238)

Taxonomic History: *Ephemerella atrescens* McDunnough, 1925 (syn.); *Ephemerella deficiens* Morgan, 1911 (orig.); *Serratella deficiens* (Morgan), 1911 (comb.); *Teloganopsis deficiens* (Morgan), 1911 (curr. comb., Jacobus and McCafferty 2008).

Larval Descriptions: Traver (1932b, 1935), Burks (1953), Leonard and Leonard (1962), and Allen and Edmunds (1963a), all as *Ephemerella deficiens*.

Larval Habitus: Leonard and Leonard (1962) and Berner and Pescador (1988), both as *Ephemerella deficiens*.

Determination: Identification of *T. deficiens* larvae is **Moderately Easy**. The species is the only member of the genus in the Midwest. Larvae have sparse setation of the caudal filaments (Fig. 183c), no maxillary palpi (Fig. 183f), and no paired tergal protuberances or spines. These characters are distinctive in both mature and immature larvae. Larvae of *Ephemerella invaria* and *E. excrucians* can be confused with *T. deficiens* if characters in the keys are not carefully used.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Ephemerella deficiens*; DuBois (1993) and Randolph and McCafferty (1998), both as *Serratella deficiens*.

New County Records: ASHLAND: 1L, Flambeau R., Creamery Rd., 46.01025°N 90.36851°W, VI-13-2000, K. L. Schmude, C. Brennan, J. Denninger, and K. Mielke (UWS); **DUNN:** 10L, S. Fork Hay R., St. Rd. 64, 45.135195°N 92.098229°W, VI-25-2008, K. L. Schmude and A. Reynolds (UWS); **KEWAUNEE:** 1L, Casco Crk., Rock Ledge Rd., site "Door 698", 44.545092°N 87.635548°W, Summer 2012, K. L. Schmude (UWS); **MARINETTE:** 15L, Pike R., VI-23-1997 (WiDNR); 1L, Menominee R., Faithorn, T36NR22E S6, VI-24-1997 (WiDNR); **ONEIDA:** 2L, Wolf R., Meister-Stockley Rd., 45.53194°N 89.11214°W, VI-9-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **ST. CROIX:** 3L in two vials, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); **WASHBURN:** 3L in two vials, Bean Brk., Hwy. 63, 2 mi. SW. of Springbrook, 45°55'17"N 91°43'50"W, VII-15-2011, THK (THK); 25L in two vials, Brill R., Bridge Rd., 2.5 mi. N. of Brill, 45°38'21"N 91°40'27"W, VII-15-2011, THK (THK); 39L in two vials, Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK); 21L in two vials, Namekagon R., Co. Rd. K, T40NR12W S18, VI-24-1998, R. A. Lillie (WiDNR).

Biological Information: The habitat of *T. deficiens* is generally similar to that of the closely related *Serratella*. It lives in streams with moderate to high current (Hubbard and Peters 1978). In Wisconsin, it is known from both large and small rivers. Larvae usually are taken from vegetated or rocky margins of streams, where they are protected from the current in mats of moss or algae (Berner 1950; Berner and Allen 1961; Leonard and Leonard 1962). Larvae also are associated with coarse organic matter collected downstream of large rocks that protect them from current (Burian and Gibbs 1991).

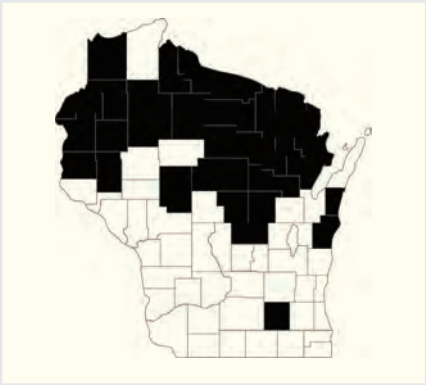


Figure 237. *Teloganopsis deficiens,* larva.

Figure 238. Wisconsin records of *Teloganopsis deficiens.*

13 EPHEMERIDAE

The Family Ephemeridae includes many of our larger mayflies, including those often noticed by members of the public. They generally are burrowing mayflies, with larvae that form tubular burrows in sediment. In North America, the family contains three genera and thirteen species (Anonymous 2014a).

Key to the Genera of Ephemeridae

1. Antennae with only short setae on most segments (Fig. 239a); gill I not forked . . . . . ***Litobrancha recurvata***

Antennae with whorls of long setae on most segments (Fig. 239c); gill I forked **2**

2. Head with forked frontal process (Fig. 239b) . . . . . ***Ephemera***

Head with rounded frontal process (Fig. 239c). . . . . ***Hexagenia***

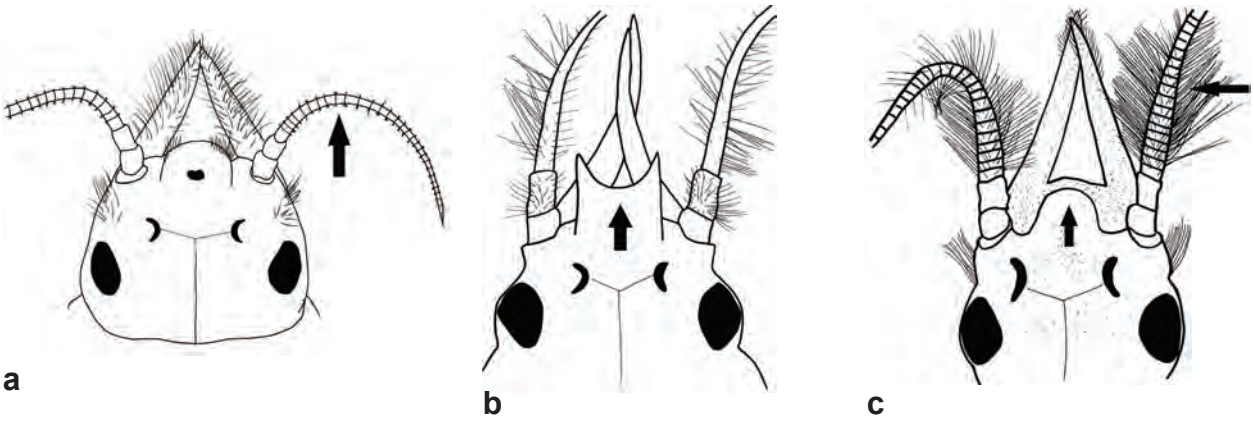


Figure 239. Ephemeridae. **a,** *Litobrancha recurvata,* head (dorsal); **b,** *Ephemera simulans,* head (dorsal); **c,** *Hexagenia limbata,* head (dorsal).

Ephemera

Comments: Of the five extant North American species of *Ephemera*, only one species in the genus is known from Wisconsin.

Determination: Identification of *Ephemera* larvae is **Moderately Easy** for the genus and **Slightly to Moderately Difficult** for species within the genus.

Larval Keys: Traver (1935); Burks (1953); McCafferty (1975).

Key to the Species of *Ephemera*

1. Meso- and metathoracic wingpads of mature larvae marked with dark blotches (Fig. 240) . . . . . ***E. simulans***

Mesothoracic wingpads, but not metathoracic wingpads, of mature larvae marked with dark blotches; not known from Wisconsin . . . . . ***E. varia***

Ephemera simulans Walker, 1853 (Figs. 240 and 241)

Taxonomic History: *Ephemera decora* Walker, 1853 (syn.); *Ephemera natata* (Walker), 1853 (syn.); *Palingenia natata* Walker, 1853 (syn.).

Larval Descriptions: Needham (1920), as *E. simulans/varia*; Ide (1935b); Leonard and Leonard (1962).

Larval Habitus: McCafferty (1975).

Determination: Identification of *E. simulans* larvae is **Slightly Difficult**. Young larvae may be inseparable from *E. varia*, as full coloration of the metathoracic wingpads may not occur until later instars.

Previous Wisconsin Records: Britt (1962); Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); Jacobs (1990); DuBois (1993); Randolph and McCafferty (1998).

New County Records: ASHLAND: 1L, N. Fork Flambeau R., Holt's Landing, T41NR1E S21, VI-19-1997 (WiDNR); **BARRON:** 15L, Bear Crk., 25th Ave., site "Chipr 5948", 45.567221°N 91.770873°W, Summer 2012, K. L. Schmude (UWS); **CHIPPEWA:** 1L, Chippewa R., Cornell, T31NR7W S24, VI-19-1997 (WiDNR); **LINCOLN:** 1L, Big Hay Meadow Crk., 1st Ave., site "Wiscn 3776", 45.307597°N 89.465643°W, Summer 2012, K. L. Schmude (UWS); **MANITOWOC:** 1A, W. Twin R., VI-13-2002, T. Valenta (UWGB); **MARINETTE:** 2L in two vials, Menominee R., Co. Rd. Z, VI-24-1997 and VI-30-1998 (WiDNR); **PORTAGE:** 1L, Bradley Crk., St. Rd. 49, 44.63937°N 89.26906°W, VI-7-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 29L, Emmons Crk., Stratton Lk. Rd., 44.30875°N 89.26387°W, V-23-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **SHAWANO:** 23L, Comet Crk., Much Rd., 44.70801°N 89.17643°W, V-26-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 1L, Middle Br. Embarrass R., Co. Rd. J, 44.80852°N 89.01844°W, V-27-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **VILAS:** Star Lk., VI-28-2002, S. Glaser (UWGB); Crystal Lk., IX-12-2005, A. M. Lederer (UWGB); **WAUPACA:** 1L, Waupaca R., 2 mi. W. of Waupaca, V-19-2010, S. Davis-Faust (UWO); **WAUSHARA:** 3L, Gilbert Lk., 23rd Rd., 44.21393°N 89.15809°W, V-23-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 5A, Lunch Crk., VI-9-1968 (UW); **WINNEBAGO:** Fish Trap Pond, T18NR14W S36, IX-14-1982 (UWO); **WOOD:** 2L, Yellow R., St. Rd. 80 below falls, 44.4682°N 90.13034°W, X-13-1998, W. Steffens (WiDNR).

Biological Information: Larvae of *E. simulans* occur in moderate-sized rivers as well as along lake shorelines with wave action (Burks 1953; Hubbard and Peters 1978; Burian and Gibbs 1991). Larvae prefer substrates with a greater proportion of sand and gravel than the typical *Hexagenia*, which prefers a greater amount of silt (Leonard and Leonard 1962). At one time, the species was extremely abundant in Lake Michigan (Burks 1953), but populations in the lake have declined over several decades (Beeton 1969; Cochran 1992). Wisconsin records of adults are from 30 May in Sawyer County to the end of June.

Figure 240. *Ephemera simulans,* larva.

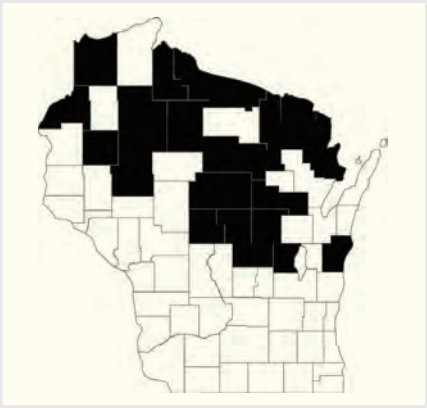


Figure 241. Wisconsin records of *Ephemera simulans.*

Ephemera varia Eaton, 1883 (Fig. 242)

Larval Descriptions: Needham and Betten (1901).

Larval Habitus: Needham and Betten (1901); Needham (1920), as *E. simulans*/*varia*; Traver (1935).

Determination: Identification of *E. varia* larvae is **Moderately Difficult**. Only relatively mature, recently collected larvae can be reliably identified based on the absence of dark mottling on the metathoracic wingpads.

Previous Wisconsin Records: None. Nearest records of *E. varia* are from northeastern Minnesota and southern Indiana (McCafferty 1994) and Lower Michigan (Needham 1908, 1920). It is expected in Wisconsin and likely has been overlooked.

Biological Information: In contrast to *E. simulans*, *E. varia* is more restricted to cool, shallow, and unpolluted streams (Hubbard and Peters 1978; Burian and Gibbs 1991). Its substrates include fine sediment and gravel in riffles and transitional runs, especially in depositional pockets downstream of rocks and boulders (Burian and Gibbs 1991).

Figure 242. *Ephemera varia,* larva.

Hexagenia

Comments: There currently are seven recognized North American species of *Hexagenia*, with four of them known from Wisconsin. They are very large mayflies associated with silty substrates of both rivers and lakes.

Determination: Identification of *Hexagenia* larvae is **Fairly Easy** for the genus, and **Fairly Easy to Slightly Difficult** for species within the genus.

Larval Keys: Traver (1931a, 1935); Burks (1953); Hamilton (1959); McCafferty (1975).

Key to the Species of *Hexagenia* (larvae over 16 mm)

1. Head with apically truncate frontal process with a small mesal indentation (Fig. 243a); each abdominal tergum and sternum sometimes with a pair of small, submedian, round pale spots with dark margins (Fig. 243b) . . . ***H. atrocaudata***

Head with apically rounded or conical frontal process (Figs. 239c, 243f); abdominal terga and sterna never both with pale spots as described above **2**

2. Mesotarsal claw thick near tip (Fig. 243c) . . . . . ***H. bilineata***

Mesotarsal claw slender near tip (Fig. 243d) **3**

3. Developing penes of mature male larva long and straight (Fig. 243e); head with narrowly conical frontal process (Fig. 243f) . . . . . ***H. rigida***

Developing penes of mature male larva turned inward at tips (Fig. 243g); head with broadly rounded or slightly conical frontal process (Fig. 239c) . . . . . ***H. limbata***

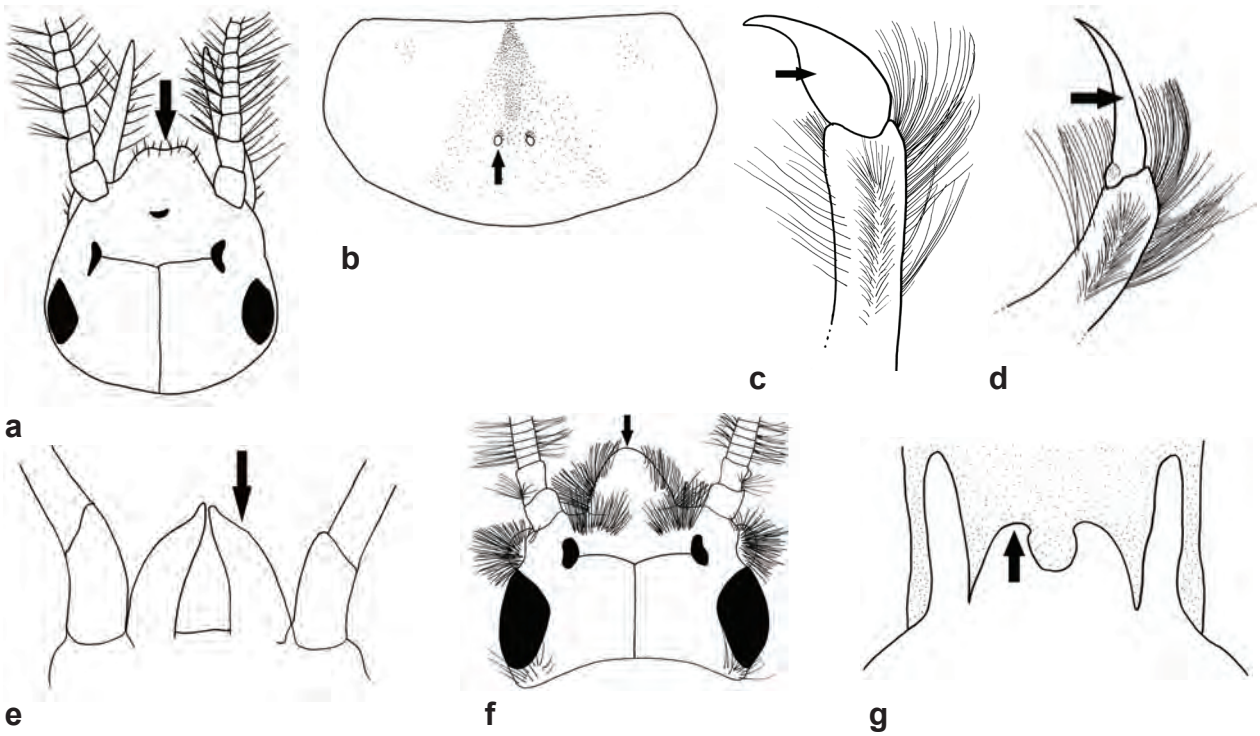


Figure 243. *Hexagenia* (Ephemeridae). **a,** *H. atrocaudata,* head (dorsal); **b,** *H. atrocaudata,* sternum VII; **c,** *H. bilineata,* middle claw; **d,** *H. limbata,* middle claw; **e,** *H. rigida,* developing male penes; **f,** *H. rigida,* head (dorsal); **g,** *H. limbata,* developing male penes.

Hexagenia atrocaudata McDunnough, 1924 (Figs. 244 and 245)

Larval Descriptions: Traver (1931a); Spieth (1941); Burks (1953); Leonard and Leonard (1962).

Determination: Identification of *H. atrocaudata* larvae is **Fairly Easy**. The distinctive shape of the frontal process (Fig. 243a) is present in both mature and moderately mature larvae.

Previous Wisconsin Records: McCafferty (1975); Randolph and McCafferty (1998).

New County Records: BAYFIELD: 1L (blackwing), Namekagon R., Co. Rd. M, VII-13-1977, L. Schadt (UWO); **CLARK:** 2L, Black R., Bryan Rd., 44.501753°N 90.636741°W, VII-3-2008, K. L. Schmude, R. A. Lillie, and A. Reynolds (UWS); **MARINETTE:** 1L, Peshtigo R., Parkway Rd., 45.35784°N 88.22021°W, X-9-2003, K. L. Schmude and C. Brennan (UWS); **OUTAGAMIE:** 1L, Embarrass R., St. Rd. 54, 44.39364°N 88.73449°W, VI-8-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 3L, Wolf R., Co. Rd. S, 44.39325°N 88.59736°W, VI-9-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **RUSK:** 1L, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998 (WiDNR); 1L, Chippewa R., Co. Rd. D, T33NR7W S33, VI-23-1998, R. A. Lillie (WiDNR); **SHAWANO:** 2L, Wolf R., St. Rd. 29, 44.75441°N 88.6047°W, V-21-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **WAUPACA:** 1L, Hatton Crk., Hatton Rd., VI-5-1999, 44.25976°N 88.99263°W, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Status: *Hexagenia atrocaudata* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is much less common in the state than *H. limbata* and *H. bilineata*.

Biological Information: *Hexagenia atrocaudata* is sensitive to agricultural runoff (Spieth 1941). It is known from cool, rapid creeks and small rivers, as well as beaver ponds (Burks 1953; Leonard and Leonard 1962). In Wisconsin, records from the Chippewa, Namekagon, and Black Rivers also indicate acceptance of medium-sized rivers, though these are some of the state's premier waters.

Figure 244. *Hexagenia atrocaudata,* larva.

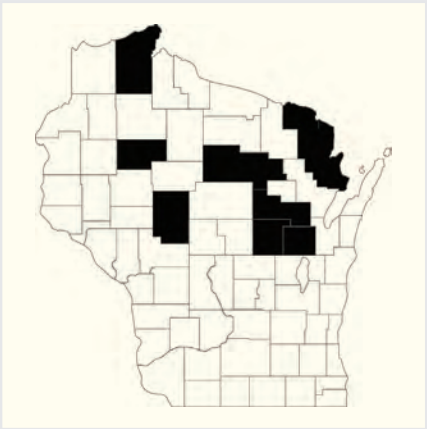


Figure 245. Wisconsin records of *Hexagenia atrocaudata.*

Hexagenia bilineata (Say), 1824 (Figs. 246 and 247)

Taxonomic History: *Baetis bilineata* Say, 1824 (orig.); *Hexagenia bilineata* (Say), 1824 (curr. comb., Walsh 1863b); *Palingenia bilineata* (Say), 1824 (comb.).

Larval Descriptions: Clemens (1913); Needham (1920); Spieth (1941); Burks (1953); Gooch (1967).

Larval Habitus: Clemens (1913); Needham (1920).

Determination: Identification of *H. bilineata* larvae is **Fairly Easy**. Relatively mature larvae are required for reliable separation from *H. limbata*.

Previous Wisconsin Records: Hamilton (1959); Elstad (1986); Henry et al. (1986); Fremling and Johnson (1990); Cochran (1992); Randolph and McCafferty (1998).

New County Records: BAYFIELD: 5L, Iron R., N. River Loop Rd., site "Lksup 936", 46.765383°N 91.487359°W, Summer 2012, K. L. Schmude (UWS); **DOUGLAS:** 1L, Amnicon R., S. Amnicon R. Rd., site "Lksup 1406", 46.690863°N 91.857244°W, Summer 2012, K. L. Schmude (UWS); **OUTAGAMIE:** 1L, Bass Crk., Market Rd., 44.366545°N 88.536883°W, VI-3-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 6L, Embarrass R., St. Rd. 76, 44.48906°N 88.64564°W, VI-8-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **RUSK:** 7L, N. Fork Skinner Crk., Co. Rd. M, 45.60417°N 90.72081°W, V-31-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **SAWYER:** 1L, Clear Lk., T41NR7W S20, IX-10-1973 (MPM); **VILAS:** 1L, Deerskin R., Rangeline Rd., 45.9523°N 89.17682°W, VII-2-2008, K. L. Schmude and A. Reynolds (UWS); **WINNEBAGO:** Wolf R., Co. Rd. H, 44.84939°N 88.84939°W, VI-5-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Biological Information: *Hexagenia bilineata* is a locally common mayfly, often associated with large lakes and rivers with silt substrates (Burks 1953; Fremling 1960, 1973; McCafferty 1975). Mass emergence of adults along the Mississippi River is widely publicized. Degraded water qualities of the Mississippi River and the Great Lakes dramatically reduced the abundance of this species, to the point of local extirpation, in those waters during the latter half of the twentieth century. Fortunately, water quality has improved and populations in the Mississippi River have increased, especially north of its confluence with the Chippewa River (Fremling and Johnson 1990; Krieger et al. 2007).

Figure 246. *Hexagenia bilineata,* larva.

Figure 247. Wisconsin records of *Hexagenia bilineata.*

Hexagenia limbata (Serville), 1829 (Figs. 248 and 249)

Taxonomic History: *Ephemera limbata* Serville, 1829 (orig.); *Hexagenia affiliata* McDunnough, 1927 (syn.); *Hexagenia californica* Upholt, 1937 (syn.); *Hexagenia carolina* Traver, 1931 (syn.); *Hexagenia elegans* Traver, 1931 (syn.); *Hexagenia kanuga* Traver, 1937 (syn.); *Hexagenia limbata* (Serville), 1829 (curr. comb., Walsh 1863b); *Hexagenia marilandica* Traver, 1931 (syn.); *Hexagenia mingo* Traver, 1931 (syn.); *Hexagenia munda* Eaton, 1883 (syn.); *Hexagenia occulta* (Walker), 1853 (syn.); *Hexagenia pallens* Traver, 1935 (syn.); *Hexagenia rosacea* Traver, 1931 (syn.); *Hexagenia variabilis* Eaton, 1883 (syn.); *Hexagenia venusta* Eaton, 1883 (syn.); *Hexagenia viridescens* (Walker), 1853 (syn.); *Hexagenia weewa* Traver, 1931 (syn.); *Palingenia limbata* (Serville), 1829 (comb.); *Palingenia occulta* Walker, 1853 (syn.); *Palingenia viridescens* Walker, 1853 (syn.).

Larval Descriptions: Needham and Betten (1901), as *H. variabilis*; Traver (1931a), as *H. carolina* and *H. mingo*; Traver (1937), as *H. marilandica*; Burks (1953); Leonard and Leonard (1962); Gooch (1967).

Larval Habitus: Burks (1953); Leonard and Leonard (1962); McCafferty (1975); Edmunds et al. (1976); Berner and Pescador (1988).

Determination: Identification of *H. limbata* larvae is **Fairly Easy**. Relatively mature larvae are required for reliable separation of *H. limbata* from other members of the genus. Mature male larvae are most reliably separated from the uncommon *H. rigida*.

Previous Wisconsin Records: Spieth (1941); Hamilton (1959); Hilsenhoff et al. (1972); McCafferty (1975); Shapas and Hilsenhoff (1976); Fremling and Johnson (1990); Jacobs (1990); DuBois (1993); Randolph and McCafferty (1998).

New County Records: JEFFERSON: 6L, Allen Crk., T5NR14E S17, V-7-1975 (MPM); **JUNEAU:** 4F, Pentenwell Dam, 12.8 mi. S. of Necedah on Co. Rd. Q and 6.8 mi. E. on Co. Rd. G-HH, VI-23-1980 (MPM); **KEWAUNEE:** Kewaunee R., Luxemburg, XI-14-2000, J. Daeschler (UWGB); **LINCOLN:** 1F, Johnson Crk., VI-23-1970 (UW); **PRICE:** 1L, Butternut Crk., Rock Crk. Rd., 45.85692°N 90.65636°W, VI-19-2000, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 3L, Douglas Crk., Co. Rd. C, 45.518035°N 90.257984°W, VI-18-2008, K. L. Schmude and A. Reynolds (UWS); **RACINE:** 2L, Husher Crk., T4NR22E S5, IX-5-1975 (MPM); **SAWYER:** 8L, N. Fork Flambeau R., Co. Rd. W, T38NR3W S20, VI-18-1997 (WiDNR); **SHAWANO:** 3L, Middle Branch Embarrass R., Co. Rd. Z, 45.00867°N 89.1281°W, VI-8-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 3L, Wolf R., Co. Rd. CCC, 44.696348°N 88.578892°W, VI-2-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **WALWORTH:** 4L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VIII-4-2000, THK (THK); 1L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VI-23-2011, THK, C. Brown, and E. Wolf (THK); **WASHINGTON:** 1F, 4 mi. SE. of Hartford, near junction of St. Rd. 167 & Co. Rd. CC, date unknown, C. Yanek and S. Borkin (MPM); **WINNEBAGO:** 1M, Oshkosh, VII-1-1976, J. E. Keolbl (UWO).

Biological Information: *Hexagenia limbata* is the most common burrowing mayfly throughout the Midwest (Randolph and McCafferty 1998). Larvae are associated with silty, organic, and mucky substrates in streams, rivers, and lakes (Burks 1953; Fremling 1960; Leonard and Leonard 1962; McCafferty 1975; Burian and Gibbs 1991).

Figure 248. *Hexagenia limbata,* larva.
Figure 249. Wisconsin records of *Hexagenia limbata.*

Hexagenia rigida McDunnough, 1924 (Figs. 250 and 251)

Taxonomic History: *Hexagenia form falcata* Needham, 1920 (syn. nud.).

Larval Descriptions: Spieth (1941); Burks (1953); Leonard and Leonard (1962).

Determination: Identification of *H. rigida* larvae is **Slightly Difficult**. Mature male larvae most reliably allow separation of *H. rigida* from *H. limbata*. Immature male larvae have developing penes that are shorter, thicker, and may be slightly incurved.

Previous Wisconsin Records: McCafferty (1975).

New County Records: ASHLAND: Adults, S. Fish Crk., T47NR4W S1, VIII-3-2008, T. Erdman (UWGB); **JUNEAU:** 2F, Pentenwell Dam, 12.8 mi. S. of Necedah on Co. Rd. Q and 6.8 mi. E. on Co. Rd. G-HH, VI-23-1980 (MPM); **ONEIDA:** 6M, Lk. Tomahawk, VI-29-1972 (UW).

Status: *Hexagenia rigida* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). This species is considered the rarest member of the genus in the state.

Biological Information: Larvae of *H. rigida* prefer moderate-sized rivers with fairly rapid flow and organic or silty substrates (Burks 1953; Burian and Mack 1990).

Figure 250. *Hexagenia rigida,* larva.

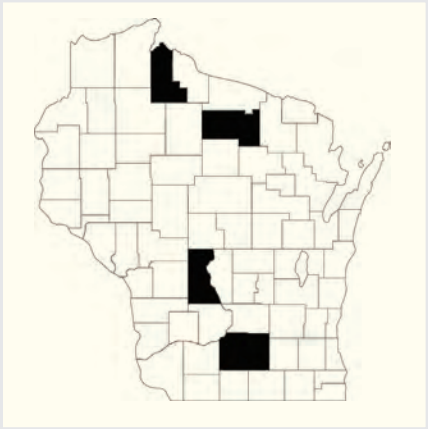


Figure 251. Wisconsin records of *Hexagenia rigida.*

Litobrancha

Comments: *Litobrancha* consists of one species, formerly placed in *Hexagenia*.

Determination: Identification of *Litobrancha* larvae is **Fairly Easy**. Extremely young larvae are more difficult to separate from those of *Hexagenia*.

Litobrancha recurvata (Morgan), 1913 (Figs. 252 and 253)

Taxonomic History: *Hexagenia recurrata* Morgan, 1913 (spell.); *Hexagenia recurvata* Morgan, 1913 (orig.); *Litobrancha recurvata* (Morgan), 1913 (curr. comb., McCafferty 1971).

Larval Descriptions: Leonard and Leonard (1962); McCafferty (1971).

Larval Habitus: Schwiebert (1973), as *Hexagenia recurvata*; McCafferty (1975).

Determination: Identification of *L. recurvata* larvae is **Fairly Easy**. Very young *Hexagenia* larvae often have shorter whorls of setae on antennal segments and resemble larvae of *Litobrancha*.

Previous Wisconsin Records: None. The first verified state records of *L. recurvata* are given below. Hilsenhoff (1981, 1995) listed it for Wisconsin but provided no actual records. McCafferty (1994) indicated its presence on a range map but also gave no data. Nearest previously published records are from the Upper Peninsula of Michigan (Spieth 1941; Leonard and Leonard 1962) and northeastern Minnesota (Lager et al. 1982).

New State Records: BAYFIELD: 1L, Mountain Rd., 46.80263°N 91.08226°W, IX-22-2010, P. Kanehl (UWSP); **FLORENCE:** 1L, Montagne Crk., Edith Lk. Rd., 40 m upstream, 45°56'22.2"N 88°22'48.9"W, X-17-2001, J. Klosiewski (UWSP); **JACKSON:** 4L, N. Fork Buffalo R., Bloom Rd., VII-6-2011, K. L. Schmude (UWS); 1L, Stockwell Crk., Sand Rd. near Co. Rd. F, VII-5-2011, K. L. Schmude (UWS); **LANGLADE:** 2L, E. Branch Pratt Crk., S. Pratt Rd., 20 m upstream, 45.24373°N 89.37489°W, X-8-2010, H. Yang (UWSP); 5L, unnamed crk., 1 mi. S. of intersection of Hunting R. and Co. Rd. T, 45°21'44" N 89°1'54" W, VI-14-2011, K. L. Schmude (UWS); **MARINETTE:** 1L, Handsaw Crk., Ranch Rd., 45.32003°N 88.24954°W, X-9-2013, A. Hudak (UWSP); 2L, Spikehorn Crk., unnamed lane off of Barlow Lk. Rd., site "Menom 8110", 45.740262°N 87.998098°W, Summer 2012, K. L. Schmude, vial 071212B (UWS); **OCONTO:** 1L, N. Fork Thunder R., bridge at powerline crossing, 3 m upstream, 45.32246°N 88.30860°W, X-17-2013, A. Hudak (UWSP); 1L, N. Fork Thunder R., Bucks Ranch Rd., 7 m upstream, 45.32471°N 88.32822°W, X-17-2013, A. Hudak (UWSP); 1L, unnamed tributary to N. Fork Thunder R., LaFave Rd., 129 m downstream, 45.31623°N 88.33102°W, X-17-2013, A. Hudak (UWSP); **TAYLOR:** 1L, Copper Crk., Bear Ave., 4 mi. NE. of Rib Lk., VI-18-2008, K. L. Schmude, vial 072612A (THK).

Biological Information: *Litobrancha recurvata* larvae appear more restricted to cool-water streams with rapid current than other ephemerids (McCafferty 1971, 1975; Randolph and McCafferty 1998), but the species also is known from lakes (Burian and Gibbs 1991). Larvae burrow into highly organic and silty substrates (Edmunds et al. 1976; Burian and Gibbs 1991; Randolph and McCafferty 1998). The Wisconsin records above are from first- to third-order forested streams with cold water, good flow, and a sandy or sand-silt substrate with leafy detritus.

Figure 252. *Litobrancha recurvata,* larva.

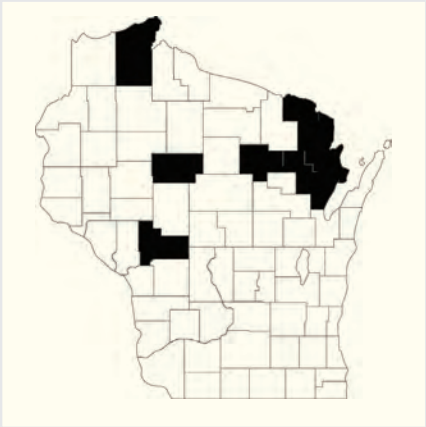


Figure 253. Wisconsin records of *Litobrancha recurvata.*

14 HEPTAGENIIDAE

The heptageniid flat-headed mayflies represent the second-most diverse family of mayflies in Wisconsin. There are ten genera and at least 25 species of heptageniids known from the state, with an additional six genera elsewhere in North America. Larvae often are large mayflies clinging to logs and rocks, using their flattened bodies to avoid the strength of the current. Larvae in some genera, such as *Rhithrogena*, are fairly sensitive to water quality. Larvae of *Stenacron interpunctatum*, in contrast, are ubiquitous and less affected by habitat degradation.

Key to the Genera of Heptageniidae

1. All gill attachments and gill tufts ventral (Fig. 254a); mouthparts raptorial (Fig. 254b); not known from Wisconsin ..... ***Raptoheptagenia cruentata***

At least some gills completely dorsolateral, or uncommonly with gill tufts dorsal and lamellae of gills I–VII expanded ventrally **2**

2. Two caudal filaments **3**

Three caudal filaments **4**

3. Head and thorax with paired, dorsal tubercles (Fig. 307); each tergum with a median dorsal tubercle (Fig. 254c); gills I–II with ventral attachments; rare. ..... ***Spinadis simplex***

Body without dorsal tubercles; all abdominal gills with dorsal attachments; locally common ..... ***Epeorus***

4. Gills I–VII with enlarged, overlapping lamellae expanded ventrally beneath the abdomen (Fig. 254d) ..... ***Rhithrogena***

All gills dorsolateral, not expanded ventrally **5**

5. Gill VII minute, smaller than lateral spine on that segment (Fig. 254e) ..... ***Macdunnoa persimplex***

Gill VII lanceolate or lamellate, larger than lateral spine on that segment **6**

6. Gill VII lanceolate, narrower than preceding gills (Fig. 254f) **7**

Gill VII lamellate or lanceolate, but similar to anterior gills (Fig. 254g) **9**

7. Gills I–VI each with an acute, terminal projection (Fig. 254h); pronotum of mature larvae usually with a pair of dark, oblique dashes (Fig. 254i) ..... ***Stenacron***

Gills I–VI rounded or quadrate; pronotum variable **8**

8. Gills I–VI rounded (Fig. 254j); abdominal sterna with paired, sublateral, round spots (Fig. 254k) ... ***Stenonema femoratum***

Gills I–VI quadrate (Fig. 254l); abdominal sterna not as above ..... ***Maccaffertium***

9. Gill VII with fibrilliform portion present (Fig. 254g); claws without denticles; frons lacking freckle-like spots. . . ***Heptagenia***

Gill VII with fibrilliform portion absent; claws with denticles (Fig. 255a); frons often with numerous black, freckle-like spots (Fig. 255b) **10**

10. Caudal filaments with whorls of short setae at articulations (Fig. 255c). ..... ***Leucrocuta*** (not keyed)

Caudal filaments with long, lateral, intersegmental setae (primarily in distal half), in addition to whorls of short setae at articulations (Fig. 255d). ..... ***Nixe***

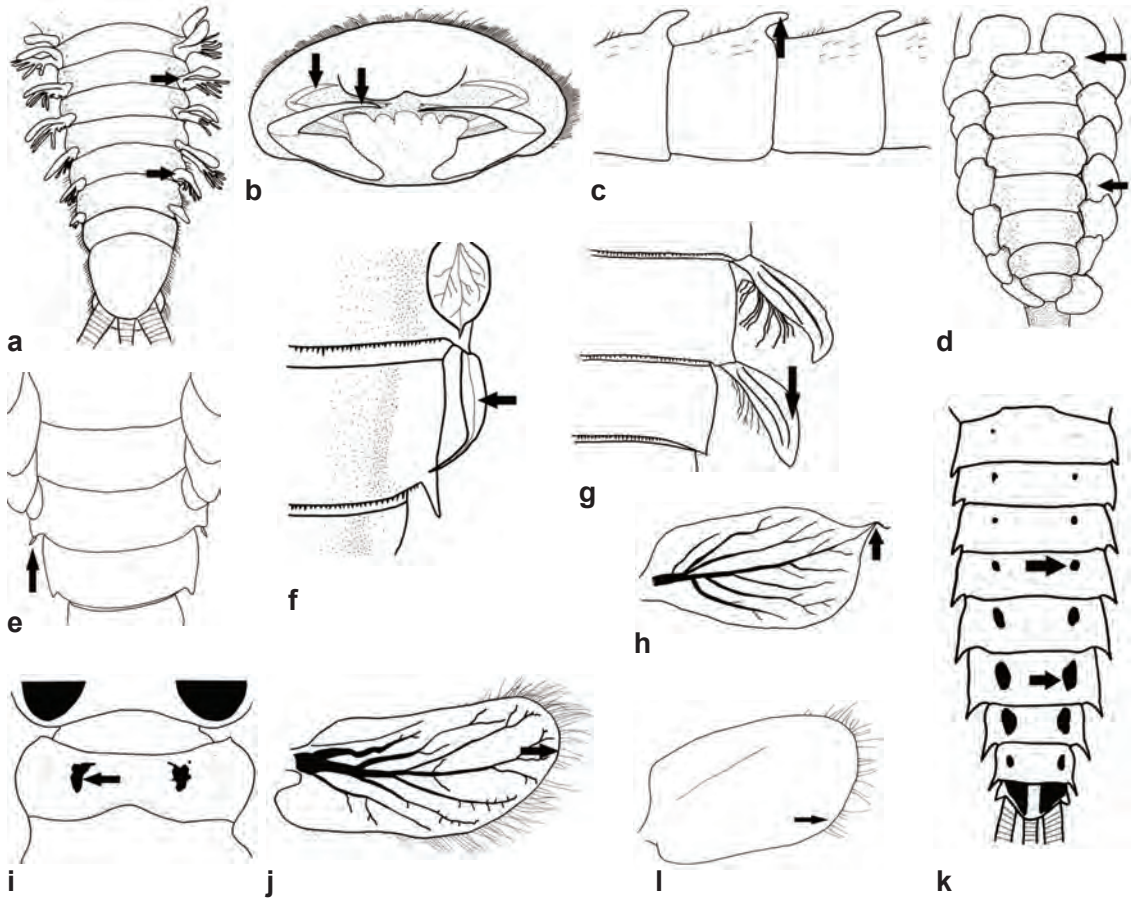


Figure 254. Heptageniidae. **a,** *Raptoheptagenia cruentata,* abdominal sterna; **b,** *R. cruentata,* head (ventral); **c,** *Spinadis simplex,* terga VI–IX (lateral); **d,** *Rhithrogena* sp., abdominal sterna; **e,** *Macdunnoa persimplex,* terga V–IX; **f,** *Stenacron interpunctatum,* gills VI–VII; **g,** *Heptagenia elegantula,* gills VI–VII; **h,** *S. interpunctatum,* gill V; **i,** *S. interpunctatum,* pronotum; **j,** *Stenonema femoratum,* gill V; **k,** *S. femoratum,* abdominal sterna; **l,** *Maccaffertium terminatum terminatum,* gill V.

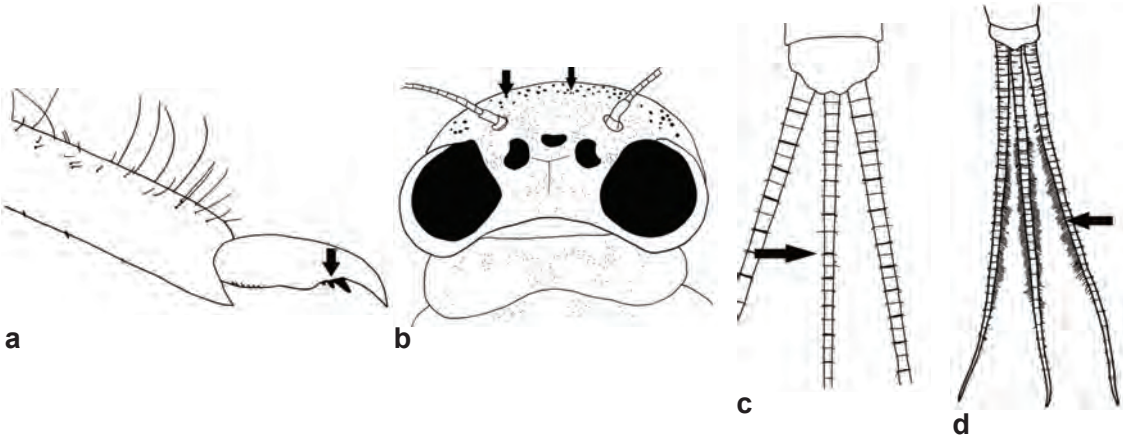


Figure 255. Heptageniidae. **a,** *Leucrocuta* sp., hind claw; **b,** *Leucrocuta* sp., head (dorsal); **c,** *Leucrocuta* sp., tails; **d,** *Nixe* sp., tails.

Epeorus

Comments: Nineteen North American species of *Epeorus* are recognized in North America, with a single species known from Wisconsin.

Determination: Identification of *Epeorus* larvae is **Easy** for the genus, but **Slightly Difficult** for species within the genus. Larvae are two-tailed, broad-bodied, and have large gills. In the field, the dark spot on the anterior surface of each femur suggests a *Rhithrogena*, but lacking a median caudal filament.

Larval Keys: Webb and McCafferty (2006); Burian et al. (2008).

Key to the Species of *Epeorus*

1. Gill I with an anterior lobe (Fig. 256a); femora with pectinate subdorsal setae (Fig. 256b); maxillary lacinia with more than one seta at base of apical tooth-like structure (Fig. 256c); not known from Wisconsin . . . . . ***E. namatus***

Gill I rounded overall (Fig. 256d); femora with simple subdorsal setae (Fig. 256e); maxillary lacinia with a single seta at base of apical tooth-like structure (Fig. 256f) . . . . . ***E. vitreus***

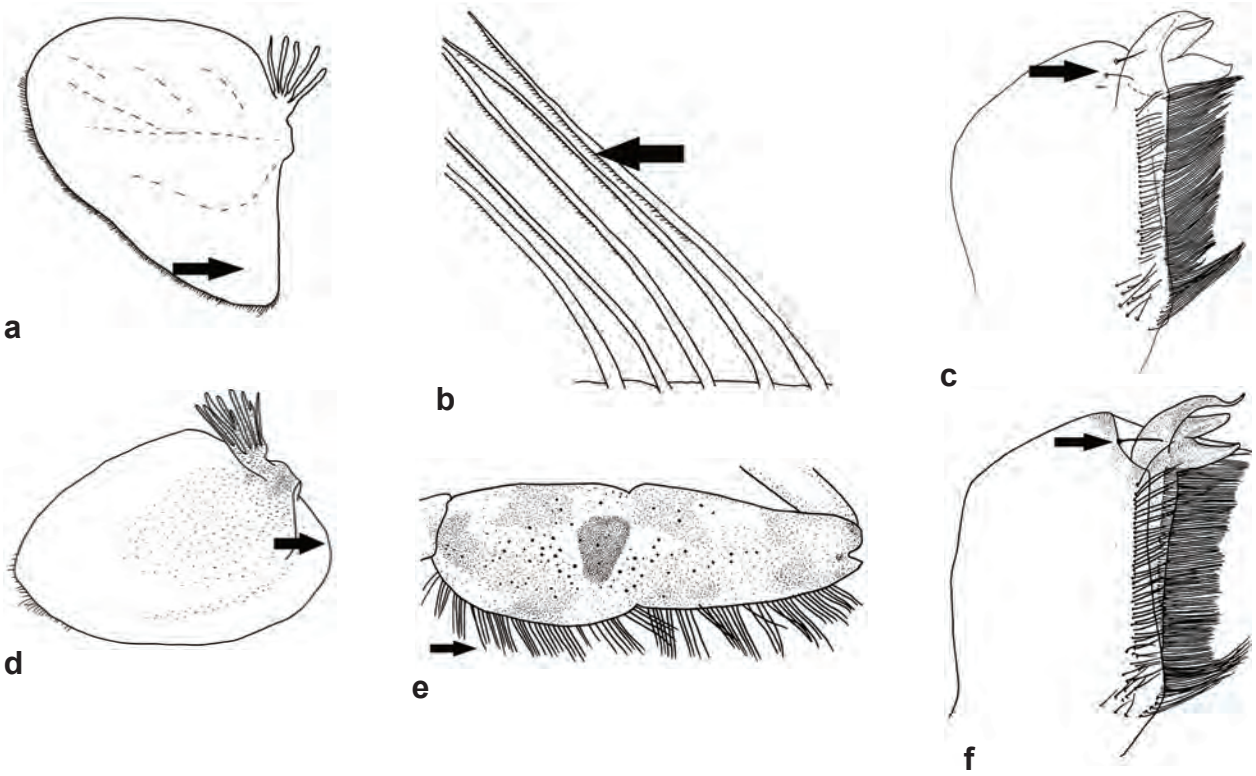


Figure 256. *Epeorus* (Heptageniidae). **a,** *E. namatus,* gill I; **b,** *E. namatus,* dorsal setae from front femur; **c,** *E. namatus,* galea-lacinia (ventral); **d,** *E. vitreus,* gill I; **e,** *E. vitreus,* front femur (anterior); **f,** *E. vitreus,* galea-lacinia (ventral).

Epeorus namatus (Burks), 1946 (Fig. 257)

Taxonomic history: *Epeorus namatus* (Burks), 1946 (curr. comb., Edmunds and Traver 1954); *Iron namatus* Burks, 1946 (orig.).

Larval Description: Burks (1946), as *Iron namatus*.

Larval Habitus: Burks (1953).

Determination: Identification of *E. namatus* larvae is **Difficult**. Removal of gill I and preparation of a slide mount of femur are recommended for positive identification. The anterior lobe of gill I (Fig. 256a) can be missed unless carefully examined, especially for immature larvae.

Previous Wisconsin Records: None. Nearest records of *E. namatus* are from northwestern Indiana (Randolph and McCafferty 1998). It is possible but not likely in Wisconsin.

Biological Information: Little is published about the biology of *E. namatus*. Larvae have been reported from small, clear streams with cold water (Burks 1953; Randolph and McCafferty 1998).

Figure 257. *Epeorus namatus,* larva.

Epeorus vitreus (Walker), 1853 (Figs. 258 and 259)

Taxonomic History: *Epeorus humeralis* Morgan, 1911 (syn.); *Epeorus rubidus* (Traver), 1933 (syn.); *Epeorus vitrea* (Walker), 1853 (spell.); *Epeorus vitreus* (Walker), 1853 (curr. comb., Leonard and Leonard 1962); *Heptagenia vitrea* (Walker), 1853 (comb.); *Iron humeralis* (Morgan), 1911 (syn.); *Iron vitreus* (Walker), 1853 (comb.); *Iron rubidus* Traver, 1933 (syn.); *Palingenia vitrea* Walker, 1853 (orig.); *Rhithrogena vitrea* (Walker), 1853 (comb.).

Larval Description: Traver (1933), as *Iron rubidus*; Leonard and Leonard (1962).

Larval Habitus: Morgan (1913), as *E. humeralis*; Leonard and Leonard (1962).

Determination: Identification of *E. vitreus* larvae is **Slightly Difficult**. Removal of gill I and preparation of a slide mount of the femur and maxilla are recommended for positive identification.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976), as *E. vitrea*; Flowers and Hilsenhoff (1978), as *E. vitrea*; Jacobs (1990); Randolph and McCafferty (1998).

New County Records: ADAMS: 1M, Big Roche a Cri, V-4-1970 (UW); **BARRON:** 1L, Rock Crk., IV-26-1980 (UW); **ONEIDA:** 1L, Prairie R., V-2-1981, A. Rauf (UW); 4L, Wolf R., Meister-Stockley Rd., 45.53194°N 89.11214°W, VI-9-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **SHAWANO:** Red R., Silver Crk. Rd., 44.924589°N 88.955999°W, VI-8-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 3L, W. Branch Red R., V-15-1979 (UW).

Biological Information: *Epeorus vitreus* is the most widespread and common *Epeorus* in the Upper Midwest (Randolph and McCafferty 1998). It was considered an indicator of excellent water quality in Wisconsin by Hilsenhoff (1982). Larvae occur in a variety of rocky streams and rivers with swift current and cold water (Burks 1953; Leonard and Leonard 1962; Flowers and Hilsenhoff 1975; Hubbard and Peters 1978). Within such habitats, larvae of *E. vitreus* graze on diatoms and filamentous algae covering rocks and other large particles (Shapas and Hilsenhoff 1976; Burian and Gibbs 1991).

Figure 258. *Epeorus vitreus,* larva.

Figure 259. Wisconsin records of *Epeorus vitreus.*

Heptagenia

Comments: There are twelve species of *Heptagenia* in North America, though only three are known from Wisconsin.

Determination: Identification of *Heptagenia* larvae is **Moderately Easy** for the genus, and **Moderately to Fairly Easy** for the species within the genus.

Larval Keys: Traver (1935); Burks (1953); Flowers and Hilsenhoff (1975); Hilsenhoff (1982).

Key to the Species of *Heptagenia* (mature larvae more reliable)

1. Mesonotum with a nearly quadrate pale area at posteromedian margin between wingpads (Fig. 260a) . . . . . ***H. elegantula***

Mesonotum without a quadrate pale area at posteromedian margin, at most a slight thickening of pale line along medial suture (Fig. 260b) **2**

2. Caudal filaments of mature larvae white; terga VIII–IX each with pale V-shaped mark (Fig. 263) . . . . . ***H. flavescens***

Caudal filaments of mature larvae with alternating dark and light segments; tergum IX without pale V-shaped mark (Fig. 265). . . . . ***H. pulla***

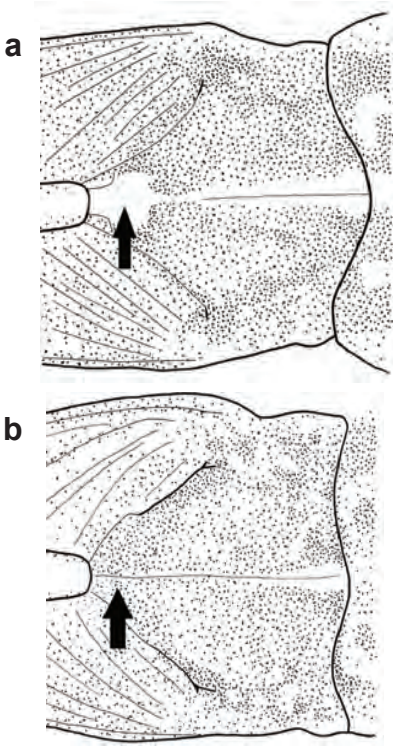


Figure 260. *Heptagenia* (Heptageniidae). **a,** *H. elegantula,* mesonotum; **b,** *H. flavescens,* mesonotum.

Heptagenia elegantula (Eaton), 1885 (Figs. 261 and 262)

Taxonomic History: *Heptagenia coxalis* Banks, 1914 (syn.); *Heptagenia diabasia* Burks, 1946 (syn.); *Heptagenia elegantula* (Eaton), 1885 (curr. comb., Banks 1907); *Heptagenia querula* McDunnough, 1924 (syn.); *Rhithrogena elegantula* Eaton, 1885 (orig.).

Larval Descriptions: Burks (1946, 1953), both as *H. diabasia*; Bednarik and Edmunds (1980).

Larval Habitus: Daggy (1945); Burks (1946, 1953), as *H. diabasia*.

Determination: Identification of *H. elegantula* larvae is **Moderately Easy**. The quadrate pale area on the mesonotum (Fig. 260a) is visible in both immature and mature larvae and is moderately persistent in preserved specimens. Mature larvae typically are more darkly pigmented, with narrower pale markings on abdominal terga.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976); Flowers and Hilsenhoff (1978); Hilsenhoff (1982); Randolph and McCafferty (1998). All known specimens from Wisconsin are of the "diabasia" type, with more limited pale markings on the thoracic nota than those historically referred to as *H. elegantula* from more western North America.

New County Records: OUTAGAMIE: 1L, Embarrass R., Spurr Rd., 44.419914°N 88.698242°W, VI-8-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); 2L, Wolf R., near Co. Rd. S, 44.39325°N 88.59736°W, VI-9-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Biological Information: Though not as abundant in most Wisconsin counties as it is in the Great Plains and Rocky Mountains, *H. elegantula* still is a common Wisconsin mayfly, particularly in the Driftless Area (Randolph and McCafferty 1998). Larvae prefer streams with sandy substrates, though tolerant of a considerable amount of sediment and organic matter. In regards to water quality, Hilsenhoff (1982) considered *H. elegantula* the least sensitive member of the genus in Wisconsin. Larvae can be taken from a variety of medium to large rocks, logs, and other debris (Flowers and Hilsenhoff 1975, 1978; Bednarik and Edmunds 1980).

Figure 261. *Heptagenia elegantula,* larva.

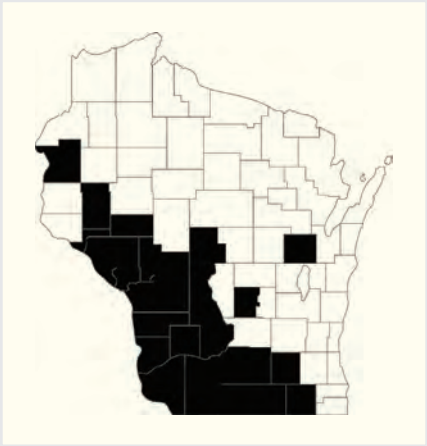


Figure 262. Wisconsin records of *Heptagenia elegantula.*

Heptagenia flavescens (Walsh), 1862 (Figs. 263 and 264)

Taxonomic History: *Heptagenia flavescens* (Walsh), 1862 (curr. comb., Eaton 1868); *Palingenia flavescens* Walsh, 1862 (orig.).

Larval Descriptions: Clemens (1913, 1915a); Burks (1953).

Larval Habitus: Clemens (1913, 1915a); Burks (1953); Daggy (1945).

Determination: Identification of *H. flavescens* larvae is **Fairly Easy**. Pale V-shaped markings on posterior abdominal terga of larvae are relatively persistent in preserved specimens. Very young or faded larvae can be difficult to separate from other species in the genus.

Previous Wisconsin Records: Flowers and Hilsenhoff (1978); Lillie and Hilsenhoff (1992); Randolph and McCafferty (1998). Randolph and McCafferty (1998) indicated records for this species on their map from Buffalo, Juneau, and Crawford Counties, but gave no data.

New County Records: BUFFALO: 11L, Trempealeau R., Co. Rd. P, 2 mi. N. of St. Rd. 35, VII-10-2013, K. L. Schmude (UWS); **LA CROSSE:** 4L, Black R., St. Rd. 35, N. side of rd., VII-10-2013, K. L. Schmude (UWS); **MARINETTE:** 1L, Peshtigo R., Co. Rd. BB, 45.01972°N 87.70625°W, X-11-2003, K. L. Schmude and C. Brennan (UWS); 1L, Peshtigo R., Forest Rd. 1634, 45.26267°N 88.12877°W, X-17-2003, K. L. Schmude (UWS); **OUTAGAMIE:** 2L, Wolf R., Co. Rd. S, 44.39325°N 88.59736°W, VI-9-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **PEPIN:** 1L, Chippewa R., St. Rd. 35, W. side, VII-10-2013, K. L. Schmude (UWS); **WAUPACA:** 1L, Little Wolf R., St. Rd. 22, 44.51307°N 89.90471°W, VI-5-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Biological Information: Larvae of *H. flavescens* are more restricted to medium to large streams with moderate to high current than are larvae of *H. elegantula* (Flowers and Hilsenhoff 1975, 1978; Hubbard and Peters 1978). Though listed as rare by Flowers and Hilsenhoff (1975), *H. flavescens* is now known from many counties in Wisconsin and merits a more positive appraisal of its conservation status. The species can be associated with a variety of substrates, including rocks, logs, and other debris exposed to the current (Flowers and Hilsenhoff 1975, 1978; Lillie and Hilsenhoff 1992).

Figure 263. *Heptagenia flavescens,* larva.

Figure 264. Wisconsin records of *Heptagenia flavescens.*

Heptagenia pulla (Clemens), 1913 (Figs. 265 and 266)

Taxonomic History: *Ecdyonurus pullus* (Clemens), 1913 (comb.); *Ecdyurus grandis* Clemens, 1913 (nomen. nud.); *Ecdyurus pullus* Clemens, 1913 (orig.); *Heptagenia pullus* Clemens, 1913 (spell.).

Larval Descriptions: Clemens (1913, 1915c), as *Ecdyurus pullus*; Ide (1935b); Burks (1953); Leonard and Leonard (1962).

Larval Habitus: Clemens (1913), as *Ecdyurus pullus*; DuBois (1993).

Determination: Identification of *H. pulla* larvae is **Fairly Easy**. Posterior abdominal terga of larvae are more uniformly dark than on larvae of *H. flavescens*, though young specimens are less reliably identified.

Previous Wisconsin Records: Selgeby (1974); Shapas and Hilsenhoff (1976); Flowers and Hilsenhoff (1978); DuBois (1993); Randolph and McCafferty (1998).

Status: *Heptagenia pulla* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Flowers and Hilsenhoff (1975) considered it uncommon in the state. Though it has widely scattered populations across the state, I have rarely encountered this species in Wisconsin.

Biological Information: Hilsenhoff (1982) considered *H. pulla* an indicator of excellent water quality in Wisconsin. It most commonly occurs in well-oxygenated, unpolluted streams with strong current (Hubbard and Peters 1978; Burian and Gibbs 1991), though it may stay in areas of slack current and eddies, as well as in lakes (Leonard and Leonard 1962; Flowers and Hilsenhoff 1975). Flowers and Hilsenhoff (1978) found that streams running through sandstone formations favor the species. It most commonly occurs on or below rocky substrates composed of particles ranging of size from pebbles to boulders (Flowers and Hilsenhoff 1975; Burian and Gibbs 1991). Wisconsin records of blackwing larvae are from 10 May (Door Co.) to 13 September (Bayfield Co.).

Figure 265. *Heptagenia pulla,* larva (gills missing).

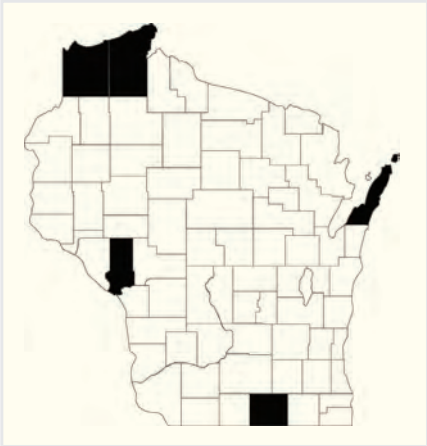


Figure 266. Wisconsin records of *Heptagenia pulla.*

Leucrocuta (Fig. 267)

Comments: There are ten North American species of *Leucrocuta*. Members of the genus were removed from *Heptagenia* by Flowers (1980). The larvae are smaller than most other heptageniids, with a large-headed appearance.

Determination: Identification of *Leucrocuta* larvae is **Fairly Easy** for the genus, but **Problematic** for the species within the genus. Older keys used width of the head capsule as an important character for separating *Nixe* from *Leucrocuta*. This character, however, does not consistently allow separation of the two genera (McCafferty 2004). Setation of the caudal filaments is much more reliable. The species of *Leucrocuta* cannot be reliably separated based upon abdominal color patterns and color of the caudal filaments, as was used in several older keys (W. P. McCafferty, pers. comm.). Many specimens in Wisconsin collections are identified and labeled as *L. hebe*, even though they could be other *Leucrocuta*.

Larval Keys: Traver (1933, 1935), Burks (1953), Flowers and Hilsenhoff (1975), and Hilsenhoff (1982), all as *Heptagenia*.

Figure 267. *Leucrocuta* sp., larva.

Leucrocuta aphrodite (McDunnough), 1926 (Fig. 268)

Taxonomic History: *Ecdyonurus aphrodite* (McDunnough), 1926 (comb.); *Heptagenia aphrodite* McDunnough, 1926 (orig.); *Leucrocuta aphrodite* (McDunnough), 1926 (curr. comb., Flowers 1980).

Larval Description: Traver (1933) and Burks (1953), both as *Heptagenia aphrodite*.

Determination: Identification of *L. aphrodite* larvae is **Problematic**. They cannot be reliably identified using any of the previously published keys.

Previous Wisconsin Records: None. The first Wisconsin records are given below. Burks (1953) listed *L. aphrodite* as known from Wisconsin, but gave no formal records. Nearest previously published records were from northern Illinois (Burks 1953; DeWalt et al. 1999).

New Wisconsin Records: SAUK: 1M, Otter Crk., coll. VI-4-1980, emer. VI-16-1980 (UW); 2M, Otter Crk., coll. IV-30-1980, emer. VII-1-1980 (UW); 2M, Otter Crk., coll. VIII-14-1980, emer. III-18-1981, J. Steven (UW).

Biological Information: Little is known about the biology of *L. aphrodite*. In Illinois, DeWalt et al. (1999) found it primarily in small streams. Burian and Gibbs (1991) in Maine found the species in second- to fifth-order streams, specifically where gravel and poorly sorted sediment occurred in erosional zones.

Figure 268. Wisconsin records of *Leucrocuta aphrodite.*

Leucrocuta hebe (McDunnough), 1924 (Fig. 269)

Taxonomic History: *Ecdyonurus hebe* (McDunnough), 1924 (comb.); *Heptagenia hebe* McDunnough, 1924 (orig.); *Leucrocuta hebe* (McDunnough), 1924 (curr. comb., Flowers 1980).

Larval Description: Ide (1935b) and Burks (1953), both as *Heptagenia hebe*.

Determination: Identification of *L. hebe* larvae is **Problematic**. Larvae cannot be reliably identified using any of the previously published keys.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976); Flowers and Hilsenhoff (1978); Jacobs (1990); Hilsenhoff (1996); Lillie and Isenring (1996); Randolph and McCafferty (1998).

Most published records of this species in Wisconsin are of larval specimens. Given the difficulty of separating *L. hebe* from other members of the genus, it is unknown how many of these records are misidentifications. A study of adult males of *Leucrocuta* in Wisconsin is needed to verify distributional records.

Biological Information: It is possible that some observations of the biology of *L. hebe* actually are of other *Leucrocuta*. The species was considered abundant in Wisconsin by Flowers and Hilsenhoff (1975) and Randolph and McCafferty (1998). It can occur on or under rocky substrates in a wide variety of habitats, including all sizes of streams and also lakes (Leonard and Leonard 1962; Flowers and Hilsenhoff 1975, 1978; Hubbard and Peters 1978; Burian and Gibbs 1991).

Figure 269. Wisconsin records of *Leucrocuta hebe.*

Leucrocuta juno (McDunnough), 1924

Taxonomic History: *Ecdyonurus juno* (McDunnough), 1924 (comb.); *Heptagenia juno* McDunnough, 1924 (orig.); *Leucrocuta juno* (McDunnough), 1924 (curr. comb., Flowers 1980).

Larval Description: Traver (1933) and Burks (1953), both as *Heptagenia juno*.

Determination: Identification of *L. juno* larvae is **Problematic**. Larvae cannot be reliably identified using any of the previously published keys.

Previous Wisconsin Records: None. Nearest records of *L. juno* are from northeastern Illinois (McCafferty 2009) and central Iowa (McCafferty and Hubbard 1998). It is likely in Wisconsin.

Biological Information: None.

Leucrocuta maculipennis (Walsh), 1863 (Fig. 270)

Taxonomic History: *Ecdyonurus maculipennis* (Walsh), 1863 (comb.); *Ecdyurus maculipennis* (Walsh), 1863 (comb.); *Heptagenia maculipennis* Walsh, 1863 (orig.); *Leucrocuta maculipennis* (Walsh), 1863 (curr. comb., Flowers 1980).

Larval Description: Burks (1953), as *Heptagenia maculipennis*.

Larval Habitus: Needham (1905), as *Ecdyonurus maculipennis*; Clemens (1913), as *Ecdyurus maculipennis*.

Determination: Identification of *L. maculipennis* is **Problematic**. Larvae cannot be reliably identified using any of the previously published keys.

Previous Wisconsin Records: Muttkowski (1918), as *H. maculipennis*. Randolph and McCafferty (1998) considered the Muttkowski record as dubious, possibly a misidentification, despite including the Wisconsin record on their geographic map. The species also is known from Hennepin County near St. Paul, Minnesota (McCafferty 2009).

Status: *Leucrocuta maculipennis* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: Burian and Gibbs (1991) reported *L. maculipennis* (as *Heptagenia)* in Maine from small gravel substrates along slower reaches of riffles and runs.

Figure 270. Wisconsin records of *Leucrocuta maculipennis.*

Maccaffertium

Comments: There are nineteen recognized species of *Maccaffertium* in North America and eight species known from Wisconsin. It is the most diverse, common, and widespread genus of heptageniids in the state. All eight Wisconsin species formerly were included in the genus *Stenonema*.

Determination: Identification of *Maccaffertium* larvae is **Moderately Easy** for the genus, but **Slightly Difficult** for species within the genus.

Larval Keys: Traver (1933, 1935), Burks (1953), Lewis (1974a), Flowers and Hilsenhoff (1975), Bednarik and McCafferty (1979), and Hilsenhoff (1982), all as *Stenonema*. The key below primarily is modified from Bednarik and McCafferty (1979).

Key to the Species of *Maccaffertium*

1. Abdominal segments anterior to VI with posterolateral projections (Fig. 271a) **2**

Abdominal segments anterior to VI without posterolateral projections (Fig. 271b) **4**

2. Maxilla with fewer than 10 hair-like setae on crown (Fig. 271c); each abdominal sternum with a dark, roughly transverse band near midlength (Fig. 271a). . . . . ***M. mediopunctatum arwini***

Maxilla with 10 or more hair-like setae on crown (Fig. 271d); each abdominal sternum with a dark band, if present, located along posterior margin (Fig. 271e) **3**

3. Protarsal claw with two to five minute denticles (Fig. 271f); sternum VIII usually with posterior dark band that is narrowest medially and wider sublaterally (Fig. 271g); terga II–VII without contrasting crossbands on posterior quarter of each segment, though narrow crossbands may be present; abdominal segment IX with lateral projection shorter than that on segment VIII (Fig. 271g); mature larvae 9–10 mm long; lateral setation of cerci sparse . . . . . ***M. luteum***

Protarsal claw without denticles (Fig. 271h); sternum VIII usually with posterior dark band not narrowed medially (Fig. 271e); terga II–VII often with bold crossbands on posterior quarter of each segment, especially on mature specimens (Fig. 287); abdominal segment IX with lateral projection as long or longer than that on VIII; mature larvae 10–18 mm long; lateral setation of cerci long and dense . . . . . ***M. vicarium***

4. Maxilla with fewer than 10 hair-like setae on crown (Fig. 271i) **5**

Maxilla with 10 or more hair-like setae on crown (Fig. 271j) **7**

5. Terga V and VII mostly dark (Fig. 285); mesonotum of mature larva never with conspicuous large pale spots or complete pale band at base of wingpads (Fig. 285); maxilla with two to six (usually three to four) spine-like setae on crown, with up to two hair-like setae; sterna IV–VII of dark specimens often with oblique submedian dashes and lateral longitudinal streaks (Fig. 271b); sternum IX variously marked laterally, but often also forming a dark band across the posterior margin; lateral caudal filaments usually with many fine, lateral setae in basal third . . . . . ***M. terminatum terminatum***

Terga IV–V and VII paler than other terga and similarly patterned, particularly in more mature larvae (Figs. 271k, 273); mesonotum of mature larva as above (Fig. 283) or with conspicuous large pale spots or complete pale band at base of wingpads (Fig. 273); maxilla with four to nine spine-like setae on crown, without hair-like setae (Fig. 271l); sterna IV–VIII usually lightly marked or unmarked; sternum IX without dark posterior margin; lateral caudal filaments usually with fine, lateral setae sparse in basal third. **6**

6. Mesonotum of mature larva with large pale spots or complete pale band contrasting with dark base of wingpads (Fig. 273); maxilla with four to nine (usually five to six) spine-like setae on crown . . . . . ***M. exiguum***

Mesonotum of very mature larvae without large pale spots or complete pale band contrasting with base of wingpads (Fig. 283); maxilla with five to six spine-like setae on crown . . . . . ***M. pulchellum***

7. Terga VII–IX together forming a distinct, pale, V-shaped mark that is most distinct in mature larvae (Figs. 272a, 279); maxilla with only two to three spine-like setae on crown (Fig. 271j); abdominal sterna without dark transverse bands . . . . . ***M. mexicanum integrum***

Terga VII–IX not forming a distinct, pale, V-shaped mark (Figs. 272b, 281); maxilla with three to seven spine-like setae on crown (Fig. 272c); sternum VIII often with a dark transverse band and sternum IX with a dark, U-shaped mark (Fig. 272d) . . . . . ***M. modestum***

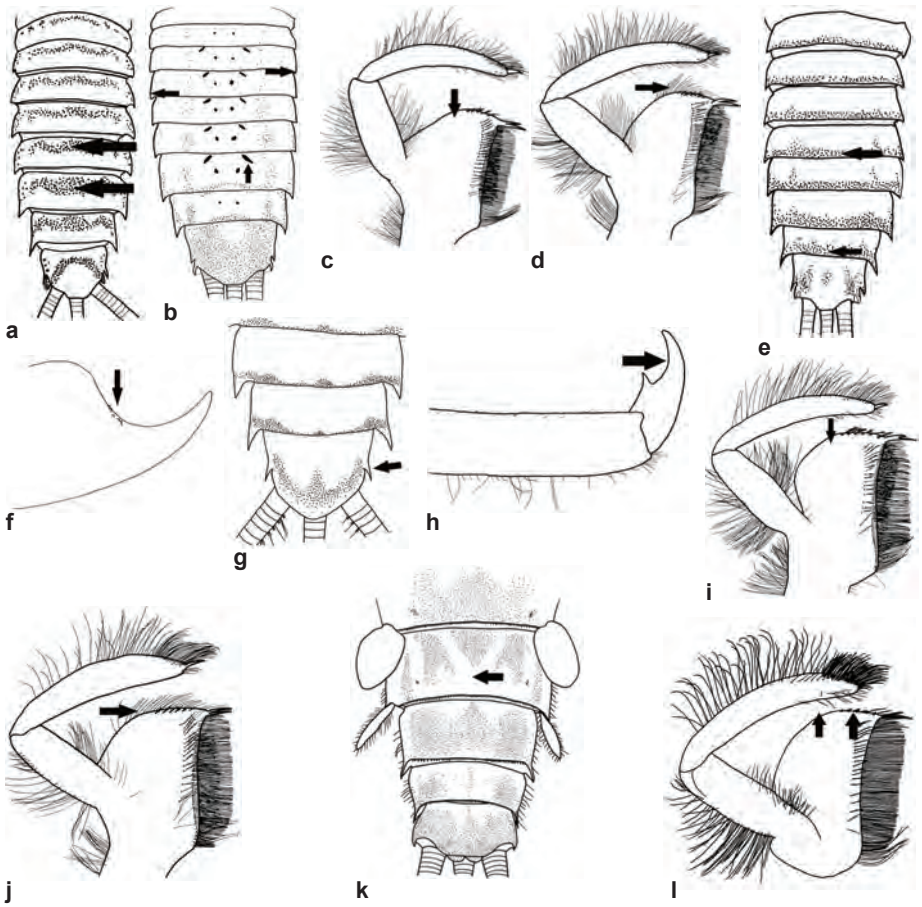


Figure 271. *Maccaffertium* (Heptageniidae). **a,** *M. mediopunctatum,* abdominal sterna; **b,** *M. terminatum terminatum,* abdominal sterna; **c,** *M. mediopunctatum,* maxilla (ventral); **d,** *M. vicarium,* maxilla (ventral); **e,** *M. vicarium,* abdominal sterna; **f,** *M. luteum,* front claw; **g,** *M. luteum,* abdominal sterna; **h,** *M. vicarium,* front claw; **i,** *M. exiguum,* maxilla (ventral); **j,** *M. mexicanum integrum,* maxilla (ventral); **k,** *M. pulchellum,* terga VI–X; **l,** *M. pulchellum,* maxilla (ventral).

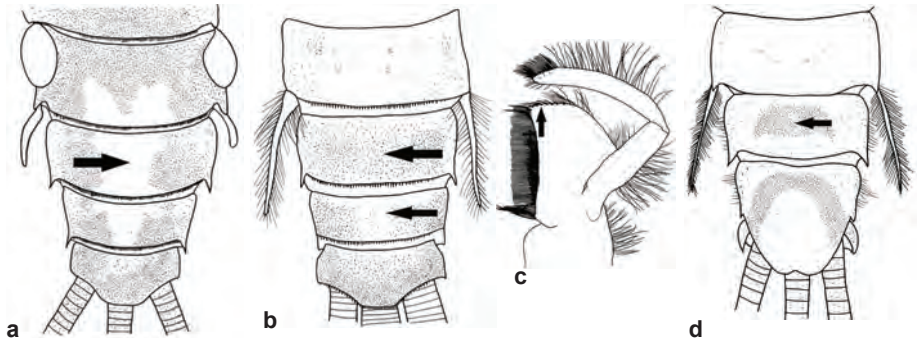


Figure 272. *Maccaffertium* (Heptageniidae). **a,** *M. mexicanum integrum,* terga VI–X; **b,** *M. modestum,* terga VII–X; **c,** *M. modestum,* maxilla (ventral); **d,** *M. modestum,* sterna VII–IX.

Maccaffertium exiguum (Traver), 1933 (Figs. 273 and 274)

Taxonomic History: *Heptagenia exigua* (Traver), 1933 (comb.); *Maccaffertium exiguum* (Traver), 1933 (curr. comb., Wang and McCafferty 2004); *Stenonema alabamae* Traver, 1937 (syn.); *Stenonema exiguum* Traver, 1933 (orig.); *Stenonema quinquespinum* Lewis, 1974 (syn.).

Larval Descriptions: Daggy (1945), as *Stenonema exiguum*; Lewis (1974a), as *S. exiguum* and *S. quinquespinum*; Lewis (1974b), as *S. quinquespinum*; Flowers and Hilsenhoff (1975) and Bednarik and McCafferty (1979), both as *S. exiguum*.

Larval Habitus: Daggy (1945), as *Stenonema exiguum*; Lewis (1974a), as *S. exiguum* and *S. quinquespinum*; Lewis (1974b), as *S. quinquespinum*; Berner and Pescador (1988), as *S. exiguum*.

Determination: Identification of *M. exiguum* larvae is **Slightly Difficult**. Larvae of the *M. exiguum*/*pulchellum* group easily are misidentified as the variable *M. terminatum* without examination of maxillae. In addition, moderately mature or immature larvae may not be reliably separated from *M. pulchellum* as the pale band at base of wingpads is visible only in later instars of *M. exiguum*.

Previous Wisconsin Records: (all as *Stenonema exiguum*): Lewis (1974a); Shapas and Hilsenhoff (1976); Flowers and Hilsenhoff (1978); Bednarik and McCafferty (1979); Lillie and Hilsenhoff (1992); Dubois (1993); Randolph and McCafferty (1998).

New County Records: ASHLAND: 2L, N. Fork Flambeau R., Holt's Landing, T41NR1E S21, VI-19-1997 (WiDNR); **JACKSON:** 1L, Black R., St. Rd. 71, VII-11-2013, K. L. Schmude (UWS); 1L, Black R., Haugstad Rd., 44.2546°N 90.86549°W, V-28-1997, W. A. Smith (WiDNR); 2L in two vials, Black R., Hawk Island Rd., 44.245869°N 90.878398°W, VI-15-1998, K. L. Schmude and R. Bautz (UWS and WiDNR); **MONROE:** 2L, Brandy Crk., Co. Rd. G, 44.05129°N 90.41605°W, VI-16-1998, K. L. Schmude (UWS); **SHAWANO:** 3L, Embarrass R., St. Rd. 22, 44.69191°N 88.70084°W, VI-6-1999, K. L. Schmude and C. Brennan (UWS); 6L, Middle Br. Embarrass R., Co. Rd. J, 44.80852°N 89.01844°W, V-27-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 1L, Mill Crk., Willow Crk. Rd., 44.75561°N 88.75651°W, VI-6-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS).

Biological Information: Larvae of *Maccaffertium exiguum* are fairly common in medium- to large-sized streams (Lewis 1974a; Flowers and Hilsenhoff 1975). Larval substrates include rocks and debris in otherwise sand-bottomed streams (Lewis 1974a; Flowers and Hilsenhoff 1978). Pollution tolerance of larvae has been described as moderate (Lewis 1974a) to limited (Hubbard and Peters 1978).

Figure 273. *Maccaffertium exiguum,* larva.

Figure 274. Wisconsin records of *Maccaffertium exiguum.*

Maccaffertium luteum (Clemens), 1913 (Figs. 275 and 276)

Taxonomic History: *Ecdyonurus luteus* (Clemens), 1913 (comb.); *Heptagenia lutea* Clemens, 1913 (orig.); *Maccaffertium luteum* (Clemens), 1913 (curr. comb., Wang and McCafferty 2004); *Stenonema luteum* (Clemens), 1913 (comb.).

Larval Descriptions: Clemens (1913, 1915a), as *Heptagenia lutea*; Burks (1953), Lewis (1974a), and Bednarik and McCafferty (1979), all as *Stenonema luteum*.

Larval Habitus: Clemens (1913, 1915a), as *Heptagenia lutea*.

Determination: Identification of *M. luteum* larvae is **Slightly Difficult**. They most closely resemble larvae of *M. vicarium*, with immature larvae being especially difficult to identify.

Previous Wisconsin Records (all as *Stenonema luteum*): Shapas and Hilsenhoff (1976); Randolph and McCafferty (1998). Several vials of specimens in the UW collection used as the Wisconsin records of *M. luteum* (as *S. luteum*) by Randolph and McCafferty (1998) are *M. mexicanum integrum*. The only county affected by these corrections is Richland County, which now has no verified records of *M. luteum*.

New County Record: DOUGLAS: 2L, St. Croix R., Hwy. 53, Gordon, [no date] (UW).

Status: *Maccaffertium luteum* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is widespread in the state, however.

Biological Information: *Maccaffertium luteum* is a mayfly of lake shores and riffles with clean water (Lewis 1974a; Bednarik and McCafferty 1979). Larvae are most associated with clumps of organic matter in gravel substrates (Burian and Gibbs 1991).

Figure 275. *Maccaffertium luteum,* larva.

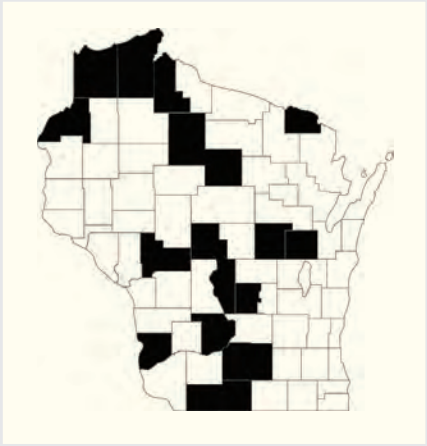


Figure 276. Wisconsin records of *Maccaffertium luteum.*

Maccaffertium mediopunctatum arwini (Bednarik & McCafferty), 1979 (Figs. 277 and 278)

Taxonomic History: *Heptagenia mediopunctata arwini* (Bednarik and McCafferty), 1979 (comb.); *Maccaffertium mediopunctatum arwini* (Bednarik & McCafferty), 1979 (curr. comb., Wang and McCafferty 2004); *Stenonema mediopunctata arwini* Bednarik and McCafferty, 1979 (orig.).

Larval Descriptions: Burks (1953), as *Stenonema mediopunctatum* and *S. nepotellum*; Leonard and Leonard (1962), as *S. nepotellum*; Lewis (1974a) and Bednarik and McCafferty (1979), both as *S. mediopunctatum.*

Determination: Identification of *M. m. arwini* larvae is **Slightly Difficult**. They have dark markings on the abdominal sterna that are at or anterior to the midlength of each segment (Fig. 271a), not near the posterior margins as in larvae of *M. vicarium* (Fig. 271e). These markings usually are present in both mature and immature larvae. The Wisconsin subspecies *M. m. arwini* and the more southern subspecies *M. m. mediopunctatum* (McDunnough) are very similar. In *M. m. arwini*, nearly the entire width of the dark band on each abdominal sternum is touching or nearly touching the anterior margin of the sternum (Fig. 271a). In *M. m. mediopunctatum,* the lateral portions of each dark band are closer to the midlength of the sternum (Bednarik and McCafferty 1979).

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Stenonema mediopunctatum*; Lewis (1974a), as *S. mediopunctatum*; Flowers and Hilsenhoff (1975), as *S. mediopunctatum*; Shapas and Hilsenhoff (1976), as *S. mediopunctatum*; Flowers and Hilsenhoff (1978), as *S. mediopunctatum*; Randolph and McCafferty (1998), as *S. mediopunctatum arwini*.

New County Records: IRON: 3L, Flambeau R., Upper Flambeau Boat Ramp, 46.06545°N 90.23382°W, VI-13-2000, K. L. Schmude, C. Brennan, J. Denninger, and K. Mielke (UWS); **KEWAUNEE:** Kewaunee R., XI-5-2001, R. Fischer (UWGB).

Biological Information: Larvae of *M. m. arwini* occur in medium to large streams with large gravel and rubble (Flowers and Hilsenhoff 1975; Bednarik and McCafferty 1979; Burian and Gibbs 1991). This species was considered uncommon in Wisconsin by Flowers and Hilsenhoff (1975) and limited to clean water by Lewis (1974a).

Figure 277. *Maccaffertium mediopunctatum arwini,* larva.

Figure 278. Wisconsin records of *Maccaffertium mediopunctatum arwini.*

Maccaffertium mexicanum integrum (McDunnough), 1924 (Figs. 279 and 280)

Taxonomic History: *Heptagenia integer* McDunnough, 1924 (orig.); *Heptagenia mexicana integer* McDunnough, 1924 (comb.); *Maccaffertium mexicanum integrum* (McDunnough), 1924 (curr. comb., Wang and McCafferty 2004); *Stenonema bellum* Traver, 1933 (syn.); *Stenonema integrum* (McDunnough), 1924 (comb.); *Stenonema metriotes* Burks, 1953 (syn.); *Stenonema mexicanum integrum* (McDunnough), 1924 (comb.); *Stenonema wabasha* Daggy, 1945 (syn.).

Larval Descriptions: Daggy (1945), as *Stenonema wabasha*; Leonard and Leonard (1962), Lewis (1973, 1974a), and Bednarik and McCafferty (1979), all as *S. integrum*.

Larval Habitus: Daggy (1945), as *Stenonema wabasha*; Lewis (1974a), as *S. integrum*.

Determination: Identification of *M. m. integrum* larvae is **Slightly Difficult**. The pale, V-shaped mark on posterior abdominal terga (Fig. 272a) is more distinct in mature larvae. It varies in width, and rarely is discontinuous from tergum VII to IX. The remainder of the abdominal color pattern varies widely in this species. Mature larvae have terga ranging from light brown with pale freckles to black with distinct paired anterior, sublateral, pale streaks. Sterna may be white or may have various degrees of coloration similar to *M. terminatum*. Some specimens are very difficult to identify and are suggestive of hybrids.

Previous Wisconsin Records: Flowers and Hilsenhoff (1975), Flowers and Hilsenhoff (1978), and Lillie and Hilsenhoff (1992), all as *Stenonema integrum*; Randolph and McCafferty (1998), as *S. m. integrum*.

New County Records: BAYFIELD: 1L, Porcupine Crk., Forest Rd. 213, V-2-1992, G. Drecktrah (UWO); **BUFFALO:** 1L, Trempealeau R., Co. Rd. P, 2 mi. N. of St. Rd. 35, VII-10-2013, K. L. Schmude (UWS); **DUNN:** 5L, Chippewa R., 640th St. Landing, VII-9-2013, K. L. Schmude (UWS); **PEPIN:** 6L, Chippewa R., St. Rd. 35, W. side, VII-10-2013, K. L. Schmude (UWS); **POLK:** 2L, St. Croix R., Nevers Landing, 1 mi. S. of Wolf Creek, 45°32'10"N 92°43'25"W, VII-13-2011, THK (THK); **ROCK:** larvae, Rock R., St. Rd. 184/Co. Rd. H near Gibbs Lk. Rd., 2 mi. S. of Fulton, VI-7-1999, THK and C. Hess (THK); larvae, Yahara R., Murwin Co. Pk., Fulton, VIII-29-1998, THK (THK); **RUSK:** 1L, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998, R. A. Lillie (WiDNR); **WASHBURN:** 1L, Hay Crk., Hamilton Rd., 0.6 mi. NW. of Springbrook, 45°57'27"N 91°41'29"W, VII-15-2011, THK (THK); Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK); 4L, Namekagon R., Stinnett Landing on Stinnett Landing Rd., 45°59'9"N 91°35'34"W, VII-15-2011, THK (THK); **WINNEBAGO:** 1L, Wolf R., Co. Rd. H, 44.23362°N 88.84939°W, VI-5-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Biological Information: Though *M. m. integrum* is second in abundance only to *M. terminatum* in Iowa (McCafferty et al. 2003a), it is not commonly represented in Wisconsin collections (Lillie and Hilsenhoff 1992). The species occurs in a wide variety of stream sizes, but prefers large, deep rivers with moderate to high flow rates (Leonard and Leonard 1962; Lewis 1974a; Flowers and Hilsenhoff 1975, 1978; Hubbard and Peters 1978; Bednarik and McCafferty 1979). It is moderately tolerant of nutrient-enriched water (Lewis 1974a; Burian and Gibbs 1991). Common larval substrates include rocks and woody debris in deep water (Leonard and Leonard 1962; Flowers and Hilsenhoff 1975; Lillie and Hilsenhoff 1992).

Figure 279. *Maccaffertium mexicanum integrum,* larva.
Figure 280. Wisconsin records of *Maccaffertium mexicanum integrum.*

Maccaffertium modestum (Banks), 1910 (Figs. 281 and 282)

Taxonomic History: *Ecdyonurus ruber* McDunnough, 1926 (syn.); *Ecdyonurus rubromaculatus* (Clemens), 1913 (syn.); *Epeorus modestus* Banks, 1910 (orig.); *Heptagenia modesta* (Banks), 1910 (comb.); *Heptagenia rubromaculata* Clemens, 1913 (syn.); *Iron modestus* (Banks), 1910 (comb.); *Maccaffertium modestum* (Banks), 1910 (curr. comb., Wang and McCafferty 2004); *Stenonema annexum* Traver, 1933 (syn.); *Stenonema modestum* (Banks), 1910 (comb.); *Stenonema ruber* (McDunnough), 1926 (syn.); *Stenonema rubromaculatum* (Clemens), 1913 (syn.); *Stenonema rubrum* (McDunnough), 1926 (syn.); *Stenonema varium* Traver, 1933 (syn.).

Larval Descriptions: Clemens (1913, 1915), as *Heptagenia rubromaculata*; Traver (1933), as *Stenonema annexum* and *S. varium*; Burks (1953) and Lewis (1974a), both as *S. rubromaculatum* and *S. rubrum*; Bednarik and McCafferty (1979), as *S. modestum*.

Larval Habitus: Clemens (1913, 1915), as *Heptagenia rubromaculata*; Lewis (1974a), as *S. rubromaculatum*.

Determination: Identification of *M. modestum* larvae is **Slightly Difficult**. The U-shaped color pattern on abdominal sternum IX (Fig. 272d) easily separates most specimens of *M. modestum* from others species in the genus, even in the field. Dorsally, *M. modestum* can resemble earlier instars of *M. exiguum*.

Previous Wisconsin Records: Hilsenhoff et al. (1972), as *Stenonema rubrum*; Lewis (1974a), as *S. rubromaculatum* and *S. rubrum*; Flowers and Hilsenhoff (1975), as *S. rubrum*; Flowers and Hilsenhoff (1978), as *S. rubrum*; DuBois (1993), as *S. modestum*; Randolph and McCafferty (1998), as *S. modestum*.

New County Records: ASHLAND: 1L, Brunsweiler R., Forest Rd. 189, V-26-2006, G. Drecktrah (UWO); **CHIPPEWA:** 1L, Yellow R., Co. Rd. S, 45.0599°N 91.0224°W, V-16-2002, K. L. Schmude and C. Brennan (UWS); **ONEIDA:** 33L, Wolf R., Meister-Stockley Rd., 45.53194°N 89.11214°W, VI-9-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS).

Biological Information: *Maccaffertium modestum* was considered an indicator of excellent water quality in Wisconsin by Hilsenhoff (1982). It is a fairly common species of a variety of river and stream sizes with rocky substrates (Flowers and Hilsenhoff 1975, 1978; Bednarik and McCafferty 1979; Burian and Gibbs 1991) and most commonly strong current (Lewis 1974a). It also is known from lakeshores with wave action (Burian and Gibbs 1991).

Figure 281. *Maccaffertium modestum,* larva.

Figure 282. Wisconsin records of *Maccaffertium modestum.*

Maccaffertium pulchellum (Walsh), 1862 (Figs. 283 and 284)

Taxonomic History: *Ecdyonurus pulchellus* (Walsh), 1862 (comb.); *Heptagenia luridipennis* (Burmeister), 1839 (id.); *Heptagenia pulchella* (Walsh), 1862 (comb.); *Maccaffertium pulchellum* (Walsh), 1862 (curr. comb., Wang and McCafferty 2004); *Palingenia pulchella* Walsh, 1862 (orig.); *Stenonema pulchellum* (Walsh), 1862 (comb.).

Larval Descriptions: Needham and Betten (1901), as *Heptagenia pulchella*; Clemens (1913), as *H. luridipennis*; Burks (1953), Leonard and Leonard (1962), Lewis (1974a), and Bednarik and McCafferty (1979), all as *Stenonema pulchellum*.

Determination: Identification of *M. pulchellum* larvae is **Difficult**. They are most easily confused with larvae of *M. terminatum* and *M. exiguum* because of their limited ventral markings. Only nearly mature larvae of *M. pulchellum* can be separated with confidence.

Previous Wisconsin Records (all as *Stenonema pulchellum*): Hilsenhoff et al. (1972); Flowers and Hilsenhoff (1975); Flowers and Hilsenhoff (1978); DuBois (1993); Randolph and McCafferty (1998). Some of the larvae in the UW collection identified as *M. pulchellum* and used previously for published county records (Hilsenhoff et al. 1972; Flowers and Hilsenhoff 1975, 1978) are too immature to differentiate from *M. exiguum*. Records from Bayfield County (White R., VI-20-1968 and VI-4-1973) are herein deleted until more mature specimens become available.

New County Records: LANGLADE: 1L, Wolf R., Wolf R. Landing Rd., 45.27677°N 88.41127°W, VI-8-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **POLK:** 1L, St. Croix R., Nevers, near Wolf Creek, Summer 1996 (WiDNR); **SHAWANO:** 2L, Embarrass R., Hayman Falls Ln., 44.74853°N 88.84183°W, V-26-2000; K. L. Schmude, C. Brennan, and J. Denninger (UWS); **VILAS:** Crystal Lk., IX-12-2005, A. M. Lederer (UWGB); **WAUPACA:** 1L, Little Wolf R., Co. Rd. X, 44.38873°N 88.82193°W, VI-4-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS).

Status: *Maccaffertium pulchellum* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b) and is the rarest member of the genus known from Wisconsin.

Biological Information: *Maccaffertium pulchellum* in Wisconsin is a rarely encountered mayfly of medium to large streams, associated with rocks and submerged woody debris (Leonard and Leonard 1962; Flowers and Hilsenhoff 1975; Bednarik and McCafferty 1979). Despite its scattered distribution, Lewis (1974a) described it as tolerant of organic pollution. It is known from throughout the Upper Midwest east to western New York and Pennsylvania. Northern Wisconsin and the Upper Peninsula of Michigan are along the northern edge of its range (Randolph & McCafferty 1998).

Figure 283. *Maccaffertium pulchellum,* larva.

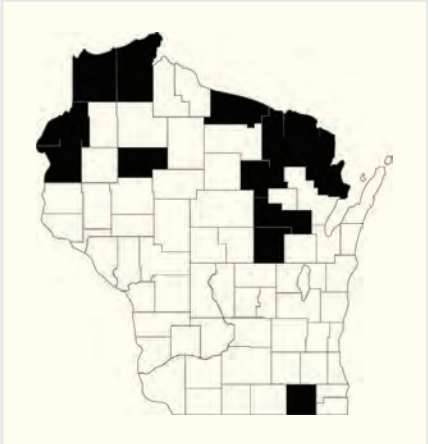


Figure 284. Wisconsin records of *Maccaffertium pulchellum.*

Maccaffertium terminatum terminatum (Walsh), 1862 (Figs. 285 and 286)

Taxonomic History: *Ecdyonurus bipunctatus* McDunnough, 1926 (syn.); *Ecdyonurus terminatus* (Walsh), 1862 (comb.); *Heptagenia terminata* (Walsh), 1862 (comb.); *Heptagenia terminata terminata* (Walsh), 1862 (comb.); *Maccaffertium terminatum terminatum* (Walsh), 1862 (curr. comb., Wang and McCafferty 2004); *Palingenia terminata* Walsh, 1862 (orig.); *Stenonema ares* Burks, 1953 (syn.); *Stenonema bipunctatum* (McDunnough), 1926 (syn.); *Stenonema lepton* Burks, 1946 (syn.); *Stenonema terminatum* (Walsh), 1862 (comb.); *Stenonema terminatum terminatum* (Walsh), 1862 (comb.).

Larval Descriptions: Daggy (1945), as *Stenonema bipunctatum*; Burks (1953), as *S. ares* and *S. bipunctatum*; Lewis (1973), as *S. terminatum*; Lewis (1974a), as *S. ares*, *S. bipunctatum,* and *S. terminatum*; Flowers and Hilsenhoff (1975), as *S. bipunctatum*; Bednarik and McCafferty (1979), as *S. terminatum*.

Larval Habitus: Daggy (1945), as *Stenonema bipunctatum*; Lewis (1973), as *S. terminatum*; Lewis (1974a), as *S. ares*, *S. bipunctatum,* and *S. terminatum*.

Determination: Identification of *M. t. terminatum* larvae is **Slightly Difficult**. They usually have fairly uniformly patterned abdominal terga, often with white speckles scattered over the brown background (Fig. 285). The abdominal sterna vary widely in coloration, some with extensive dark markings on each segment. Misidentifications most often involve immature specimens of *M. exiguum*, *M. mexicanum integrum*, and *M. pulchellum*.

Previous Wisconsin Records: Lewis (1974a), as *Stenonema ares*, *S. bipunctatum*, and *S. lepton*; Flowers and Hilsenhoff (1975), as *S. bipunctatum* and *S. terminatum*; Shapas and Hilsenhoff (1976), as *S. terminatum*; Flowers and Hilsenhoff (1978), as *S. bipunctatum* and *S. terminatum*; Bednarik and McCafferty (1979), Hilsenhoff (1982), Lillie and Hilsenhoff (1992), and DuBois (1993), all as *S. terminatum*; Randolph and McCafferty (1998), as *S. t. terminatum*.

New County Records: ASHLAND: 1L, N. Fork Flambeau R., Holt's Landing, T41NR1E S21, VI-19-1997 (WiDNR); No specific location, VIII-11-2005, M. Beebe (UWGB); **LANGLADE:** 1L, Wolf R., Wolf R. Landing Rd., 45.27677°N 88.841127°W, VI-8-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **PRICE:** 13L, Flambeau R., St. Rd. 70, 45.8404°N 90.66077°W, VI-14-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **SHAWANO:** 1L, Embarrass R., St. Rd. 22, 44.69191°N 88.70084°W, VI-6-1999, K. L. Schmude and C. Brennan (UWS); 3L, Wolf R., St. Rd. 29, 44.75441°N 88.6047°W, V-21-1999, K. L. Schmude, C. Brennan, and J. Tanck (UWS); **ST. CROIX:** 1L, St. Croix R., Somerset Landing on Marine Rd., 7 mi. NW. of Somerset, 45°12'14"N 92°45'47"W, VII-13-2011, THK (THK); **WALWORTH:** Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VII-20-2000, THK (THK).

Biological Information: *Maccaffertium t. terminatum* is common throughout much of Wisconsin. It is the most common *Maccaffertium* species in the lower Wisconsin River (Lillie and Hilsenhoff 1992). Larvae can be common in medium to large rivers and streams, particularly if there are mixed substrates of sand, rocks, and woody debris (Flowers and Hilsenhoff (1975, 1978; Bednarik and McCafferty 1979). Lewis (1974a) considered the species more typical of unpolluted rivers with relatively fast current.

Figure 285. *Maccaffertium terminatum terminatum,* larva.

Figure 286. Wisconsin records of *Maccaffertium terminatum terminatum.*

Maccaffertium vicarium (Walker), 1853 (Figs. 287 and 288)

Taxonomic History: *Baetis tessellata* Walker, 1853 (syn.); *Baetis vicaria* Walker, 1853 (orig.); *Ecdyonurus fusca* (Clemens), 1913 (syn. spell); *Ecdyonurus fuscum* (Clemens), 1913 (syn.); *Ecdyonurus fuscus* (Clemens), 1913 (syn. spell); *Ecdyonurus rivulicolus* McDunnough, 1933 (syn.); *Ecdyonurus vicarius* (Walker), 1853 (comb.); *Ecdyurus vicarius* (Walker), 1853 (comb.); *Heptagenia fusca* Clemens, 1913 (syn.); *Heptagenia vicaria* (Walker), 1853 (comb.); *Maccaffertium vicarium* (Walker), 1853 (curr. comb., Wang and McCafferty 2004); *Stenonema fuscum* (Clemens), 1913 (syn.); *Stenonema rivulicolum* (McDunnough), 1933 (syn.); *Stenonema tessellata* (Walker), 1853 (syn.); *Stenonema vicarium* (Walker), 1853 (comb.).

Larval Descriptions: Clemens (1913, 1915a), as *Heptagenia fusca*; Ide (1935b), as *Stenonema fuscum*; Burks (1953), Leonard and Leonard (1962), and Lewis (1974a), all as *S. fuscum* and *S. vicarium*; Bednarik and McCafferty (1979), as *S. vicarium*.

Larval Habitus: Clemens (1913, 1915a), as *Heptagenia fusca*; Leonard and Leonard (1962), as *Stenonema fuscum*; Lewis (1974a), as *S. fuscum* and *S. vicarium*.

Determination: Identification of *M. vicarium* is **Slightly Difficult**. Abdominal sterna with dark posterior borders (Fig. 271e) clearly separate them from larvae of *M. mediopunctatum*. *Maccaffertium vicarium* is most likely confused with the much less common *M. luteum*, especially with immature larvae.

Previous Wisconsin Records: Hilsenhoff et al. (1972), Lewis (1974a), Flowers and Hilsenhoff (1975), Shapas and Hilsenhoff (1976), and Flowers and Hilsenhoff (1978), all as *Stenonema fuscum*; Bednarik and McCafferty (1979); Dubois (1993); Hilsenhoff (1996); Lillie and Isenring (1996).

New County Records: BROWN: Devil's R., IX-12-2002, S. Gagnon (UWGB); **KEWAUNEE:** Kewaunee R., XI-5-2001, R. Fischer (UWGB); Mahone Lk., XI-11-2001, M. M. Schivik (UWGB); **ROCK:** 1L, E. Fork Raccoon R. [Crk.], T1NR12E S31, XI-5-1975 (MPM).

Biological Information: *Maccaffertium vicarium* is an abundant species, particularly in the cool streams of the northern half of Wisconsin. It was the most common heptageniid found in a survey of the Brule River in Douglas County (DuBois 1993). Larvae of *M. vicarium* occur in a variety of stream sizes, ranging from small to large streams, but also are known from ponds and lakes (Flowers and Hilsenhoff 1975; Bednarik and McCafferty 1979). Larvae prefer moderate to strong current and are sensitive to organic pollution (Leonard and Leonard 1962; Lewis 1974a; Bednarik and McCafferty 1979). Mature larvae of *M. vicarium* are most often associated with clumps of coarse organic matter in otherwise gravel substrates (Leonard and Leonard 1962; Burian and Gibbs 1991).

Figure 287. *Maccaffertium vicarium,* larva.

Figure 288. Wisconsin records of *Maccaffertium vicarium.*

Macdunnoa

Comments: There are three species of *Macdunnoa* in North America. The genus was established by Lehmkuhl (1979). Only *M. persimplex*, which originally was placed in *Heptagenia*, is known from the Midwest.

Determination: Identification of *Macdunnoa* larvae in Wisconsin is **Fairly Easy**.

Larval Key: Flowers (1982).

Macdunnoa persimplex (McDunnough), 1929 (Figs. 289 and 290)

Taxonomic History: *Heptagenia persimplex* McDunnough, 1929 (orig.); *Macdunnoa persimplex* (McDunnough), 1929 (curr. comb., Flowers 1982).

Larval Descriptions: None. The larva of *M. persimplex* has not been formerly described, though based upon adult records, it is the only species known from the Midwest.

Determination: Identification of *M. persimplex* larvae is **Fairly Easy**. Heptageniid specimens that have lost their gill VII can be misidentified as *M. persimplex*.

Previous Wisconsin Records: Lillie (1992); Lillie and Hilsenhoff (1992); Lillie (1995).

Status: *Macdunnoa persimplex* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Lillie and Hilsenhoff (1992) found *M. persimplex* only at one site in their study of the lower Wisconsin River, which is representative of this species' scattered distribution in the state.

Biological Information: Larvae of *M. persimplex* occur in moderate depths with slow current, and are associated with substrates of sand mixed with detritus.

Figure 289. *Macdunnoa persimplex,* larva.

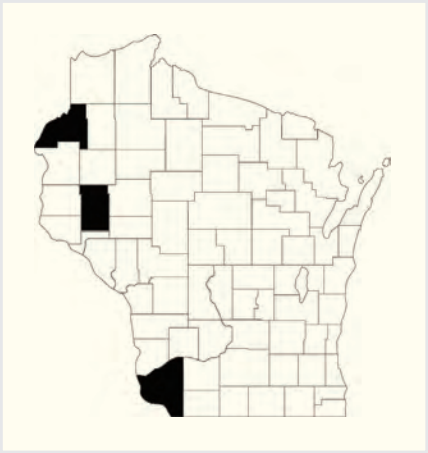


Figure 290. Wisconsin records of *Macdunnoa persimplex.*

Nixe

Comments: Members of the genus *Nixe* were removed from *Heptagenia* by Flowers (1980). Many *Nixe* larvae in Wisconsin collections are labeled and published as *N. lucidipennis*, but probably represent a mixture of species. Studies involving reared material are needed for this genus.

Determination: Identification of *Nixe* larvae is **Fairly Easy** for the genus and **Difficult** for species within the genus. Older keys used width of the head capsule as an important character for separating *Nixe* from *Leucrocuta*. This character, however, does not consistently allow separation of the two genera (McCafferty 2004). Older keys for identifying the species of *Nixe*, such as in Traver (1935) and Burks (1953), also were based upon unreliable characters. The very recent and effective key by Webb and McCafferty (2011) was used to develop the key to Wisconsin species below.

Larval Keys: Traver (1935), Burks (1953), Flowers and Hilsenhoff (1975), and Hilsenhoff (1982), all as *Heptagenia*; Webb and McCafferty (2011).

Key to the Species of *Nixe*

1. Each femur with pointed or bluntly pointed robust setae on anterior surface (Fig. 291a) . . . . . ***N. perfida***

Each femur with spatulate robust setae on anterior surface (Fig. 291b) **2**

2. Maxilla with at least 15–20 comb setae on anterior margin (Fig. 291c); terga each with one pair of sublateral pale spots . . . . . ***N. rusticalis***

Maxilla with fewer than 15 comb setae on anterior margin (Fig. 291d); terga each with two pairs of sublateral pale spots (Figs. 292, 294) **3**

3. Mature male larvae with dark area between antennal bases and extending to anterior margin of head capsule (Fig. 291e), whereas female larvae are mostly light brown in this area and similar in darkness to lateral portions of head capsule; terga with white background color and with tergum VIII almost entirely white, contrasting strongly with tergum VII (Fig. 292); tergum X lacking distinct W-shaped marking. . . . . ***N. inconspicua***

Male and female larvae both lacking distinct dark area between antennal bases and anterior margin of head capsule; terga with cream or pale brown background color and with tergum VIII similar in darkness and markings to anterior terga (Fig. 294); tergum X with distinct W-shaped marking . . . . . ***N. lucidipennis***

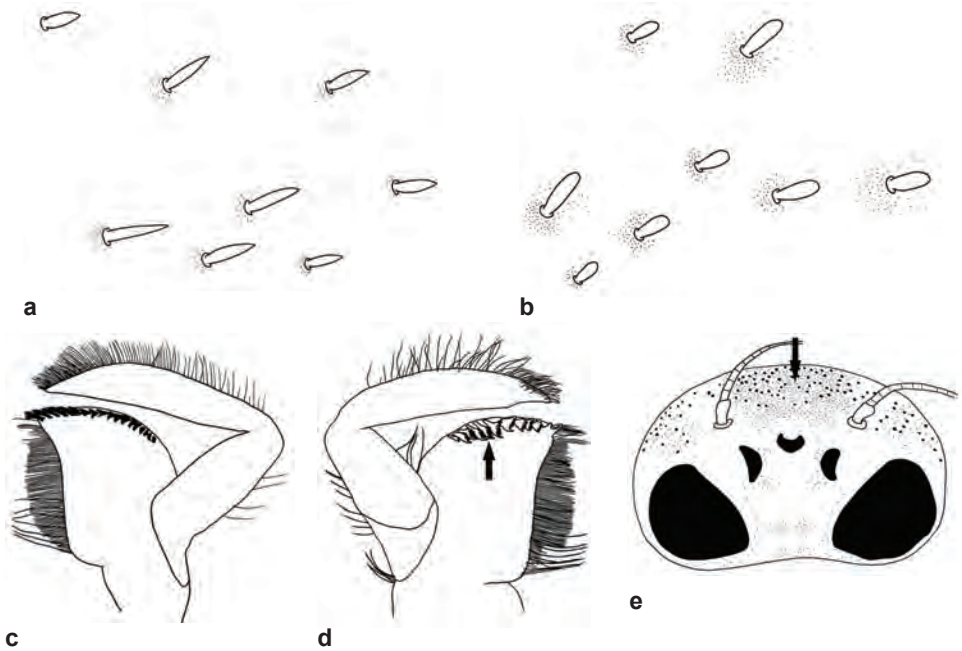


Figure 291. *Nixe* (Heptageniidae). **a,** *N. perfida,* front femur, setae on anterior surface; **b,** *N. inconspicua,* front femur, setae on anterior surface; **c,** *N. rusticalis,* maxilla (ventral); **d,** *N. inconspicua,* maxilla (ventral); **e,** *N. inconspicua,* head (male, dorsal).

Nixe inconspicua (McDunnough), 1924 (Figs. 292 and 293)

Taxonomic History: *Ecdyonurus inconspicuus* (McDunnough), 1924 (comb.); *Heptagenia inconspicua* McDunnough, 1924 (orig.); *Nixe inconspicua* (McDunnough), 1924 (curr. comb., Flowers 1980).

Larval Description and Habitus: McCafferty (1977b), as *Heptagenia inconspicua*.

Determination: Identification of *N. inconspicua* larvae is **Difficult**. Wisconsin specimens are most similar to *N. lucidipennis*. The pale tergum of abdominal segment VIII is found in both mature and most immature larvae. The striking head pattern of male larvae (Fig. 291e) is consistent only in mature specimens.

Previous Wisconsin Records: Randolph and McCafferty (1998). Burks (1953) and Hilsenhoff (1995) both listed it as present in Wisconsin, but gave no supporting data.

New County Records: DUNN: 34L (including blackwing), Chippewa R., 640th St. Landing, VII-9-2013, K. L. Schmude (UWS); 7L, Chippewa R., Co. Rd. H, VII-9-2013, K. L. Schmude (UWS); 22L, Chippewa R., Spring Brk. Landing, VII-9-2013, K. L. Schmude (UWS).

Status: *Nixe inconspicua* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). The original state record was based upon adults collected in 1940 (Randolph and McCafferty 1998). The new county records given above, based upon larvae collected in 2013 by Kurt Schmude at the University of Wisconsin–Superior, are the first such specimens collected in over 70 years.

Biological Information: Very little is known about *N. inconspicua*, likely because of the difficulty of identifying larvae. DeWalt et al. (1999) found it in small streams in Illinois. The Chippewa River sites in Dunn County, in contrast, are along seventh-order segments.

Figure 292. *Nixe inconspicua,* larva.

Figure 293. Wisconsin records of *Nixe inconspicua.*

Nixe lucidipennis (Clemens), 1913 (Figs. 294 and 295)

Taxonomic History: *Ecdyonurus lucidipennis* (Clemens), 1913 (comb.); *Ecdyurus lucidipennis* Clemens, 1913 (orig.); *Heptagenia lucidipennis* (Clemens), 1913 (comb.); *Nixe lucidipennis* (Clemens), 1913 (curr. comb., Flowers 1980).

Larval Description: Clemens (1913, 1915c), as *Ecdyurus lucidipennis*; Burks (1953), as *Heptagenia lucidipennis*.

Larval Habitus: Clemens (1913), as *Ecdyurus lucidipennis*.

Determination: Identification of *N. lucidipennis* larvae is **Difficult**. Wisconsin larvae are most similar to larvae of *N. inconspicua*. The similarity in coloration of abdominal tergum VIII to other terga is best determined in mature or relatively immature larvae.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976) and Flowers and Hilsenhoff (1978), both as *Heptagenia lucidipennis*; DuBois (1993); Randolph and McCafferty (1998). It is likely that at least some of these records were based upon misidentified specimens.

New County Records: DUNN: 2L, Chippewa R., 640th St. Landing, VII-9-2013, K. L. Schmude (UWS); **RUSK:** 1L, N. Fork Chippewa R., Hwy. 8, ½ mi. E. of Bruce, 45°27'8"N 91°15'37"w, VII-15-2011, THK (THK).

Biological Information: *Nixe lucidipennis* is not well known and is sporadically collected. The larvae in Wisconsin have been reported from medium-sized streams with small- to medium-sized rocks and slow current (Flowers and Hilsenhoff 1975, 1978), though it is likely that at least some of these observations were based on other species of *Nixe*.

Figure 294. *Nixe lucidipennis,* larva.

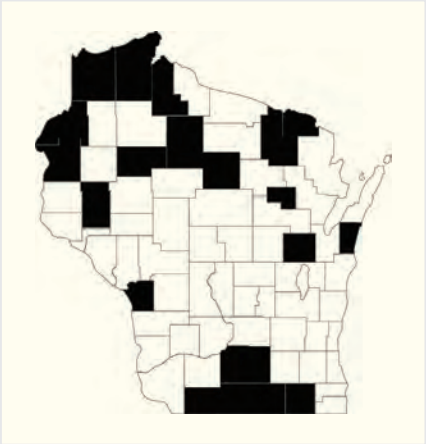


Figure 295. Wisconsin records of *Nixe lucidipennis.*

Nixe perfida (McDunnough), 1926 (Fig. 296)

Taxonomic History: *Ecdyonurus perfidus* (McDunnough), 1926 (comb.); *Heptagenia perfida* McDunnough, 1926 (orig.); *Nixe perfida* (McDunnough), 1926 (curr. comb., Flowers 1980).

Larval Description and Habitus: Burks (1953), as *Heptagenia perfida*.

Determination: Identification of *N. perfida* larvae is **Moderately Difficult**. The profemur should be removed and mounted on a slide for determination, though with practice the robust setae on the anterior surface (Fig. 291a) can be discerned with a dissecting microscope.

Previous Wisconsin Records: None. Closest records of *N. perfida* are from northeastern Illinois (Burks 1953). It is expected to occur in Wisconsin.

Biological Information: Almost nothing has been published regarding the biology of *N. perfida*. In Pennsylvania, Grant and Masteller (1984) reported it from a first-order tributary.

Figure 296. *Nixe perfida,* larva.

Nixe rusticalis (McDunnough), 1931

Taxonomic History: *Ecdyonurus rusticalis* (McDunnough), 1931 (comb.); *Heptagenia rusticalis* McDunnough, 1931 (orig.); *Nixe rusticalis* (McDunnough), 1931 (curr. comb., Flowers 1980).

Determination: Identification of *N. rusticalis* larvae is **Difficult**, requiring examination of slide-mounted maxillae.

Previous Wisconsin Records: None. Nearest records of *N. rusticalis* are from Iowa (Klubertanz 1995). It is expected to occur in Wisconsin.

Biological Information: None.

Raptoheptagenia

Comments: There is only one species in *Raptoheptagenia*, and the genus is restricted to North America.

Determination: Identification of *Raptoheptagenia* is **Fairly Easy**.

Raptoheptagenia cruentata (Walsh), 1863 (Fig. 297)

Taxonomic History: *Heptagenia cruentata* Walsh, 1863 (orig.); *Heptagenia reversalis* McDunnough, 1924 (syn.); *Raptoheptagenia cruentata* (Walsh), 1863 (curr. comb., Whiting and Lehmkuhl 1987).

Determination: Identification of *R. cruentata* larvae is **Moderately Easy**. Whiting and Lehmkuhl (1987) correctly associated the larvae, which other authors suspected were *Anepeorus*, with adults of *R. cruentata*.

Previous Wisconsin Records: None. Nearest records of *R. cruentata* are from the Rock River in northern Illinois (Burks 1953) and Sibley County, Minnesota (Waltz et al. 1998). Several additional Illinois records were given in Randolph and McCafferty (1998). It is expected to occur in Wisconsin, particularly in the Mississippi, Wisconsin, or other large rivers of the state.

Biological Information: *Raptoheptagenia cruentata* is a carnivorous, large-river species that prefers fast current and gravel substrates (Whiting and Lehmkuhl 1987).

Figure 297. *Raptoheptagenia cruentata,* larva.

Rhithrogena

Comments: Four of the 23 recognized species of *Rhithrogena* from North America are known from Wisconsin. These species are considered indicators of very good to excellent water quality and larvae occur in current-swept areas with stone and gravel substrates (Percival and Whitehead 1929; Flowers and Hilsenhoff 1975; Edmunds et al. 1976; Flowers and Hilsenhoff 1978; Burian and Gibbs 1991). In Wisconsin, these mayflies are known only from the northern half of the state.

Determination: Identification of *Rhithrogena* larvae is **Moderately Easy** for the genus and **Fairly Easy** for the Wisconsin species within the genus.

Larval Key: Flowers and Hilsenhoff (1975).

Key to the Species of *Rhithrogena*

1. Gills II–VI each with a finger-like projection on dorsal, trailing margin (Fig. 298a, c) **2**

Gills II–VI with dorsal margins evenly to irregularly rounded (Fig. 298b) **3**

2. Gills II–VI each with elongate finger-like projection on dorsal margin, projection longer than its width (Fig. 298a) . . . . . ***R. undulata***

Gills II–VI each with short finger-like projection on dorsal margin, projection shorter than its width (Fig. 298c) . . . . . ***R. impersonata***

3. Profemur (and usually all femora) with distinct purple-black band through pale area of anterior surface (Fig. 298d) . . . . . ***R. jejuna***

Each femur of mature larvae lacking a distinct dark band through pale area of anterior surface, though pale area usually bisected by a brown band similar in darkness to rest of femur; immature larvae not identifiable . . . . . ***R. manifesta***

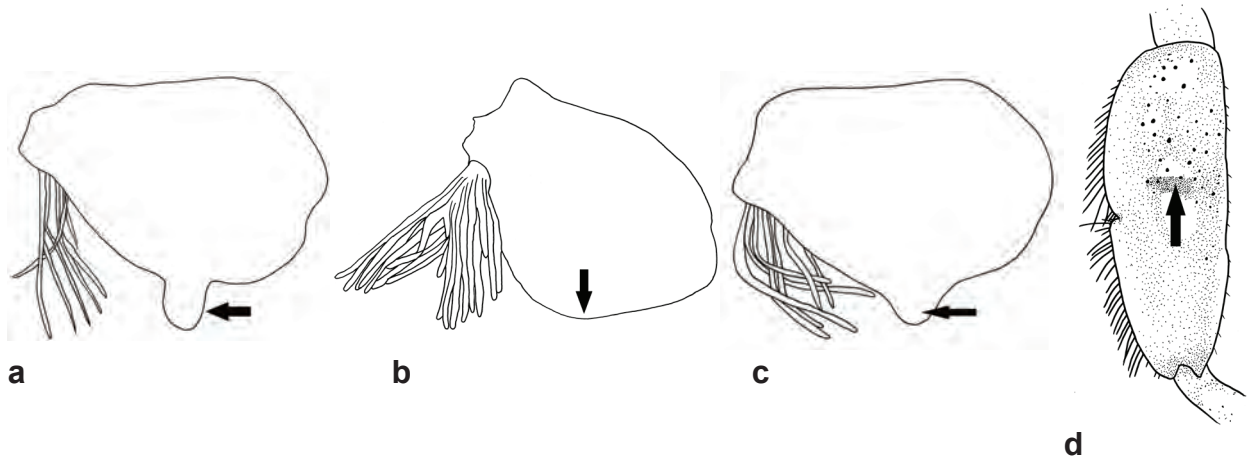


Figure 298. *Rhithrogena* (Heptageniidae). **a,** *R. undulata,* gill V; **b,** *R. jejuna,* gill V; **c,** *R. impersonata,* gill V; **d,** *R. jejuna,* front femur (anterior).

Rhithrogena impersonata (McDunnough), 1925 (Figs. 299 and 300)

Taxonomic History: *Heptagenia impersonata* McDunnough, 1925 (orig.); *Rhithrogena impersonata* (McDunnough), 1925 (curr. comb., McDunnough 1926); *Rhithrogena sanguinea* Ide, 1954 (syn.).

Larval Description: Ide (1954) and Leonard and Leonard (1962), both as *R. impersonata* and *R. sanguinea*; Flowers and Hilsenhoff (1975).

Larval Habitus: Leonard and Leonard (1962), as *R. sanguinea*.

Determination: Identification of *R. impersonata* larvae is **Fairly Easy**. Identification of immature larvae may be difficult.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976); Flowers and Hilsenhoff (1978); Randolph and McCafferty (1998).

New County Records: MENOMINEE: 8L (including blackwing), Evergreen R., V-5-1980 (UW); **ST. CROIX:** 10L (including blackwing), Harvey Crk., V-26-1970 (UW).

Status: *Rhithrogena impersonata* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is uncommon in the state (Flowers and Hilsenhoff 1975).

Biological Information: *Rhithrogena impersonata* was considered an indicator of excellent water quality in Wisconsin by Hilsenhoff (1982). Larvae prefer cool, shallow streams with swift current and gravel substrates (Daggy 1945; Ide 1954; Leonard and Leonard 1962; Flowers and Hilsenhoff 1975; Burian and Gibbs 1991). Larvae often hide in crevices of rocks and on the undersides of larger stones (Burian and Gibbs 1991).

Figure 299. *Rhithrogena impersonata,* larva.

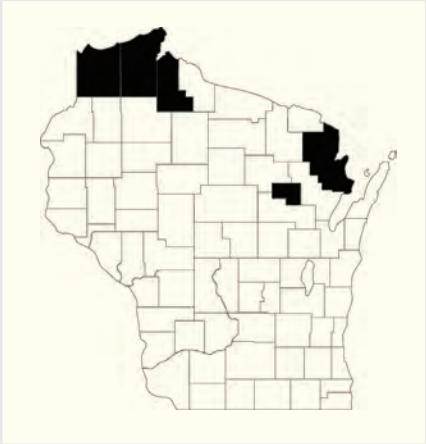


Figure 300. Wisconsin records of *Rhithrogena impersonata.*

Rhithrogena jejuna Eaton, 1885 (Figs. 301 and 302)

Taxonomic History: *Baetis fusca* Walker, 1853 (hom.: *B. fusca* Burmeister, 1839); *Heptagenia fusca* (Walker), 1853 (hom. comb.); *Rhithrogena fusca* (Walker), 1853 (hom. comb.).

Larval Description: Flowers and Hilsenhoff (1975).

Determination: Identification of *R. jejuna* larvae is **Fairly Easy**. Highly faded or very immature larvae may not show the distinct crossband on the femora (Fig. 298d), in which case separation from *R. manifesta* is not possible.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976); DuBois (1993); Randolph and McCafferty (1998).

New County Records: BURNETT: 1L, St. Croix R., VI-24-1998 (WiDNR); 1L, St. Croix R., Sand Rock Cliffs, 5 mi. NW. of Grantsburg, T38NR19W S7, Summer 1997 (WiDNR); 2L, St. Croix R., canoe landing on S. Markville Rd., 1000 ft. W. of St. Rd. 35 bridge, 46°4'26"N 92°15'3"W, VII-13-2011, THK (THK); **DUNN:** 11L, Chippewa R., 220th St. Landing, VII-9-2013, K. L. Schmude (UWS); 2L, Chippewa R., Co. Rd. H, VII-9-2013, K. L. Schmude (UWS); **FOREST:** 9L (including blackwing), Peshtigo R., V-6-1980 (UW); **POLK:** 1L, St. Croix R., Sunrise Landing, VI-10-1996 (WiDNR); **RUSK:** 1L, N. Fork Chippewa R., Hwy. 8, ½ mi. E. of Bruce, 45°27'8"N 91°15'37"W, VII-15-2011, THK (THK); 14L in two vials, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998, R. A. Lillie (WiDNR); **SAWYER:** 4L in two vials, Chippewa R., Town Line Rd., T37NR7W S35, VI-23-1998 (WiDNR); 5L (including blackwing), N. Fork Flambeau R., Co. Rd. W, T38NR3W S20, VI-18-1997 (WiDNR); **ST. CROIX:** 5L (including blackwing), Apple R., X-12-1980 (UW); **WASHBURN:** 5L (including blackwing), Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK).

Status: *Rhithrogena jejuna* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is, however, the most commonly encountered member of the genus in the state.

Biological Information: *Rhithrogena jejuna* was considered an indicator of excellent water quality in Wisconsin by Hilsenhoff (1982). Larvae are restricted to swift, shallow streams of small to medium size (Daggy 1945; Ide 1954; Leonard and Leonard 1962; Flowers and Hilsenhoff 1975; Burian and Gibbs 1991), though the numerous records from seventh-order segments of the Chippewa River indicate it can occur in larger rivers. Larvae typically occur in riffles with gravel, especially in protected areas under large stones (Flowers and Hilsenhoff 1975; Burian and Gibbs 1991).

Figure 301. *Rhithrogena jejuna,* larva.

Figure 302. Wisconsin records of *Rhithrogena jejuna.*

Rhithrogena manifesta Eaton, 1885 (Figs. 303 and 304)

Taxonomic History: *Heptagenia manifesta* (Eaton), 1885 (comb.); *Rhithrogena pellucida* Daggy, 1945 (syn.).

Larval Descriptions: Daggy (1945), Burks (1953), Leonard and Leonard (1962), and Durfee and Kondratieff (1994), all as *R. pellucida*.

Larval Habitus: Daggy (1945), as *R. pellucida*.

Determination: Identification of *R. manifesta* larvae is **Fairly Easy**. Highly faded or very immature larvae may be inseparable from *R. jejuna*. Durfee and Kondratieff (1994) described and illustrated *R. manifesta* (as *R. pellucida*) as having a pale, V-shaped marking on ventral surface of gill lamellae. I have not verified if this feature is unique to *R. manifesta* among Wisconsin species.

Previous Wisconsin Records: Hilsenhoff et al. (1972), Flowers and Hilsenhoff (1978), Jacobs (1990), and Randolph and McCafferty (1998), all as *R. pellucida.*

New County Records: DOUGLAS: 1L, Brule R., VI-9-1979 (UW); **WASHBURN:** 6L, Namekagon R., VI-19-1973 (UW).

Status: *Rhithrogena manifesta* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Flowers and Hilsenhoff (1978) considered it the most widespread species of the genus in the state, though I have collected it less frequently than *R. jejuna*.

Biological Information: *Rhithrogena manifesta* was considered an indicator of excellent water quality in Wisconsin by Hilsenhoff (1982). It is known from streams with swift current (Ide 1954; Leonard and Leonard 1962; Flowers and Hilsenhoff 1975; Daggy 1945) and shallow, gravel riffles and runs (Flowers and Hilsenhoff 1975; Burian and Gibbs 1991; Ferro and Sites 2007).

Figure 303. *Rhithrogena manifesta,* larva.

Figure 304. Wisconsin records of *Rhithrogena manifesta.*

Rhithrogena undulata (Banks), 1924 (Figs. 305 and 306)

Taxonomic History: *Epeorus undulata* Banks, 1924 (spell.); *Epeorus undulatus* Banks, 1924 (orig.); *Rhithrogena undulata* (Banks), 1924 (curr. comb., McDunnough 1926).

Determination: Identification of *R. undulata* larvae is **Fairly Easy**. The elongate, finger-like extension of each gill (Fig. 298a) is easily visible, though some manipulation of gills may be needed to obtain a clear view. Larvae are most easily confused with *R. impersonata*.

Previous Wisconsin Records: Randolph and McCafferty (1998).

New County Records: BAYFIELD: 2L in two vials (including blackwing), E. Fork Cranberry R., V-25-1970 and VI-20-1972 (UW); 23L in two vials (including blackwing), N. Fork Fish Crk., VI-8-1979 and X-6-1979 (UW); 18L in three vials (including blackwing), Pine Crk., VI-20-1972, IV-18-1974 and V-30-1974 (UW).

Status: *Rhithrogena undulata* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). It is the most rarely encountered member of the genus in the state. There are unverified Wisconsin DNR records from 1996 (Bayfield County), but otherwise the most recent records are of specimens taken over forty years ago.

Biological Information: *Rhithrogena undulata* was considered an indicator of excellent water quality in Wisconsin by Hilsenhoff (1982). Larvae occur in streams with swift current and shallow, gravel riffles (Ide 1954; Flowers and Hilsenhoff 1975; Daggy 1945). The limited number of records of blackwing larvae are from 8-20 June from Bayfield County.

Figure 305. *Rhithrogena undulata,* larva.

Figure 306. Wisconsin records of *Rhithrogena undulata.*

Spinadis

Comments: There is only one species of *Spinadis*, and the genus is restricted to North America.

Determination: Identification of *Spinadis* larvae is **Easy**.

Spinadis simplex (Walsh), 1863 (Figs. 307 and 308)

Taxonomic History: *Anepeorus simplex* (Walsh), 1863 (comb.); *Heptagenia simplex* Walsh, 1863 (orig.); *Spinadis simplex* (Walsh), 1863 (curr. comb., Wang and McCafferty 2004); *Spinadis wallacei* Edmunds and Jensen, 1974 (syn.).

Larval Description: Edmunds and Jensen (1974), as *S. wallacei*.

Larval Habitus: Flowers and Hilsenhoff (1975), as *Spinadis* sp.; Edmunds et al. (1976), as *S. wallacei*; Lillie (1995), as *Anepeorus simplex*.

Determination: Identification of *S. simplex* larvae is **Easy**. The species is the only one in the genus, and the only Wisconsin heptageniid with mid-dorsal abdominal tubercles (Fig. 254c). Mature larvae of this species are among the larger heptageniids in Wisconsin. Larvae can be recognized in the field by the dark mid-dorsal stripe.

Previous Wisconsin Records: Edmunds and Jensen (1974), as *S. wallacei*; Lillie and Hilsenhoff (1992), as *Anepeorus simplex*.

Status: One of the rarest mayflies in Wisconsin, *S. simplex* is listed as an Endangered Species in the state (Anonymous 2014b).

Biological Information: *Spinadis simplex* is known only from our largest, deepest rivers with sandy bottoms and high current (Edmunds and Jensen 1974; Flowers and Hilsenhoff 1975; Edmunds et al. 1976; Hubbard and Peters 1978; Randolph and McCafferty 1998). The microhabitat is unknown (Flowers and Hilsenhoff 1975), though they are believed to feed on chironomid larvae (Edmunds et al. 1976).

Figure 307. *Spinadis simplex,* larva.

Figure 308. Wisconsin records of *Spinadis simplex.*

Stenacron

Comments: There are eight species of *Stenacron* currently known from North America, though just four of these reported from the Upper Midwest. Only *S. interpunctatum* has been confirmed from Wisconsin, though other species in the state likely have escaped detection.

Determination: Identification of *Stenacron* larvae is **Easy** for the genus, but **Difficult to Very Difficult** for species within the genus. The key by Lewis (1974a) is the best and most recent for separating the species. Most *Stenacron* larvae from the Midwest are identified and labeled as *S. interpunctatum*, even though the necessary examination of mandibles and maxillae needed for proper species identification was not done. As noted by Lewis in 1974, there is great need for detailed taxonomic work on *Stenacron*, including making positive associations between larvae and adults through rearing. Molecular studies also could help clarify the boundaries of the species in the genus, as well as for the supposed subspecies of *S. interpunctatum.*

Larval Keys: Traver (1935), Burks (1953), and Lewis (1974a), all as *Stenonema*; Flowers and Hilsenhoff (1975).

Key to the Species of *Stenacron* (mature larvae)

1. Crown of maxilla with 11–13 heavy pectinate spines (Fig. 309a); not known from Wisconsin . . . . . ***S. gildersleevei***

Crown of each maxilla with fewer than 11 pectinate spines (Fig. 309b) **2**

2. Inner margin of outer incisor of left mandible with eight teeth; maxilla with no more than 25 ventral setae just lateral of medial edge of galea-lacinia; not known from Wisconsin . . . . . ***S. candidum***

Inner margin of outer incisor of left mandible with fewer than eight teeth (Fig. 309d); maxilla with variable numbers of lateral setae (Fig. 309c, e) **3**

3. Both maxillae with a row of 30 or more lateral setae (Fig. 309e); not known from Wisconsin . . . . . **S. *minnetonka***

Either maxilla with a row of fewer than 30 such setae on ventral surface of galea-lacinia (Fig. 309c) . . . ***S. interpunctatum***

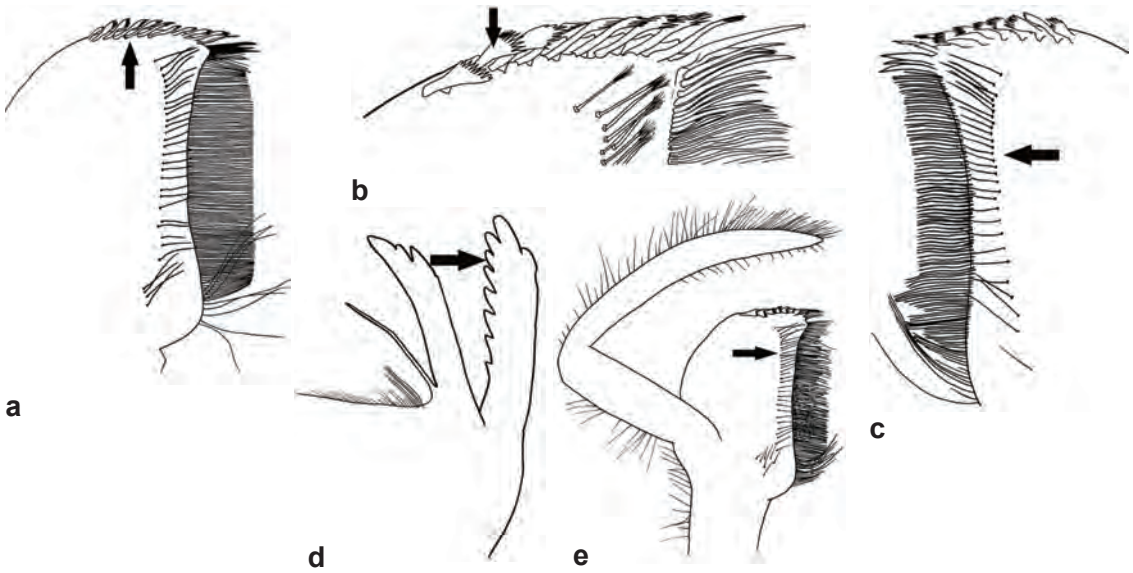


Figure 309. *Stenacron* (Heptageniidae). **a,** *S. gildersleevei,* maxilla (ventral); **b,** *S. interpunctatum,* pectinate setae of maxilla (ventral); **c,** *S. interpunctatum,* medial edge of left maxilla (ventral); **d,** *S. interpunctatum,* mandibular incisors (left); **e,** *S. minnetonka,* maxilla (ventral).

Stenacron candidum (Traver), 1935

Taxonomic History: *Heptagenia candida* (Traver), 1935 (comb.); *Stenacron candidum* (Traver), 1935 (curr. comb., Jensen 1974); *Stenonema candidum* Traver, 1935 (orig.).

Larval Description: Burks (1953), as *Stenonema candidum*.

Determination: Identification of *Stenacron candidum* larvae is **Very Difficult**. Removal of a maxilla and the left mandible are needed for identification.

Previous Wisconsin Records: None. Closest records of *Stenacron candidum* are from northern Indiana (Randolph and McCafferty 1998), Minnesota (Lewis 1974a; Lager et al. 1982), and Iowa (McCafferty and Hubbard 1998). It is expected, therefore, in Wisconsin. It is likely that larvae in collections are misidentified as *S. interpunctatum*. Any new state record should be based on adult males, as these are more easily separable based upon genitalic characters using the key in Lewis (1974a).

Biological Information: None.

Stenacron gildersleevei (Traver), 1935 (Fig. 310)

Taxonomic History: *Heptagenia gildersleevei* (Traver), 1935 (comb.); *Stenacron gildersleevei* (Traver), 1935 (curr. comb., Jensen 1974); *Stenonema gildersleevei* Traver, 1935 (orig.).

Larval Descriptions: Spieth (1947), Burks (1953), and Lewis (1974a), all as *Stenonema gildersleevei*.

Larval Habitus: Lewis (1974a).

Determination: Identification of *Stenacron gildersleevei* larvae is **Difficult**. Some of the pectinate maxillary spines (Fig. 309a) can be missing, causing confusion with more common members of the genus.

Previous Wisconsin Records: None. Closest records of *S. gildersleevei* are from northeastern Illinois (Burks 1953) and northern Indiana (Randolph and McCafferty 1998). Any new state record should be based on adult males, as these are more easily separable based upon genitalic characters using the key in Lewis (1974a).

Biological Information: In contrast to *S. interpunctatum*, *S. gildersleevei* is relatively intolerant of pollution and is more limited to cold, spring-fed streams (Lewis 1974a).

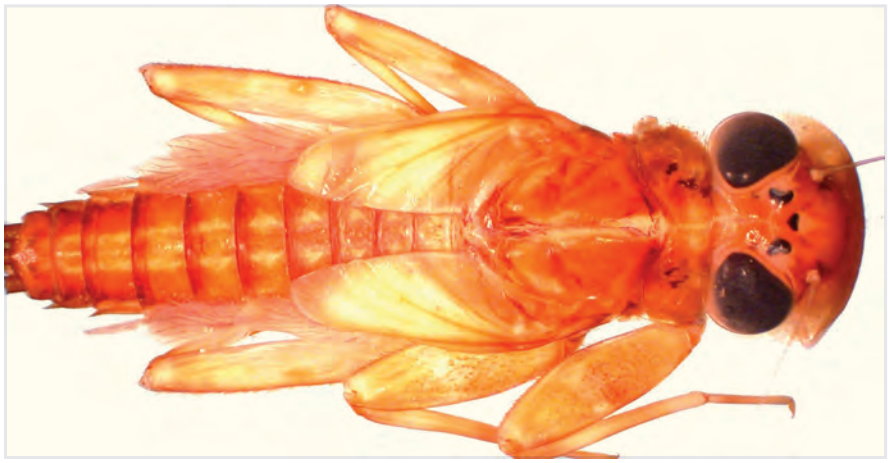


Figure 310. *Stenacron gildersleevei,* larva.

Stenacron interpunctatum (Say), 1839 (Figs. 311 and 312)

Taxonomic History: *Baetis canadensis* Walker, 1853 (syn.); *Baetis interpunctata* Say, 1839 (orig.); *Ecdyonurus canadensis* (Walker), 1853 (syn.); *Ecdyonurus frontalis* (Banks), 1910 (syn.); *Ecdyonurus heterotarsalis* McDunnough, 1933 (syn.); *Ecdyurus canadensis* (Walker), 1853 (syn.); *Heptagenia canadensis* (Walker), 1853 (syn.); *Heptagenia frontalis* Banks, 1910 (syn.); *Heptagenia interpunctata* (Say), 1839 (comb.); *Palingenia interpunctata* (Say), 1839 (comb.); *Stenacron areion* (Burks), 1953 (syn.); *Stenacron canadense* (Walker), 1853 (syn.); *Stenacron frontale* (Banks), 1910 (syn.); *Stenacron heterotarsale* (McDunnough), 1933 (syn.); *Stenacron interpunctatum* (Say), 1839 (curr. comb., Jensen 1974); *Stenonema areion* Burks, 1953 (syn.); *Stenonema affine* Traver, 1933 (syn.); *Stenonema canadense* (Walker), 1853 (syn.); *Stenonema conjunctum* Traver, 1935 (syn.); *Stenonema frontale* (Banks), 1910 (syn.); *Stenonema heterotarsale* (McDunnough), 1933 (syn.); *Stenonema interpunctatum* (Say), 1839 (comb.); *Stenonema majus* Traver, 1935 (syn.); *Stenonema ohioense* Traver, 1935 (syn.); *Stenonema proximum* Traver, 1935 (syn.).

Larval Descriptions: Clemens (1913, 1915a), as *Heptagenia canadensis* and *H. frontalis*; Traver (1933), as *Stenonema affine*; Ide (1935b), as *S. canadense*; Spieth (1947), as *S. interpunctatum canadense* and *S. i. frontale*; Burks (1953), as *S. canadense*, *S. frontale*, *S. heterotarsale*, and *S. interpunctatum*; Leonard and Leonard (1962), as *S. canadense, S. frontale*, and *S. heterosale*; Jensen (1974) and Lewis (1974a), both as *S. interpunctatum*.

Larval Habitus: Clemens (1913, 1915a), as *Heptagenia canadensis* and *H. frontalis*; Traver (1935), as *Stenonema frontale*; Leonard and Leonard (1962), as *S. canadense*; Lewis (1974a), as *S. interpunctatum*.

Determination: Identification of *Stenacron interpunctatum* larvae is **Very Difficult**. They cannot be identified reliably based upon tergal and sternal coloration. Removal of the left mandible and both maxillae are required for proper identification. Examination of both maxillae is required as some Wisconsin specimens I have examined have 30 lateral setae on one maxilla, but as few as 27 on the other. These setae commonly are missing or broken, so close inspection is necessary.

Previous Wisconsin Records: Wodsedalek (1912), as *Heptagenia interpunctata*; Muttkowski (1918), as *H. interpunctata*; Hilsenhoff et al. (1972), as *Stenonema interpunctatum*; Flowers and Hilsenhoff (1978); Hilsenhoff (1982); Jacobs (1990); Lillie and Hilsenhoff (1992); DuBois (1993); Hilsenhoff (1996); Lillie and Isenring (1996); Randolph and McCafferty (1998). As few larvae of Wisconsin *Stenacron* have been examined using the key by Lewis (1974a), including the dissection of mouthparts, it is likely that some of the published records of *S. interpunctatum* from the state are based upon misidentifications.

Biological Information: *Stenacron interpunctatum* is the most common and widespread member of the genus (Lewis 1974a; Flowers and Hilsenhoff 1975). It is more tolerant of pollution than other *Stenacron*, and is abundant even where all other heptageniid mayflies are excluded (Flowers and Hilsenhoff 1978). Larvae are tolerant of a variety of current strengths and can occur in lentic habitats (Flowers and Hilsenhoff 1975, 1978). Larvae can be associated with the undersides of large logs and boulders, as well in leafy debris and gravel (Leonard and Leonard 1962). Though most adults of *S. interpunctatum* are found in June and July, an unusually late record of adults was from 12 September 2002 in Manitowoc County (coll. by C. Bliese).

Figure 311. *Stenacron interpunctatum,* larva.

Figure 312. Wisconsin records of *Stenacron interpunctatum.*

Stenacron minnetonka (Daggy), 1945 (Fig. 313)

Taxonomic History: *Heptagenia minnetonka* (Daggy), 1945 (comb.); *Stenacron minnetonka* (Daggy), 1945 (curr. comb., Jensen 1974); *Stenonema minnetonka* Daggy, 1945 (orig.).

Larval Description: Lewis (1974a), as *Stenonema minnetonka*.

Determination: Identification of *Stenacron minnetonka* larvae is **Very Difficult**. They easily can be misidentified as *S. interpunctatum*. The use of coloration of the terga and sterna as a basis for separating these two species is not reliable and was not used by Lewis (1974a). Since some specimens of *S. interpunctatum* from Wisconsin have 30 lateral setae on one maxilla, examination of both maxillae is recommended. Any new state record should be of adult males, as these are more easily separable based upon genitalic characters using the key in Lewis (1974a).

Previous Wisconsin Records: None. Nearest records are from northern Illinois (Burks 1953) and Minnesota (Daggy 1945; Lager et al. 1982). It is expected to occur in Wisconsin.

Biological Information: *Stenacron minnetonka* is known from small to large rivers and is moderately tolerant of organic pollution (Lewis 1974a).

Figure 313. *Stenacron minnetonka,* larva.

Stenonema

Comments: As currently defined, the genus *Stenonema* contains only one species, which is limited to North and Central America (Kluge 2014). Wang and McCafferty (2004) reassigned nearly all of the members of the genus to *Maccaffertium*.

Determination: Identification of *Stenonema* larvae is **Moderately Easy**.

Stenonema femoratum (Say), 1823 (Figs. 314 and 315)

Taxonomic History: *Baetis femorata* Say, 1823 (orig.); *Ecdyonurus femoratus* (Say), 1823 (comb.); *Ecdyonurus tripunctatus* (Banks), 1910 (syn.); *Heptagenia femorata* (Say), 1823 (comb.); *Heptagenia tripunctata* Banks, 1910 (syn.); *Siphlurus femoratus* (Say), 1823 (comb.); *Stenonema birdi* Traver, 1935 (syn.); *Stenonema femoratum* (Say), 1823 (curr. comb., Traver 1933); *Stenonema scitulum* Traver, 1935 (syn.); *Stenonema tripunctatum* (Banks), 1910 (syn.).

Larval Descriptions: Clemens (1913, 1915a), as *Heptagenia tripunctata*; Ide (1935b), as *S. tripunctatum*; Spieth (1947), as three subspecies of *S. femoratum*; Burks (1953), as *S. femoratum* and *S. tripunctatum*; Leonard and Leonard (1962), as *S. tripunctatum*; Lewis (1973), as *S. scitulum*; Lewis (1974a), as *S. femoratum* and *S. tripunctatum*; Bednarik and McCafferty (1979).

Larval Habitus: Clemens (1913, 1915a), as *Heptagenia tripunctata*; Burks (1953), as *S. femoratum* and *S. tripunctatum*; Lewis (1973), as *S. scitulum*; Lewis (1974a), as *S. femoratum* and *S. tripunctatum*.

Determination: Identification of *S. femoratum* larvae is **Moderately Easy**. Abdominal sterna are uniquely patterned with paired, sublateral spots (Fig. 254k).

Previous Wisconsin Records: Hilsenhoff et al. (1972); Lewis (1974a); Flowers and Hilsenhoff (1975, 1978), as *S. tripunctatum*; DuBois (1993); Lillie and Isenring (1996); Randolph and McCafferty (1998).

New County Records: ASHLAND: Ashland, VIII-8-2005, M. Beebe (UWGB); **FOREST:** 3L, Himley Lk., Himley Lk. Rd., 45.46079°N 88.75399°W, VI-8-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); 1L, Pine Lk., Pine Lk. Rd., 45.68547°N 89.98911°W, VI-9-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **LANGLADE:** 7L, Lawrence Lk., Polar Rd., 45.25907°N 88.98516°W, VI-8-2000; K. L. Schmude, C. Brennan, and J. Denninger (UWS); **MANITOWOC:** Devil's R., IX-28-2000, A. J. Woerpel and J. Daeschler (UWGB); 1L, Two Rivers, V-29-1994, C. Rysticken (UWO); **MARINETTE:** 7L, Caldron Falls Reservoir, 45.36388°N 88.305064°W, Boat Landing 11 Rd., X-9-2003, K. L. Schmude and C. Brennan (UWS); 6L, Huber Lk., Deer Lk. Rd., 45.333528°N 88.272944°W, X-10-2003, K. L. Schmude and C. Brennan (UWS); 3L, Peshtigo R., Parkway Rd., 45.35784°N 88.22021°W, X-9-2003, K. L. Schmude and C. Brennan (UWS); **WINNEBAGO:** 4L, IV-10-1970, J. Grunwaldt (UWO).

Biological Information: *Stenonema femoratum* is associated with the greatest habitat diversity of any heptageniid mayfly in Wisconsin. Larvae occur in streams, rivers, and lakes (including Lake Michigan) where there is some current (Leonard and Leonard 1962; Lewis 1974a; Flowers and Hilsenhoff 1975; Flowers and Hilsenhoff 1978; Ferro and Sites 2007). It is more tolerant of degraded habitat quality than most flat-headed mayflies (Lewis 1974a). Typically, larvae are associated with the undersides of rocks, leaves, and woody debris (Leonard and Leonard 1962; Bednarik and McCafferty 1979). In Wisconsin, adults are known from 3 June (Door County) and 5 June (Clark, Iron, and Vilas Counties) to 13 September (Brown County).

Figure 314. *Stenonema femoratum,* larva.

Figure 315. Wisconsin records of *Stenonema femoratum.*

15 ISONYCHIIDAE

Prior to being placed in their own family, the species of the Isonychiidae were considered as a subfamily the Oligoneuriidae. The family currently contains only one recognized genus but is Holarctic in distribution (Kluge 2014). Larvae of isonychiids are large, minnow-shaped larvae capable of powerful swimming movements.

Isonychia

Comments: There are sixteen species of *Isonychia* in North America, though only four are known from Wisconsin. All four of the Wisconsin species are widespread in the state but are known from scattered localities because of the difficulty of identification.

Determination: Identification of *Isonychia* larvae is **Easy** for the genus, but **Slightly to Moderately Difficult** for species within the genus. They are large mayflies, usually dark in color when mature. Many specimens have a pale dorsal stripe, a variable character that is not useful for separating the species.

Taxonomic Key: Kondratieff and Voshell (1984).

Key to the Species of *Isonychia*

1. Each gill lamella lacking stout marginal spines around apex of gill (Fig. 316a) . . . . . ***I. sayi***

Each gill lamella with a continuous line of stout marginal spines around apex of gill (Fig. 316b) **2**

2. Gills VI–VII of mature larvae usually with three or more indistinct rows of stout spines near distal end of sclerotized anterior margin, and median sclerotized ridge of these gills usually with a continuous row of 10–30 spines (Fig. 316b); examination of a series of specimens recommended, with specimens exhibiting intermediate morphology being unidentifiable . . . . . ***I. sicca***

Gills VI–VII of mature larvae usually with two or fewer indistinct rows of stout spines near distal end of sclerotized anterior margin, and median sclerotized ridge these gills usually with 15 or fewer scattered spines (Fig. 316c); examination of a series of specimens recommended, with intermediate specimens being unidentifiable. **3**

3. Protibia of the subimago, visible through cuticle of last instar, pale at midlength and dark brown at base and apex; each abdominal sternum with a pair of sublateral dark spots near anterior margin (Fig. 316d); terga with several lateral, pale spots (Fig. 317); not known from Wisconsin . . . . . ***I. arida***

Protibia of the subimago, visible through cuticle of last instar, without pale region at midlength; other characters variable, but usually not in the above combination. **4**

4. At least one metafemur with margin of cleft at ventral, apical surface bearing six or more stout spines (Fig. 316e) (examine a series of specimens if possible; intermediate specimens are unidentifiable). . . . . ***I. bicolor***

Each metafemur with margin of cleft at ventral, apical surface bearing five or fewer stout spines (examine a series of specimens if possible; intermediate specimens are unidentifiable). . . . . ***I. rufa***

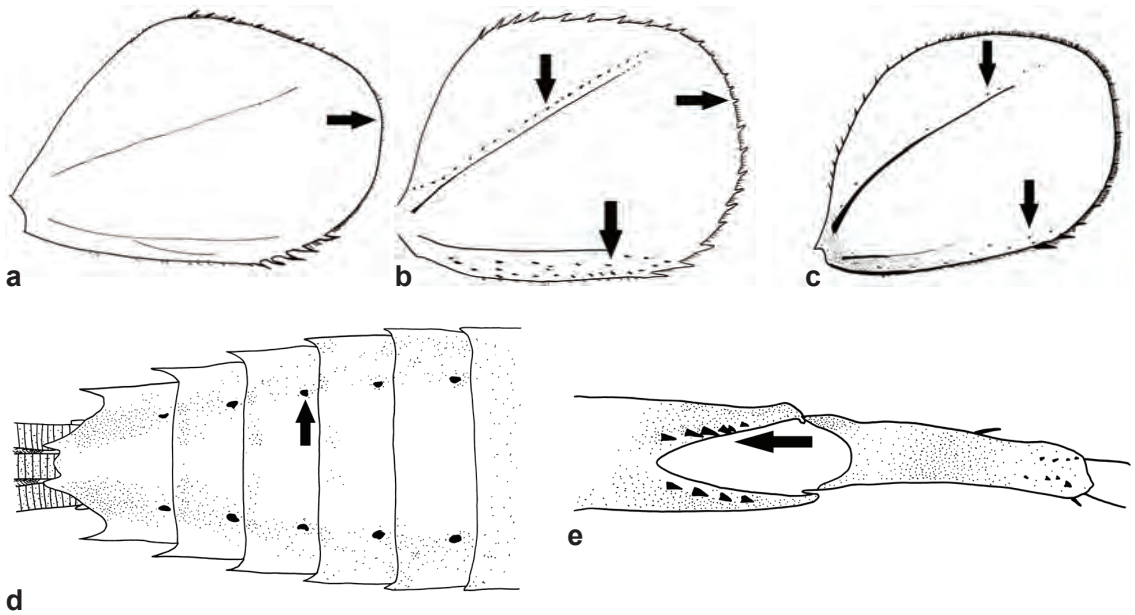


Figure 316. *Isonychia* (Isonychiidae). **a,** *I. sayi,* gill V; **b,** *I. sicca,* gill VI; **c,** *I. rufa,* gill VI; **d,** *I. arida,* sterna IV–IX; **e,** *I. bicolor,* tibiofemoral joint (ventral).

Isonychia arida (Say), 1839 (Fig. 317)

Taxonomic History: *Baetis arida* Say, 1839 (orig.); *Isonychia arida* (Say), 1839 (curr. comb., McDunnough 1931c); *Isonychia pictipes* Traver, 1934 (syn.).

Larval Description: Kondratieff and Voshell (1984).

Larval Habitus: Berner and Pescador (1988).

Determination: Identification of *I. arida* larvae is **Moderately Difficult**. The best character for identifying this species, the protibia having a pale band at midlength, is visible only on blackwing larvae.

Previous Wisconsin Records: None. Closest records are from northeastern Illinois (Burks 1953). It is expected in Wisconsin, possibly in the sandy reaches of the Sugar River in Rock and Green Counties.

Biological Information: *Isonychia arida* is a mayfly of sand-bottomed streams, where it is associated with woody debris, roots, and bank vegetation exposed to moderate to strong current (Peters and Jones 1973; Kondratieff and Voshell 1984; Berner and Pescador 1988).

Figure 317. *Isonychia arida,* larva.

Isonychia bicolor (Walker), 1853 (Figs. 318 and 319)

Taxonomic History: *Chirotonetes albomanicatus* Needham, 1905 (syn.); *Isonychia albomanicata* (Needham), 1905 (syn.); *Isonychia bicolor* (Walker), 1853 (curr. comb., McDunnough 1931c); *Isonychia christina* Traver, 1934 (syn.); *Isonychia circe* Traver, 1934 (syn.); *Isonychia fattigi* Traver, 1934 (syn.); *Isonychia harperi* Traver, 1934 (syn.); *Isonychia matilda* Traver, 1934 (syn.); *Isonychia pacoleta* Traver, 1932 (syn.); *Isonychia sadleri* Traver, 1934 (syn.); *Palingenia bicolor* Walker, 1853 (orig.); *Siphlurus bicolor* (Walker), 1853 (comb.).

Larval Descriptions: Traver (1932b), as *I. pacoleta*; Traver (1934), as *I. christina* and *I. matilda*; Ide (1935b); Leonard and Leonard (1962), as *I. bicolor and I. sadleri*; Kondratieff and Voshell (1984).

Larval Habitus: Needham (1905), as *Chirotonetes albomanicatus*; Leonard and Leonard (1962), as *I. sadleri*.

Determination: Identification of *I. bicolor* larvae is **Moderately Difficult**. Many specimens are inseparable from both *I. sicca* and *I. rufa*. Tergal coloration is highly variable. Specimens lacking either at least one metafemur or lacking gills VI–VII should not be labeled to species.

Previous Wisconsin Records: Lillie and Hilsenhoff (1992).

New County Records: BURNETT: 1L, St. Croix R., Sand Rock Cliffs, 5 mi. NW. of Grantsburg, T38NR19W S7, Summer 1996 (WiDNR); 1L, Wood R., St. Rd. 70, ½ mi. SW. of Grantsburg, 45°46'23"N 92°42'28"W, VII-13-2011, THK (THK); **CRAWFORD:** 1M, Kickapoo R., Gays Mills, VI-13-1968 (UW); **MARINETTE:** larvae, Menominee R., Co. Rd. Z, T36NR22E S20, VI-26-1996 (WiDNR); **ST. CROIX:** 2L (including blackwing), Willow R., Co. Rd. E, ½ mi. NW. of Dry Dam Lk., 45°2'10"N 92°38'20"W, VII-12-2011, THK (THK); **WASHBURN:** 2L, Bean Brk., Hwy. 63, 2 mi. SW. of Springbrook 45°55'17"N 91°43'50"W, VII-15-2011, THK (THK); 1L, Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK).

Biological Information: Larvae of *I. bicolor* occur in streams with moderate to fast current (Leonard and Leonard 1962; Burian and Gibbs 1991; Lillie and Hilsenhoff 1992). Larvae are associated with rocky and woody substrates (Lillie and Hilsenhoff 1992).

Figure 318. *Isonychia bicolor,* larva.

Figure 319. Wisconsin records of *Isonychia bicolor.*

Isonychia rufa McDunnough, 1931 (Figs. 320 and 321)

Larval Description: Daggy (1945); Kondratieff and Voshell (1984).

Determination: Identification of *I. rufa* larvae is **Moderately Difficult**. Many specimens are inseparable from both *I. sicca* and *I. bicolor*. Tergal coloration is highly variable. Specimens lacking either at least one metafemur or lacking gills VI–VII should not be labeled to species.

Previous Wisconsin Records: McCafferty (2011).

New County Records: LA CROSSE: 1M, La Crosse, VII-19-1973 (UW); **MARINETTE:** larvae, Menominee R., Co. Rd. Z, T36NR22E S20, VI-26-1996 (WiDNR); 1L, Pike R., VI-27-1996 (WiDNR); **PEPIN:** 1L, Chippewa R., Ella Boat Landing, VII-9-2013, K. L. Schmude (UWS); **ROCK:** reared adult female with exuviae, Turtle Crk., Shopiere, VII-13-1999, THK (THK); **RUSK:** 4L, Flambeau R., Washington, T33NR7W S22, VI-19-1997 (WiDNR); **SAWYER:** 1L, N. Fork Flambeau R., Co. Rd. W, T38NR3W S20, VI-18-1997 (WiDNR).

Biological Information: There are few published observations regarding the biology of *I. rufa* separate from other species in the genus. Kondratieff and Voshell (1984) described its habitat as larger streams and rivers.

Figure 320. *Isonychia rufa,* larva.

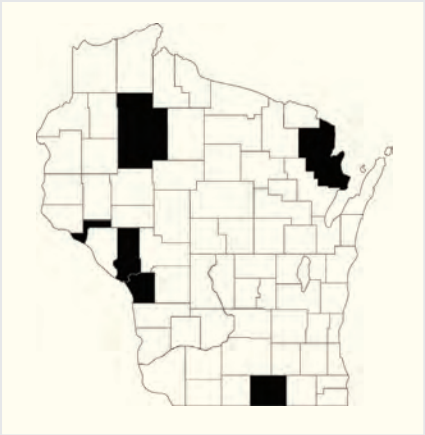


Figure 321. Wisconsin records of *Isonychia rufa.*

Isonychia sayi Burks, 1953 (Figs. 322 and 323)

Larval Description: Kondratieff and Voshell (1984).

Determination: Identification of *I. sayi* larvae is **Slightly Difficult**. Of the Wisconsin species in the genus, it is easiest to identify. It can be separated from other species in the genus in both mature and immature larvae based upon the absence of robust spines on the distal margins of gills (Fig. 316a).

Previous Wisconsin Records: Kondratieff and Voshell (1984); Randolph and McCafferty (1998).

New County Records: BUFFALO: 8L, Trempealeau R., Co. Rd. P, 2 mi. N. of St. Rd. 35, VII-10-2013, K. L. Schmude (UWS); **JACKSON:** 5L, Black R., St. Rd. 71, VII-11-2013, K. L. Schmude (UWS); 1L, Black R., Co. Rd. VV, VII-11-2013, K. L. Schmude (UWS); **ROCK:** 1L, Sugar R., Beloit-Newark Rd., Avon, VI-11-1999, THK (THK); **TREMPEALEAU:** 3L (including blackwing), Buffalo R., Thompson Rd., 1.9 mi. W. of Eleva, 44°34'37"N 91°30'33"W, VII-16-2011, THK (THK).

Biological Information: Larvae of *I. sayi* are most frequently associated with shoreline debris and exposed roots along sand-bottomed streams with rapid current (Berner 1950; Berner and Pescador 1988). All of the Wisconsin records are from medium to large rivers.

Figure 322. *Isonychia sayi,* larva.

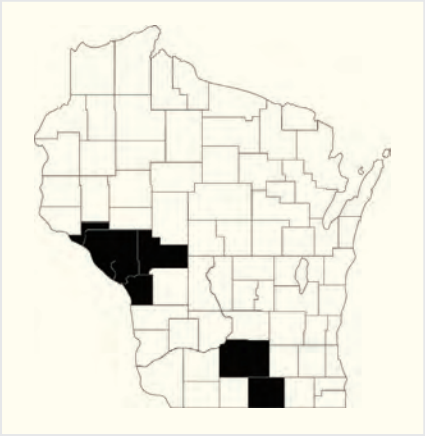


Figure 323. Wisconsin records of *Isonychia sayi.*

Isonychia sicca (Walsh), 1862 (Figs. 324 and 325)

Taxonomic History: *Baetis sicca* Walsh, 1862 (orig.); *Chirotonetes mancus* (Eaton), 1871 (syn.); *Chirotonetes siccus* (Walsh), 1862 (comb.); *Isonychia edmundsi* Kondratieff and Voshell, 1984 (syn.); *Isonychia manca* Eaton, 1871 (syn.); *Isonychia sicca* (Walsh), 1862; *Isonychia sicca manca* Eaton, 1871 (syn.); *Isonychia sicca sicca* (Walsh), 1862 (stat.); *Siphlurus siccus* (Walsh), 1862 (comb.).

Larval Description: Provonsha and McCafferty (1982); Kondratieff and Voshell (1984).

Larval Habitus: Needham (1920), as *Chirotonetes siccus*; Traver (1935); Burks (1953); Provonsha and McCafferty (1982).

Determination: Identification of *I. sicca* larvae is **Moderately Difficult**. Many specimens have intermediate morphology and are inseparable from larvae of *I. bicolor* and *I. rufa*. Tergal coloration is highly variable and should not be the basis of species identifications here, or elsewhere in the genus.

Previous Wisconsin Records: Randolph and McCafferty (1998).

New County Records: BAYFIELD: 3L, Namekagon R., Hwy. 63, VIII-21-1988, G. Drecktrah (UWO); 4L, Cable, VII-21-1979, G. Drecktrah (UWO); **BURNETT:** 1L, St. Croix R., St. Rd. 77, T41NR17W S25, VI-17-1997 (WiDNR); 1L, St. Croix R., Sand Rock Cliffs, 5 mi. NW. of Grantsburg, T38NR19W S7, Summer 1996 (WiDNR); **CLARK:** 1L, Cunningham Crk., St. Rd. 73, site "Blackr 2819", 44.531259°N 90.597912°W, K. L. Schmude (UWS); **FLORENCE:** 1L, Menominee R., T40NR18E S12, VI-22-1998 (WiDNR); **MARINETTE:** 1L, Menominee R., Saler, T38NR22E S17, VI-26-1996 (WiDNR); **ROCK:** Turtle Crk., Lather's Rd., 1 mi. WSW. of Shopiere, T2NR13E S9, VIII-27-1999, THK (THK); Turtle Crk., Lather's Rd., 1 mi. WSW. of Shopiere, T2NR13E S9, VI-6-2011, THK, C. Brown, and E. Wolf (THK); **RUSK:** 1L, N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998 (WiDNR); **SAUK:** 1L (exuviae), Wisconsin R., St. Rd. 130/133 bridge, 43°9'55"N 90°11'34"W, VII-26-2011, THK (THK); **SAWYER:** 3L, Couderay R., Co. Rd. C., site "Chipr 3847", 45.7949°N 91.352551°W, Summer 2012, K. L. Schmude (UWS); 1L, N. Fork Flambeau R., Co. Rd. W, T38NR3W S20, VI-18-1997 (WiDNR); **ST. CROIX:** 10L, Willow R., Co. Rd. E, ½ mi. NW. of Dry Dam Lk., 45°2'10"N 92°38'20"W, VII-12-2011, THK (THK); **WALWORTH:** 1L, Turtle Crk., Klug Rd. (formerly Pounder Rd.), 2 mi. NW. of Delavan, VIII-4-2000, THK (THK); **WASHBURN:** 1L, Namekagon R., Groat Landing, Brickman Rd., 7 mi. WSW. of Hayward, 45°59'45"N 91°38'6"W, VII-15-2011, THK (THK).

Biological Information: Few authors have provided biological information for *I. sicca*. It is known from large rivers with moderate to fast currents and rocky substrates (Provonsha and McCafferty 1985). Grant and Stewart (1980) examined the life history of this species in an intermittent stream in Texas. *Isonychia sicca* is widespread in Wisconsin and apparently more common than previously believed.

Figure 324. *Isonychia sicca,* larva.

Figure 325. Wisconsin records of *Isonychia sicca.*

16 LEPTOHYPHIDAE

Among the known Wisconsin fauna, the Family Leptohyphidae is represented only by species of *Tricorythodes*. There are seven other North American genera of leptohyphids, but none are expected in Wisconsin. Older literature placed the Leptohyphidae in the Subfamily Leptohyphinae of the Family Tricorythidae, but McCafferty and Wang (2000) elevated the group to family status. What remains of the Family Tricorythidae includes species known only from the Eastern Hemisphere (McCafferty and Wang 2000).

Tricorythodes

Comments: Larvae of *Tricorythodes* are small mayflies that superficially resemble some genera of the unrelated Caenidae. The general habitat for larvae is stream runs and pools with fine sand, gravel, and silt on stream beds with rooted vegetation (Edmunds et al. 1976). *Tricorythodes* is currently believed to have originated in South America, having moved north through the Pan-American land bridge, in contrast to most North American mayflies (Allen 1990; Baumgardner 2008).

Determination: Identification of *Tricorythodes* larvae is **Easy** for the genus but **Problematic** for species within the genus because of the lack of larval descriptions and published keys. The genus is one of the most taxonomically difficult in all of the Ephemeroptera. Only five species of *Tricorythodes* have published records from Wisconsin. Species accounts in the sections below are given for only these five species. Other species, such as *T. cobbi* Alba-Tercedor & Flannagan and *T. mosegus* Alba-Tercedor & Flannagan, may occur in Wisconsin but are not included in the species accounts because of taxonomic uncertainty and lack of larval descriptions.

Larval Keys: None. I have not examined enough verified, reared material to develop a taxonomic key, though the species accounts below do provide some morphological information.

Figure 326. *Tricorythodes* sp., larva.

Tricorythodes albilineatus Berner, 1946 (Figs. 327 and 328)

Larval Description: Berner (1946).

Larval Habitus: Edmunds et al. (1976); Berner and Pescador (1988).

Determination: Identification of *T. albilineatus* is **Very Difficult**. Morphological studies of *Tricorythodes* in general are insufficient to develop reliable keys. Species determination should be made only by direct comparison with verified, reared material.

Previous Wisconsin Records: McCafferty (2011). Previously, the species was believed restricted in the United States to the Southeast and Southwest. The larva in Figure 327 is the specimen from the Purdue Entomological Research Collection that is the only Wisconsin record.

Biological Information: Larvae of *T. albilineatus* are associated with moss, silt, and submerged roots in streams (Berner and Pescador 1988).

Figure 327. *Tricorythodes albilineatus,* larva.

Figure 328. Wisconsin records of *Tricorythodes albilineatus.*

Tricorythodes allectus (Needham), 1905 (Fig. 329)

Taxonomic History: *Caenis allecta* Needham, 1905 (orig.); *Tricorythodes allectus* (Needham), 1905 (curr. comb., Ulmer 1920); *Tricorythodes atratus* (McDunnough), 1923 (syn.); *Tricorythodes peridius* Burks, 1953 (syn.); *Tricorythus allectus* (Needham), 1905 (comb.); *Tricorythus atratus* McDunnough, 1923 (syn.).

Larval Habitus: Burks (1953), as *Tricorythodes atratus*.

Determination: Identification of *T. allectus* is **Problematic**. Larvae cannot be identified without direct comparison to verified, reared specimens.

Previous Wisconsin Records: McCafferty (2011).

Biological Information: None.

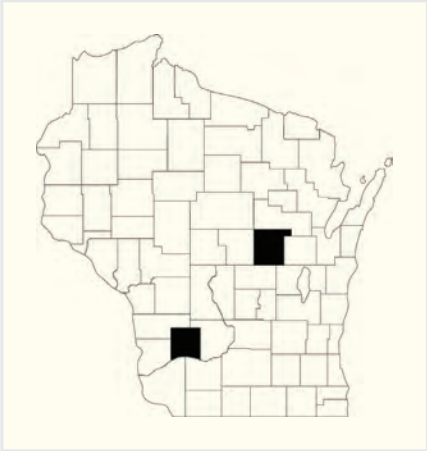


Figure 329. Wisconsin records of *Tricorythodes allectus.*

Tricorythodes explicatus (Eaton), 1892 (Fig. 330)

Taxonomic History: *Tricorythodes explicatus* (Eaton), 1892 (curr. comb., Ulmer 1920); *Tricorythodes fallacina* McDunnough, 1939 (syn.); *Tricorythodes fallax* Traver, 1935 (syn.); *Tricorythodes minutus* Traver, 1935 (syn.); *Tricorythus explicatus* Eaton, 1892 (orig.).

Larval Descriptions: Kilgore and Allen (1973), as *Tricorythodes minutus*; Allen and Murvosh (1987); Baumgardner (2009).

Determination: Identification of *T. explicatus* larvae is **Very Difficult**. Species determination can best be made with adult specimens. Based on the original descriptions, larvae should have two-segmented palpi and basally pale operculate gills (Allen 1977a; Allen and Murvosh 1987).

Previous Wisconsin Records (all as *T. minutus*): Lillie and Hilsenhoff (1992); Lillie (1995).

Biological Information: Larvae of *T. explicatus* occur in rivers and streams with substrates of fine sediment and gravel and relatively unpolluted water (Hubbard and Peters 1978; Burian and Gibbs 1991). They usually are associated with thick layers of organic matter along stream margins, becoming covered in detritus (Burian and Gibbs 1991).

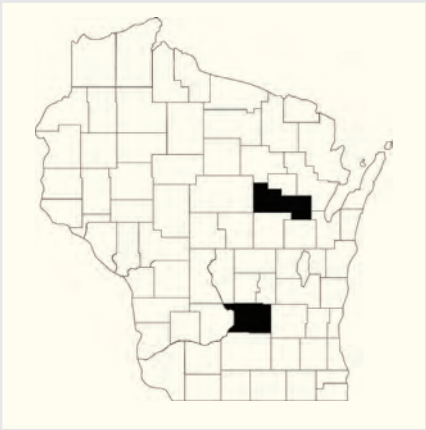


Figure 330. Wisconsin records of *Tricorythodes explicatus.*

Tricorythodes robacki (Allen), 1967 (Figs. 331 and 332)

Taxonomic History: *Leptohyphes robacki* Allen, 1967 (orig.); *Tricorythodes robacki* (Allen), 1967 (curr. comb., Baumgardner 2008).

Larval Descriptions: Allen (1967, 1978).

Determination: Identification of *T. robacki* larvae is **Difficult**. Of the species of *Tricorythodes* known from Wisconsin, *T. robacki* is most unusual. It is the only species in the genus from Wisconsin with one-segmented maxillary palpi. The femora have long, bifurcated spines. It also has smaller, more rounded operculate gills than other members of the genus in Wisconsin (Allen 1967, 1978).

Previous Wisconsin Records: McCafferty (2011). The only Wisconsin record is the larva from the Purdue Entomological Research Collection shown in Figure 331.

Figure 331. *Tricorythodes robacki,* larva.

Figure 332. Wisconsin records of *Tricorythodes robacki.*

Tricorythodes stygiatus McDunnough, 1931 (Fig. 333)

Larval Descriptions: Leonard and Leonard (1962).

Determination: Identification of *T. stygiatus* larvae is **Problematic**. Identifications of larvae should be made only by comparison with verified, reared specimens.

Previous Wisconsin Records: McCafferty (2011).

Biological Information: Larvae of *T. stygiatus* occur in slow-moving water at the edges of large streams where silt accumulates (Burks 1953; Leonard and Leonard 1962).

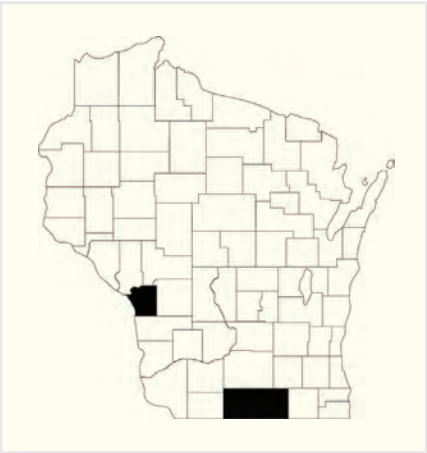


Figure 333. Wisconsin records of *Tricorythodes stygiatus.*

17 LEPTOPHLEBIIDAE

The diverse Family Leptophlebiidae includes four genera and nine species known from Wisconsin. It has much greater species diversity to the south of Wisconsin, through Central America (Anonymous 2014a). Larvae of all of the Wisconsin species have gills that easily separate from the body during handling, making species and even genus determination challenging. These species tend towards sluggish water rather than rapids and riffles.

Key to the Genera of Leptophlebiidae

1. Gill I a single, very long, slender lamella (Fig. 334a); gills II–VII bilamellate and with each lamella terminating in three pointed lobes (Fig. 334b) . . . . . ***Choroterpes basalis***

Gill I a symmetrically forked filament or bilamellate; gills II–VII variable. **2**

2. Gill I much narrower (Fig. 334c) than those on subsequent segments (Fig. 334d) . . . . . ***Leptophlebia***

Gill I similar in width and structure to those on subsequent segments **3**

3. Labrum with moderately deep U-shaped anterior notch (Fig. 334f); gills with conspicuous lateral tracheal branches (Fig. 334g); terga VI–X or VII–X only with small row of spinules along posterior margins . . . . . ***Habrophlebiodes americana***

Labrum with shallow anterior notch (Fig. 334h); gills with variable tracheation (Figs. 334e; 343a–b, e); each tergum with a row of small spinules along posterior margin. . . . . ***Paraleptophlebia***

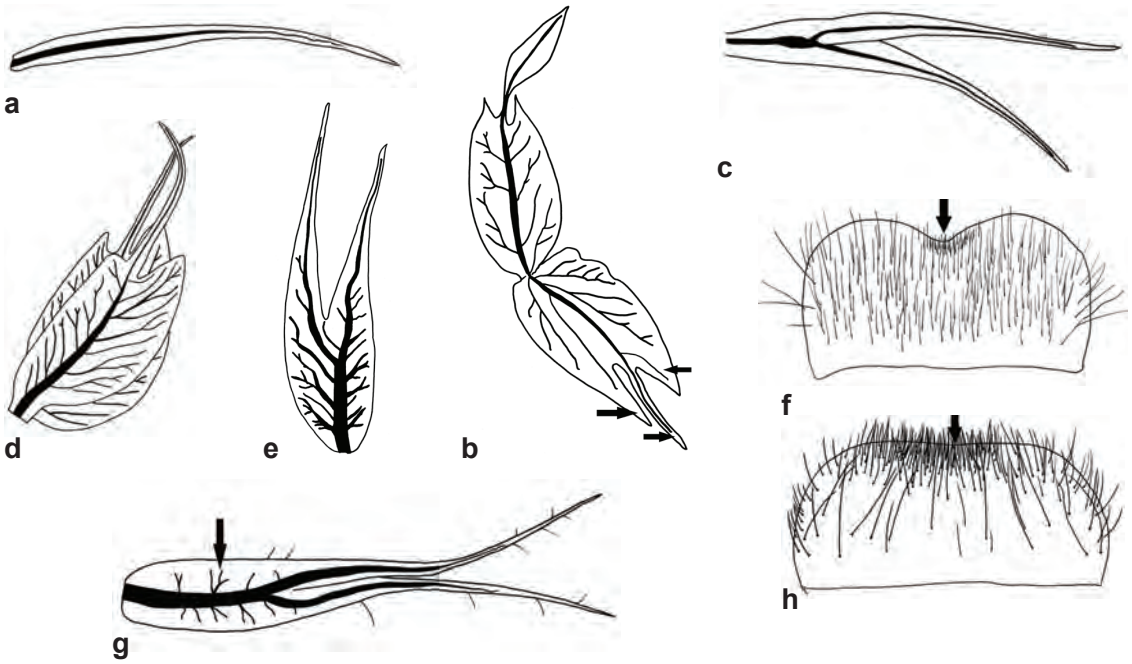


Figure 334. Leptophlebiidae. **a,** *Choroterpes basalis,* gill I; **b,** *C. basalis,* gill III; **c,** *Leptophlebia* sp., gill I; **d,** *Leptophlebia* sp., gill II; **e,** *Paraleptophlebia adoptiva,* gill V; **f,** *Habrophlebiodes americana,* labrum (dorsal); **g,** *H. americana,* gill VI; **h,** *P. adoptiva,* labrum (dorsal).

Choroterpes

Comments: There are five species of *Choroterpes* currently recognized from North America (Anonymous 2014a). The genus is widely distributed globally (Kluge 2014).

Determination: Identification of *Choroterpes* larvae in Wisconsin is **Fairly Easy**.

Choroterpes basalis (Banks), 1900 (Figs. 335 and 336)

Taxonomic History: *Choroterpes basalis* (Banks), 1900 (curr. comb., Needham 1905); *Choroterpes ferruginea* Traver, 1934 (syn.); *Choroterpes fusca* Spieth, 1938 (syn.); *Choroterpes hubbelli* Berner, 1946 (syn.); *Leptophlebia basalis* Banks, 1900 (orig.).

Larval Description: McCafferty (1992), as *C. fusca*; Burian (1995).

Larval Habitus: Needham (1905); Burian (1995).

Determination: Identification of *C. basalis* larvae is **Fairly Easy**. They have gills that are most similar to those on species of *Leptophlebia*. Larvae missing all gills are difficult to separate from several other members of the family without reference specimens.

Previous Wisconsin Records: Jacobs (1990); Randolph and McCafferty (1998).

New County Records: BAYFIELD: 1L, Star Lk., VII-18-1979, D. Volk (UWO); **MARINETTE:** 2L, Menominee R., Faithorn, T36NR22E S6, VI-30-1998 (WiDNR); 1L, Menominee R., Jones Landing, T37NR22E S8, 1.5 mi. NW. of Faithorn, VI-29-1998 (WiDNR); **RUSK:** 1L, N. Fork Chippewa R., Bruce, T34NR7W S5, Summer 1998 (WiDNR); **VILAS:** 1L, Big Muskellunge Lk., VIII-27-1985, W. B. Hilsenhoff (UW); **WASHBURN:** 1L, Namekagon R., St. Rd. K, T40NR12W S18, VI-24-1998, R. A. Lillie (WiDNR).

Biological Information: *Choroterpes basalis* occurs in cool, well-oxygenated habitats (McCafferty and Provonsha 1978; Burian 1995; Randolph and McCafferty 1998) with variable rates of current (Ferro and Sites 2007). It also is known from lakes (Hubbard and Peters 1978; Burian 1995).

Figure 335. *Choroterpes basalis,* larva.

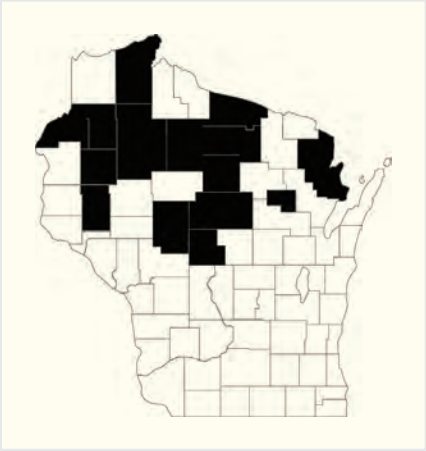


Figure 336. Wisconsin records of *Choroterpes basalis.*

Habrophlebiodes

Comments: In North America, there currently are four recognized species of *Habrophlebiodes*. In the southeastern United States, all four of these species occur. In Wisconsin, only one species of *Habrophlebiodes* is known. The genus also occurs in the Oriental region (Kluge 2014).

Determination: Identification of *Habrophlebiodes* larvae in Wisconsin is **Fairly Easy**.

Habrophlebiodes americana (Banks), 1903 (Figs. 337 and 338)

Taxonomic History: *Choroterpes betteni* Needham, 1908 (syn.); *Habrophlebia americana* Banks, 1903 (orig.); *Habrophlebiodes americana* (Banks), 1903 (curr. comb., Ulmer 1920); *Habrophlebiodes betteni* (Needham), 1908 (syn. comb.); *Leptophlebia betteni* (Needham), 1908 (syn. comb.).

Larval Description: Berry (1903), as *Habrophlebia americana*; Traver (1932b); Burks (1953).

Larval Habitus: Berry (1903), as *Habrophlebia americana*.

Determination: Identification of *Habrophlebiodes americana* larvae is **Fairly Easy**. For middle to late instars, the labral notch is deep (Fig. 334f) and clearly visible with a good dissecting microscope. Less mature larvae have a less developed labral notch and often are misidentified as *Paraleptophlebia*. Larvae have distinctive gills (Fig. 334g), but many specimens lose all of these during handling.

Previous Wisconsin Records: Jacobs (1990).

Status: Because of its rarity in Wisconsin collections, *H. americana* may be a good candidate for conservation measures. Intensive sampling in the appropriate habitats is needed, however, to accurately determine its status.

Biological Information: *Habrophlebiodes americana* occurs in small- to medium-sized streams with variable rates of current (Edmunds et al. 1976; Burian and Gibbs 1991). Larvae are usually associated with quiet eddies close to shore where leaves and other organic matter accumulate, or among submerged roots of vegetation (Burks 1953; Edmunds et al. 1976; Burian and Gibbs 1991).

Figure 337. *Habrophlebiodes americana,* larva.

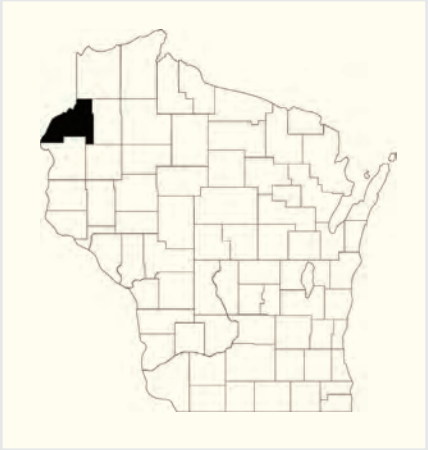


Figure 338. Wisconsin records of *Habrophlebiodes americana.*

Leptophlebia

Comments: There are seven species of *Leptophlebia* in North America, with two known from Wisconsin. They are large larvae when fully mature, with distinctive gills and tergal markings. They are shredders in slow-flowing waters, such as the backwaters of streams where decaying leaves accumulate (Burian 2001).

Determination: Identification of *Leptophlebia* larvae is **Fairly Easy** for the genus but **Moderately to Very Difficult** for species within the genus.

Larval Keys: Traver (1932b); Burks (1953); Burian (2001).

Key to the Species of *Leptophlebia*

1. Profemur with large palmate setae dominant along anterior surface of ventral edge; all leg segments distinctly banded; third segment of each labial palpus never with only four setae on dorsal surface and never as shown in Fig. 339a; not known from Wisconsin . . . . . ***L. intermedia***

Profemur with a balanced combination of setal types along anterior surface of ventral edge, including various uniserrate and biserrate setae (Fig. 339e–f); femora unbanded, faintly, or moderately banded; third segment of each labial palpus with four to seven setae on dorsal surface as shown in Fig. 339a, d **2**

2. Third segment of **each** labial palpus with no more than four setae on dorsal surface as shown at and between the arrows in Fig. 339a; palpifer with peg-like setae on anterior third to half of dorsal surface usually arranged in regular rows (Fig. 339b); legs unbanded, or with faint bands on tibiae and tarsi only . . . . . ***L. nebulosa***

Third segment of **either** labial palpus with five or more setae on dorsal surface as shown at and between the arrows in Fig. 339d; palpifer with peg-like setae on dorsal surface not usually arranged in rows (Fig. 339c); legs often with faint bands on all segments, or with tibiae and tarsi with bands darker than those on femora **3**

3. Third segment of **each** labial palpus with six or more setae on dorsal surface as shown in Fig. 339d . . . . . ***L. cupida***

Third segment of **either** labial palpus with five or fewer setae on dorsal surface. . . . . Reared adults required for separation of these forms of *L. cupida* and *L. nebulosa*.

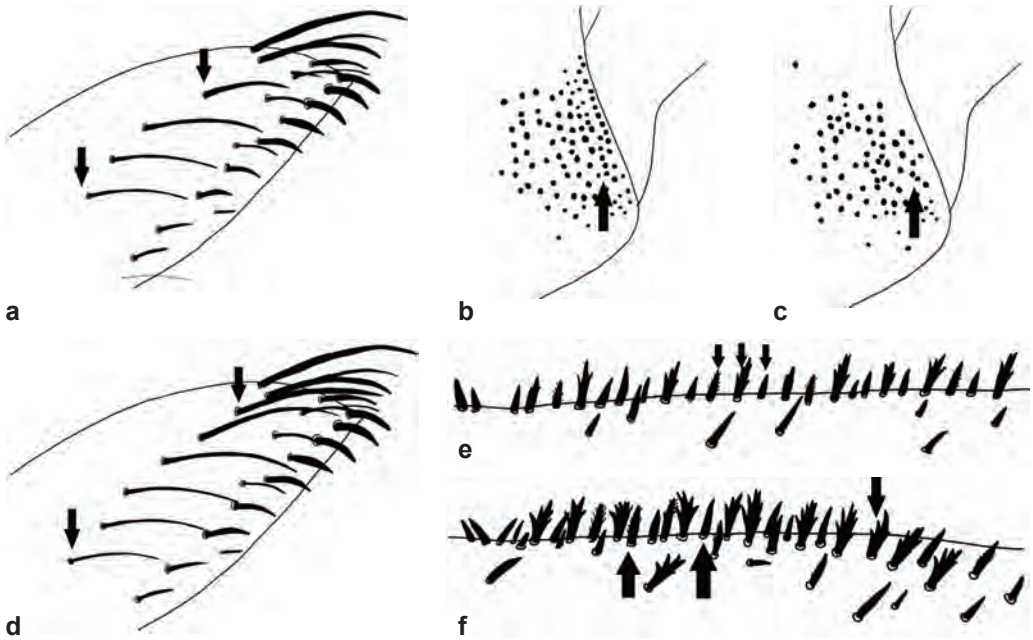


Figure 339. *Leptophlebia* (Leptophlebiidae). **a,** *L. nebulosa,* labial palpus (dorsal); **b,** *L. nebulosa,* palpifer of maxilla; **c,** *L. cupida,* palpifer of maxilla; **d,** *L. cupida,* tip of labial palpus (dorsal); **e–f,** *L. cupida,* front femur, variation in ratio of setal types along dorsal edge.

Leptophlebia cupida (Say), 1823 (Figs. 340 and 341)

Taxonomic History: *Baetis ignava* Hagen, 1861 (syn.); *Blasturus austrinus* Traver, 1932 (syn.); *Blasturus collinus* Traver, 1932 (syn.); *Blasturus concinnus* (Walker), 1853 (syn.); *Blasturus cupidus* (Say), 1823 (comb.); *Blasturus gravastellus* Eaton, 1884 (syn.); *Cloe quebecensis* Provancher, 1876 (syn.); *Ephemera cupida* Say, 1823 (orig.); *Ephemera hebes* Walker, 1853 (syn.); *Ephemerella quebecensis* (Provancher), 1876 (syn.); *Heptagenia quebecensis* (Provancher), 1876 (syn.); *Leptophlebia austrina* (Traver), 1932 (syn.); *Leptophlebia collina* (Traver), 1932 (syn.); *Leptophlebia concinna* (Walker), 1853 (syn.); *Leptophlebia cupida* (Say), 1823 (curr. comb., Eaton 1871); *Leptophlebia gravastella* (Eaton), 1884 (syn.); *Leptophlebia hebes* (Walker), 1853 (syn.); *Leptophlebia ignava* (Hagen), 1861 (syn.); *Leptophlebia pallipes* (Walker), 1853 (syn.); *Palingenia concinna* Walker, 1853 (syn.); *Palingenia pallipes* Walker, 1853 (syn.); *Potamanthus concinnus* (Walker), 1853 (syn.); *Potamanthus cupidus* (Say), 1823 (comb.).

Larval Descriptions: Berry (1903); Traver (1932b), as *Blasturus austrinus;* Leonard and Leonard (1962); Burian (2001).

Larval Habitus: Morgan (1913); Traver (1935), as *Blasturus cupidus*; Burian (2001).

Determination: Identification of *L. cupida* larvae is **Difficult**. They often are inseparable from *L. nebulosa*, even when the labium is slide-mounted. Adult males and females, however, are easily separated based upon wing coloration and features of the egg chorion, respectively (Burks 1953; Burian 2001).

Previous Wisconsin Records: Jacobs (1990); Hilsenhoff (1996); Randolph and McCafferty (1998); Burian (2001).

New County Records: ASHLAND: 2L in two vials, Lk. Owen Outflow, V-11-1985, THK (THK); **BAYFIELD:** 2L in two vials, head of Namekagon R., Forest Rd. 211, IV-20-1986, THK (THK); **FLORENCE:** 17M in three vials, Pine R., V-28-1969, V-3-1970 (emerged V-24-1970), and V-28-1970 (UW); **FOREST:** 1M, Pine R., V-28-1969 (UW); **IRON:** 2L, unnamed crk., Casey Sag Rd., site "Badri 2453", 46.36095°N 90.465515°W, Summer 2012, K. L. Schmude (UWS); **LANGLADE:** 8L, Wolf R., V-24-1997, R. McKee (UWO); **LINCOLN:** 4L, Prairie R., R and H Town Line Rd., 0.5 mi. E. of St. Rd. 17, Russel Twp., Sec. 2, IV-12-2002, THK (THK); **MARATHON:** 61L in three vials, Big Eau Pleine R., Big Rapids Co. Pk., IV-9-2011, THK (THK); **MARINETTE:** 1L, Little Peshtigo R., Co. Rd. W, 8.8 mi. SE. of Crivitz, 45°7'15"N 87°53'33"W, X-22-2011, THK (THK); 1L, Menominee R., Jones, 1.5 mi. NW. of Faithorn, T37NR22E S8, VI-24-1997 (WiDNR); **ONEIDA:** 8L, Jennie Webber Crk., Cross Country Rd., site "Wiscn 1669", 45.703985°N 89.286199°W, Summer 2012, K. L. Schmude (UWS); **POLK:** 4L in two vials, St. Croix R., Nevers Landing, near Wolf Creek, Summer 1996 (WiDNR).

Biological Information: Larvae of *L. cupida* are most commonly encountered in shallow pools and streams created during early spring flooding and snow melt, as well as among clumps of leaves and other organic detritus that accumulate along margins of slow-flowing streams, lakes, ponds, and wetlands (Traver 1925; Burks 1953; Leonard and Leonard 1962; Edmunds et al. 1976; Burian and Gibbs 1991; Burian 2001).

Figure 340. *Leptophlebia cupida,* larva.

Figure 341. Wisconsin records of *Leptophlebia cupida.*

Leptophlebia intermedia (Traver), 1932

Taxonomic History: *Blasturus grandis* Traver, 1932 (syn.); *Blasturus intermedius* Traver, 1932 (orig.); *Leptophlebia grandis* (Traver), 1932 (syn.); *Leptophlebia intermedia* (Traver), 1932 (curr. comb., Ide 1935a).

Larval Description: Traver (1932b), as *Blasturus grandis* and *B. intermedius*.

Larval Habitus: Edmunds et al. (1976); Berner and Pescador (1988); Burian (2001).

Determination: Identification of *L. intermedia* larvae is **Difficult**. Preparation of slide mounts of legs is required for identification. Profemora in larvae of *L. nebulosa* and *L. cupida* have variable numbers of palmate setae (Fig. 339e–f), occasionally being suggestive of *L. intermedia*.

Previous Wisconsin Records: None. Nearest records of *L. intermedia* are from central Illinois (Burian 2001) and Iowa (McCafferty et al. 2007). It is possible in Wisconsin, given the proximity of these records, and easily could have escaped detection.

Biological Information: *Leptophlebia intermedia* is limited to slow streams and creeks, where leaves and debris accumulate in quiet areas along shore (Berner and Pescador 1988).

Leptophlebia nebulosa (Walker), 1853 (Fig. 342)

Taxonomic History: *Blasturus nebulosus* (Walker), 1853 (comb.); *Leptophlebia nebulosa* (Walker), 1853 (curr. comb., Eaton 1871); *Palingenia nebulosa* Walker, 1853 (orig.); *Potamanthus nebulosus* (Walker), 1853 (comb.); *Potamanthus odonatus* Walsh, 1862 (syn.).

Larval Descriptions: Clemens (1913, 1915c), as *Blasturus nebulosus;* Leonard and Leonard (1962); Burian (2001).

Larval Habitus: Leonard and Leonard (1962); Burian (2001).

Determination: Identification of *L. nebulosa* larvae is **Difficult**. They often are inseparable from larvae of *L. cupida*. Adults of these two species easily are separated based upon wing coloration and structure of the egg chorion (Burks 1953; Burian 2001).

Previous Wisconsin Records: Hilsenhoff (1996); Burian (2001).

New County Records: BAYFIELD: 4M and 1F, 18-Mile Crk., VI-4-1973 (UW); **BURNETT:** 1M, Spirit Lk. Inlet, coll. IV-4-1970, emerged V-18-1970 (UW); **DOUGLAS:** 1M and 2F, St. Croix R., VI-5-1973 (UW); **FLORENCE:** 1M, Pine R., V-28-1969 (UW); 2M, Popple R., V-28-1969 (UW); **FOREST:** 10A, Pine R., V-28-1969 (UW); **LINCOLN:** 1M, Averill Crk., VI-5-1970 (UW); Big Somo R., coll. IV-19-1970, emerged V-25-1970 (UW); **WINNEBAGO:** 2M, Oshkosh, V-26-1973, R. Brey (UWO); 1M, Oshkosh, V-30-1977, G. Dubester (UWO).

Biological Information: Larvae of *L. nebulosa* occur in streams and ponds, though generally in smaller streams and cooler water compared to *L. cupida* (Burian and Gibbs 1991; Burian 2001). In streams, larvae are associated with still eddies along the bank, in even less current than *L. cupida* (Leonard and Leonard 1962). In ponds and lakes, they most commonly occur along the shoreline (Burks 1953).

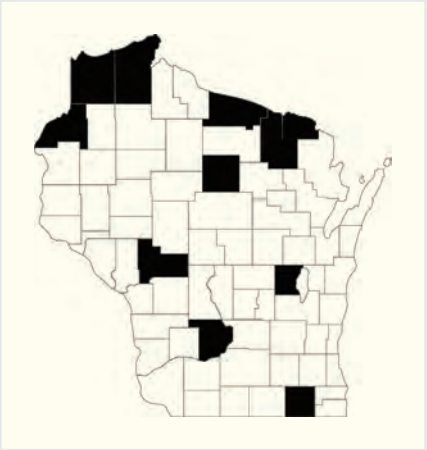


Figure 342. Wisconsin records of *Leptophlebia nebulosa.*

Paraleptophlebia

Comments: A diverse and widely distributed genus, there are 39 species of *Paraleptophlebia* recognized from North America. Currently, only seven are known or suspected from Wisconsin, making identification considerably easier.

Determination: Identification of *Paraleptophlebia* larvae is **Fairly Easy** for the genus and **Slightly Difficult to Difficult** for species within the genus. Middle to late instars are recommended for species identifications as gill measurements from more immature specimens are unreliable. Many specimens of *Paraleptophlebia* cannot be reliably identified because of the loss of gills on abdominal segments III–V. In the field, larvae of leptophlebiids in general should be preserved individually or in small groups to separate them from larger aquatic insects. This practice minimizes the number of frustrating "gill-less" specimens.

Larval Keys: Ide (1930a), as *Leptophlebia*; Traver (1935); Burks (1953).

Key to the Species of *Paraleptophlebia* (mature larvae)

1. Gills III–V divide into branches at least one-third distance from base of gill, tracheae with numerous small, lateral branches (Fig. 343a); abdominal segment VIII without distinct posterolateral spines **2**

Gills III–V divide into branches at less than one-quarter distance from base of gill, tracheae of gills with few, minute lateral branches (Fig. 343b); abdominal segment VIII with or without posterolateral spines **3**

2. Each gill III–V forked at about one-third of its length (Fig. 343a); left mandible in dorsal view strongly incurved, with line along distomedial edge of mandible passing well proximal of cleft between incisors; specimen series of mature larvae or adults recommended . . . . . ***P. mollis***

Each gill III–V forked at about one-half of its length (Fig. 334e); left mandible in dorsal view gradually incurved, with line along distomedial edge of mandible passing near or just proximal of cleft between incisors; specimen series of mature larvae or adults recommended . . . . . ***P. adoptiva***

3. Abdominal sterna forming a pair of longitudinal, sublateral brown bands (Fig. 343c); abdominal segment VIII with posterolateral spines . . . . . ***P. praepedita***

Abdominal sterna unmarked or forming narrow, irregular, brown bands near lateral borders; abdominal segment VIII with or without posterolateral spines **4**

4. Tergum VIII lacking posterolateral spines . . . . . ***P. guttata***

Terga VIII and IX both with posterolateral spines (Fig. 343d) **5**

5. Gills III–V with long, sparse marginal hairs (Fig. 343e); not known from Wisconsin. . . . . ***P. volitans***

Gills with only scattered, short marginal hairs. **6**

6. Each tibia with brown bands at middle and at base . . . . . ***P. debilis***

Each tibia with brown shading at base only . . . . . ***P. ontario***

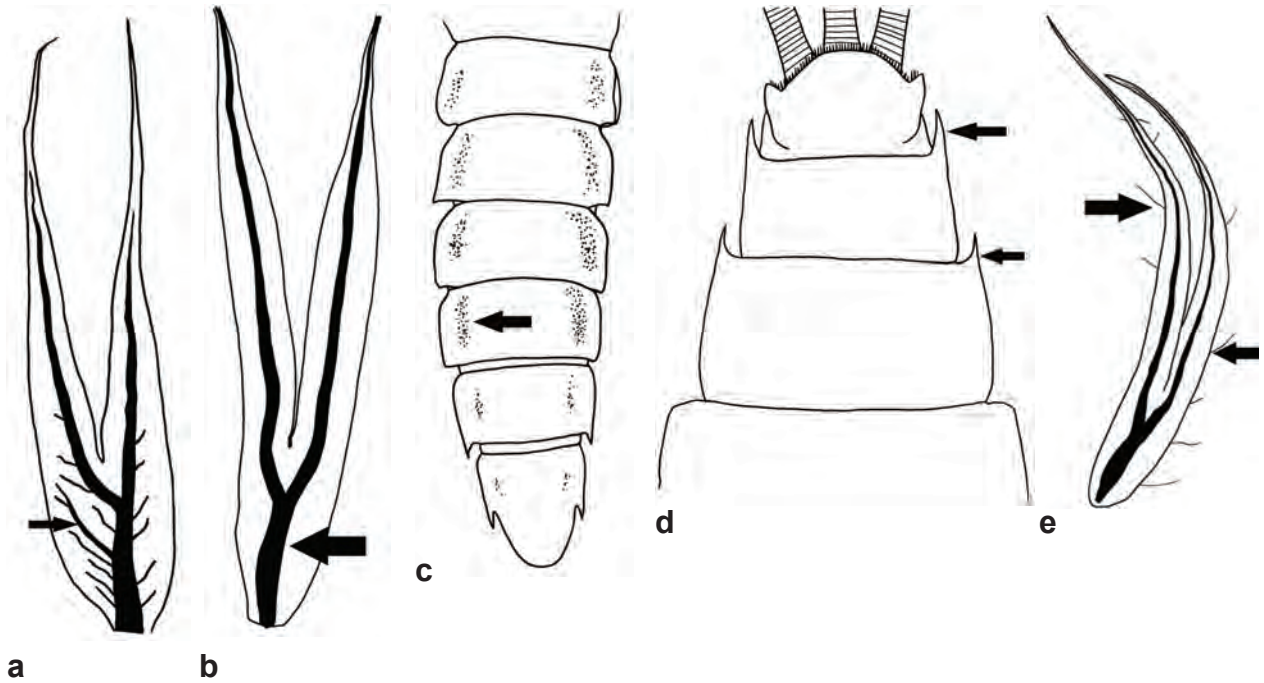


Figure 343. *Paraleptophlebia* (Leptophlebiidae). **a,** *P. mollis,* gill V; **b,** *P. praepedita,* gill IV; **c,** *P. praepedita,* sterna III–IX; **d,** *Paraleptophlebia nr. debilis,* terga VII–X; **e,** *P. volitans,* gill IV.

Paraleptophlebia adoptiva (McDunnough), 1929 (Figs. 344 and 345)

Taxonomic History: *Leptophlebia adoptiva* McDunnough, 1929 (orig.); *Paraleptophlebia adoptiva* (McDunnough), 1929 (curr. comb., Traver 1935).

Larval Description: Leonard and Leonard (1962).

Larval Habitus: Leonard and Leonard (1962).

Determination: Identification of *P. adoptiva* larvae is **Difficult**. They can be easily confused with larvae of *P. mollis*. Inspecting gills other than those on abdominal segments III–V, or using immature larvae, may lead to misidentifications. Examination of both gills and the left mandible is recommended for accuracy. This species emerges earlier in the spring than *P. mollis* (Burian and Gibbs 1991), with Wisconsin adults of *P. adoptiva* I have examined being taken from late April to late May. Adults of *P. mollis* occur from May to August (Burian and Gibbs 1991).

Previous Wisconsin Records: None. The first Wisconsin records of *P. adoptiva* are given below, though the species was expected in the state. Because of the difficulty of identification, only adult records are given as new state records. The species is known from a large number of counties in Michigan, including in the Upper Peninsula (Leonard and Leonard 1962), as well as from northwestern Indiana (Randolph and McCafferty 1998).

New Wisconsin Records: FLORENCE: 3M in two vials, Pine R., V-25-1968 and V-29-1969 (UW); **IRON:** 14M, Flood Crk., coll. IV-10-1970, emerged V-13-1970 (UW); **SAUK:** 3M, Otter Crk., coll. IV-2-1980, emer. V-5-1980 (UW).

Status: The most recent of the specimens listed above were collected in 1980. Sampling for this species is recommended to assess its current status. Tentative larval records also exist for Bayfield, Douglas, Price, and Rusk Counties.

Biological Information: Larvae of *P. adoptiva* are associated with loose gravel and rubble substrates of streams with swift current (Burian and Gibbs 1991). They usually occur in water less than 2 feet deep (Leonard and Leonard 1962).

Figure 344. *Paraleptophlebia adoptiva,* larva.

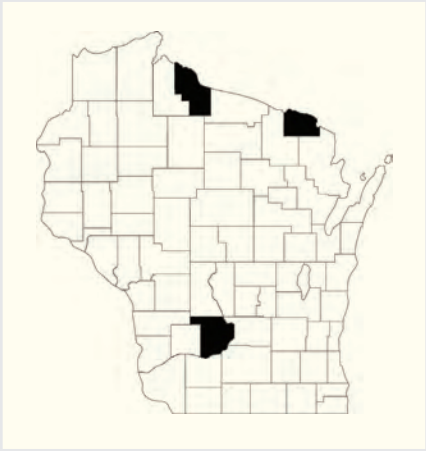


Figure 345. Wisconsin records of *Paraleptophlebia adoptiva.*

Paraleptophlebia debilis (Walker), 1853 (Figs. 346 and 347)

Taxonomic History: *Baetis debilis* Walker, 1853 (orig.); *Leptophlebia debilis* (Walker), 1853 (comb.); *Leptophlebia mollis* (Hagen), 1861 (id.); *Leptophlebia separata* Ulmer, 1920 (invalid renam.); *Paraleptophlebia debilis* (Walker), 1853 (curr. comb., Traver 1935).

Larval Descriptions: Ide (1935b), as *Leptophlebia debilis*; Leonard and Leonard (1962).

Determination: Identification of *P. debilis* larvae is **Slightly Difficult**. Faded or young specimens may not be separable from *P. ontario.*

Previous Wisconsin Records: Hilsenhoff et al. (1972); Randolph and McCafferty (1998).

Biological Information: *Paraleptophlebia debilis* larvae occur in shallow riffles of streams with swift current, where they occupy spaces in the upper 10 cm of loose gravel substrate (Leonard and Leonard 1962; Burian and Gibbs 1991). Adult emergence in Maine occurs from July to October (Burian and Gibbs 1991), and I have records of blackwing larvae and adults from Wisconsin from 15 July to 14 September.

Figure 346. *Paraleptophlebia debilis,* larva.

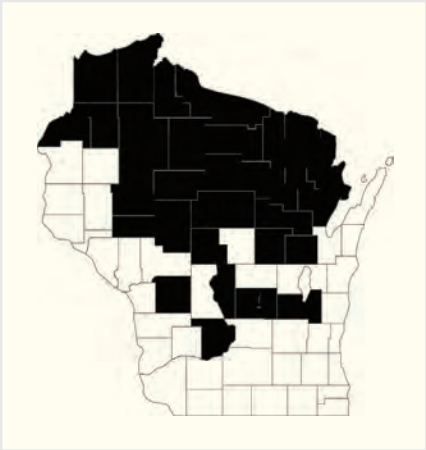


Figure 347. Wisconsin records of *Paraleptophlebia debilis.*

Paraleptophlebia guttata (McDunnough), 1924 (Fig. 348)

Taxonomic History: *Leptophlebia guttata* McDunnough, 1924 (orig.); *Paraleptophlebia guttata* (McDunnough), 1924 (curr. comb., Traver 1935).

Larval Description: Ide (1930a), as *Leptophlebia guttata*.

Determination: Identification of *P. guttata* larvae is **Slightly Difficult**. Young larvae may not be reliably separated from other members of the genus.

Previous Wisconsin Records: Randolph and McCafferty (1998).

Status: Verifiable specimens of *P. guttata* have not been collected from Wisconsin since the original 1967 Popple River specimens used by Randolph and McCafferty (1998). The location of these specimens is unknown. There are similar, but unidentifiable, specimens from the Popple River in the UW collection from 1968. Given the apparent rarity of this species in Wisconsin, sampling is needed to determine if this species remains in the state and if conservation measures are necessary.

Biological Information: Burian and Gibbs (1991) described the habitat *P. guttata* as erosional zones of swift, first- to third-order streams and substrates composed of loose gravel, rubble, and coarse organic matter.

Figure 348. Wisconsin records of *Paraleptophlebia guttata.*

Paraleptophlebia mollis (Eaton), 1871 (Figs. 349 and 350)

Taxonomic History: *Cloe mollis* Hagen, 1861 (nom. nud.); *Leptophlebia mollis* Eaton, 1871 (orig.); *Leptophlebia mollis* Hagen, 1861 (nom. nud.); *Paraleptophlebia mollis* (Eaton), 1871 (curr. comb., Traver 1935).

Larval Descriptions: Ide (1930a), as *Leptophlebia mollis*; Leonard and Leonard (1962).

Determination: Identification of *P. mollis* larvae is **Difficult**. They easily are confused with larvae of *P. adoptiva.* Inspecting gills other than those on abdominal segments III–V, or using immature larvae, may lead to misidentifications. The curvature of the mandibles becomes increasingly pronounced with age, making younger larvae easily misidentified as *P. adoptiva*.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); DuBois (1993); Hilsenhoff (1996); Randolph and McCafferty (1998). Because of the difficulty of identification, only adult records are given below as new county records.

New County Records: BAYFIELD: 1M, backyard (?) lk., VI-7-1972 (UW); **POLK:** 1M, Knapp Crk., coll. V-31-1972, emerged VI-11-1972 (UW).

Status: Tentative and possibly new larval records exist for Adams, Ashland, Barron, Burnett, Chippewa, Menominee, Oconto, Rusk, Sawyer, Shawano, Taylor, Washburn, and Wood Counties. Due to the difficulty of identifying larvae, these are not formally listed as new county records at this time.

Biological Information: Larvae of *P. mollis* are known from swift, shallow streams, though they typically are not as common in first-order streams. They occupy loose, upper layers of gravel, rubble, and coarse organic matter. *Paraleptophlebia mollis* is more tolerant of warm water than other species in the genus (Burian and Gibbs 1991). Adults of *P. mollis* occur in summer, from May to August, while *P. adoptiva* emerge from late April to late May in Maine (Burian and Gibbs 1991).

Figure 349. *Paraleptophlebia mollis,* larva.

Figure 350. Wisconsin records of *Paraleptophlebia mollis.*

Paraleptophlebia ontario (McDunnough), 1926 (Fig. 351)

Taxonomic History: *Leptophlebia ontario* McDunnough, 1926 (orig.); *Paraleptophlebia ontario* (McDunnough), 1926 (curr. comb., Traver 1935).

Larval Description: Burks (1953).

Determination: Identification of *P. ontario* larvae is **Slightly Difficult**. Faded or young specimens may not be separable from *P. praepedita* and *P. debilis*.

Previous Wisconsin Records: None, with the first state record of *P. ontario* reported below. The closest previously published records were from northeastern Illinois (Burks 1953).

New State Record: BURNETT: 1L, St. Croix R., St. Rd. 70, wood substrate, VIII-29-1985, K. L. Schmude, vial 011011A (UW).

Biological Information: Little has been published regarding the biology of *P. ontario*. The new Wisconsin state record given above was taken from a sixth-order segment of the St. Croix River.

Figure 351. Wisconsin records of *Paraleptophlebia ontario.*

Paraleptophlebia praepedita (Eaton), 1884 (Fig. 352)

Taxonomic History: *Leptophlebia praepedita* Eaton, 1884 (orig.); *Paraleptophlebia praepedita* (Eaton), 1884 (curr. comb., Traver 1935).

Larval Description: Burks (1953).

Larval Habitus: Burks (1953); Edmunds et al. (1976).

Determination: Identification of *P. praepedita* larvae is **Slightly Difficult**. They have a distinct sternal pattern (Fig. 343c). Extremely faded or young larvae may not be separable from larvae of *P. debilis* and *P. ontario*.

Previous Wisconsin Records: McCafferty (2009).

New County Records: BURNETT: 18M, Wood Crk., VI-19-1968 (UW); **DANE:** 1M (reared, with exuviae), Teal Pond, UW Arboretum, V-24-1965 (UW); **LINCOLN:** 1L, taken from creek, VIII-26-1970 (UW); **MARQUETTE:** 1L, Lawrence Crk., VIII-30-1972 (UW); **POLK:** 7M, Butternut Crk., VI-19-1968 (UW); **RUSK:** 11L (including blackwing), N. Fork Chippewa R., Bruce, T34NR7W S5, VI-23-1998 (WiDNR); **SAUK:** 1M, Otter Crk., coll. June 1980, emer. VII-8-1980 (UW); **TAYLOR:** 2L, Sheep Ranch, VIII-26-1970 (UW); **WAUSHARA:** 6L, Carter Crk., VIII-13-1970 (UW); **WINNEBAGO:** 40A in two vials, High Trestle Pk., 2 mi. S. of Oshkosh, VI-5-1969 and VI-6-1969, G. Drecktrah (UWO); 16S, 3 mi. N. of Oshkosh, V-23-1968, G. Drecktrah (UWO).

Biological Information: Burks (1953) considered *P. praepedita* the most common member of the genus in Illinois. Surprisingly, little is known about the biology and habitat associations of this species.

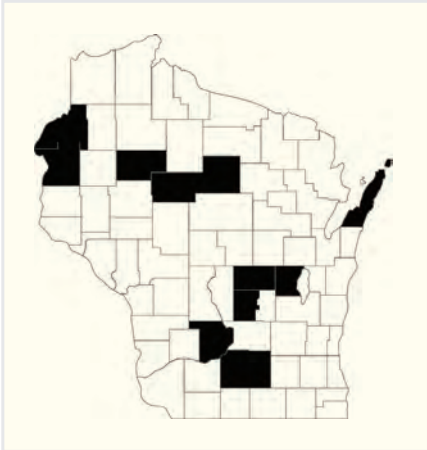


Figure 352. Wisconsin records of *Paraleptophlebia praepedita.*

Paraleptophlebia volitans (McDunnough), 1924 (Fig. 353)

Taxonomic History: *Leptophlebia volitans* McDunnough, 1924 (orig.); *Paraleptophlebia volitans* (McDunnough), 1924 (curr. comb., Traver 1935).

Larval Description and Habitus: Ide (1930a), as *Leptophlebia volitans*.

Determination: Identification of *P. volitans* larvae is **Slightly Difficult** and most reliable with mature larvae.

Previous Wisconsin Records: None. The nearest records of *P. volitans* are from the Upper Peninsula of Michigan (Yanoviak and McCafferty 1996) and northeastern Minnesota (Lager et al. 1982). It is, therefore, expected in northern Wisconsin and likely has escaped detection.

Biological Information: *Paraleptophlebia volitans* larvae are known from a wide range of lotic habitats from slow to strong currents (Hubbard and Peters 1978; Burian and Gibbs 1991; Berner and Pescador 1998). In Florida, Berner and Pescador (1988) found this species in creeks with no more than four feet of water depth. It is relatively tolerant of warm water and prefers substrates with loose gravel or sand and coarse organic matter (Berner and Pescador 1988; Burian and Gibbs 1991).

Figure 353. *Paraleptophlebia volitans,* larva.

18 METRETOPODIDAE

The mayflies belonging to the Holarctic family Metretopodidae include only two genera and nine species in North America (Anonymous 2014a; Kluge 2014). They have minnow-like, cylindrical bodies with bifid protarsal claws and are known from the northern, western, and southwestern counties of Wisconsin.

Key to the Genera of Metretopodidae

1. Protarsal claw with more than thirty marginal spines that are only slightly smaller than the short terminal spines (Fig. 354a); gill IV with two to seven stout spines, in addition to small setae, along outer margin (Fig. 354b); abdominal sterna without a medial, longitudinal stripe . . . . . ***Metretopus borealis***

Protarsal claw with fewer than twenty marginal spines that are more slender than the long terminal spines (Fig. 354c); gill IV without stout spines along outer margin (Fig. 354d); abdominal sterna usually with a continuous or nearly continuous medial, longitudinal stripe (Fig. 354e) . . . . . ***Siphloplecton***

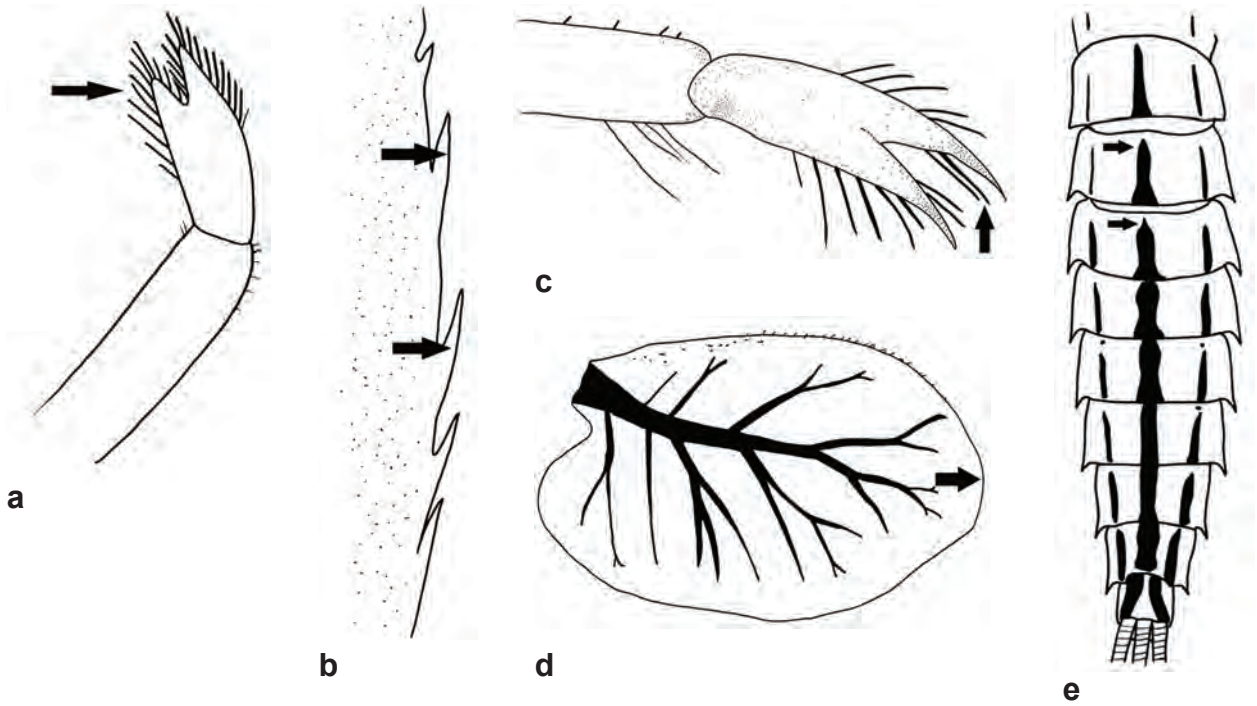


Figure 354. Metretopodidae. **a,** *Metretopus borealis,* front claw; **b,** *M. borealis,* gill IV margin; **c,** *Siphloplecton basale,* front claw; **d,** *S. basale,* gill IV; **e,** *S. interlineatum,* abdominal sterna.

Metretopus

Comments: There are only two species of the circumboreal *Metretopus*. The genus is rare in Wisconsin.

Determination: Identification of *Metretopus* larvae in Wisconsin is **Fairly Easy**.

Metretopus borealis (Eaton), 1871 (Figs. 355 and 356)

Taxonomic History: *Heptagenia borealis* Eaton, 1871 (orig.); *Metretopus borealis* (Eaton), 1871 (curr. comb., Brekke 1938); *Metretopus norvegicus* Eaton, 1901 (syn.); *Rhithrogena borealis* (Eaton), 1871 (comb.).

Larval Description: Burian et al. (1995).

Larval Habitus: Engblom et al. (1993); Burian et al. (1995); Lillie (1995).

Determination: Identification of *M. borealis* larvae is **Fairly Easy**. They are most similar to species of *Siphloplecton*.

Previous Wisconsin Records: Lillie (1992; 1995).

Status: *Metretopus borealis* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). Though other appropriate habitats exist in the northern half of the state, the species is known in the state only from the Black and Chippewa Rivers.

Biological Information: As is suggested by its name, *M. borealis* is a species of northern latitudes in both North America and Europe (Berner 1978; Engblom et al. 1993). Larvae occur in slow-flowing waters of second- to third-order streams where deposition of plant matter occurs among sand and other fine sediment, particularly close to the stream bank (Edmunds et al. 1976; Burian and Gibbs 1991; Engblom et al. 1993; Lillie 1995).

Figure 355. *Metretopus borealis,* larva.

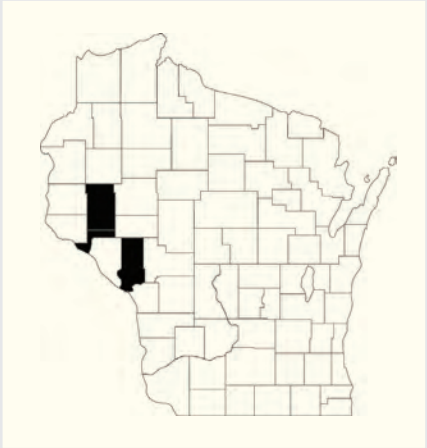


Figure 356. Wisconsin records of *Metretopus borealis.*

Siphloplecton

Comments: There are seven species of *Siphloplecton* known from North America, with the greatest species diversity in the southeastern United States. Only two species of these impressive larvae are known from Wisconsin. The larvae are similar in general appearance to those of *Metretopus*.

Determination: Identification of *Siphloplecton* larvae is **Fairly Easy** for the genus and **Moderately Easy** for species within the genus. The difference in ventral abdominal striping, as was used in older keys, is not a reliable character to separate the two Wisconsin species. Damaged larvae lacking gills on the first three abdominal segments cannot be reliably identified to the species level.

Larval Keys: Traver (1932b); Burks (1953).

Key to the Species of *Siphloplecton*

1. Gills I–III each with a ventral, recurved flap (Fig. 357a). . . . . ***S. basale***

Gills I–III simple, lacking ventral recurved flaps (Fig. 357b) . . . . . ***S. interlineatum***

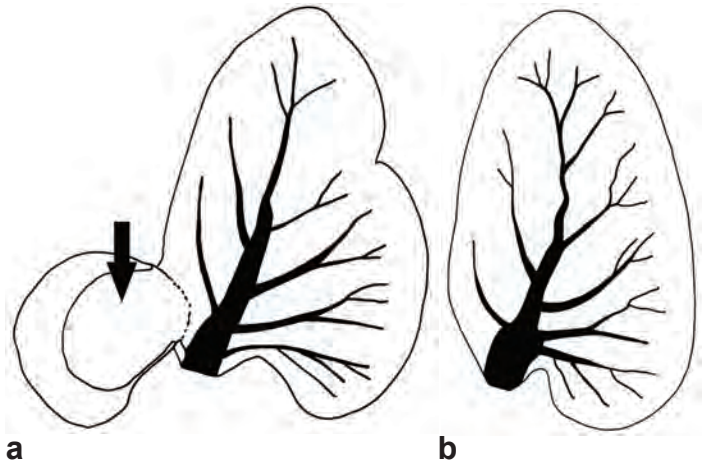


Figure 357. *Siphloplecton* (Metretopodidae). **a,** *S. basale,* gill II; **b,** *S. interlineatum,* gill II.

Siphloplecton basale (Walker), 1853 (Figs. 358 and 359)

Taxonomic History: *Baetis basalis* Walker, 1853 (orig.); *Heptagenia basalis* (Walker), 1853 (comb.); *Siphloplecton basale* (Walker), 1853 (curr. comb., Clemens 1915b); *Siphloplecton basalis* (Walker), 1853 (spell.); *Siphloplecton flexus* (Clemens), 1913 (syn.); *Siphloplecton signatum* Traver, 1932 (syn.); *Siphlurus flexus* Clemens, 1913 (syn.).

Larval Descriptions: Clemens (1913, 1915c), as *Siphlurus flexus*; Traver (1932b), as *Siphloplecton signatum*; Burks (1953); Berner (1978).

Larval Habitus: Leonard and Leonard (1962).

Determination: Identification of *S. basale* larvae is **Moderately Easy**. Taxonomic keys have used a variety of characters to separate *S. basale* and *S. interlineatum*, including claw length and ventral markings (Traver 1935; Burks 1953). These characters are not reliable, whereas the presence of ventral flaps on the anterior gills (Fig. 354d) is diagnostic in Wisconsin for *S. basale* in both mature and young larvae.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Berner (1978); Randolph and McCafferty (1998).

New County Records: BAYFIELD: Namekagon R., IV-20-1986, THK (THK); 1L, Sand R., St. Rd. 13, IX-23-1993 (UW); **IRON:** 1L, Layman Crk., Hwy. 51, IX-23-1993 (UW); **LA CROSSE:** 5L in two vials, Pond 6, IV-29-1983 (UW); **WINNEBAGO:** 1L, Lk. Butte des Morts, W. of 1st bridge, VI-18-1969 (UWO).

Biological Information: Larvae of *S. basale* occur in areas of slow current, particularly along shorelines of lakes and streams with emergent vegetation (Edmunds et al. 1976; Burian and Gibbs 1991; DuBois 1993; Webb et al. 2004). Leonard and Leonard (1962), however, described it as occurring in fairly deep water with strong current.

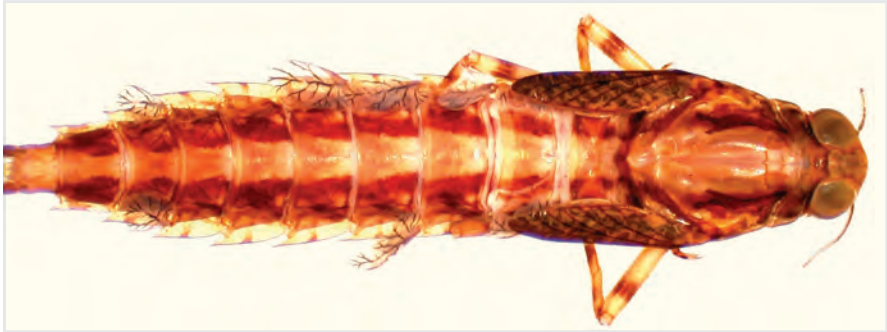


Figure 358. *Siphloplecton basale,* larva.

Figure 359. Wisconsin records of *Siphloplecton basale.*

Siphloplecton interlineatum (Walsh), 1863 (Figs. 360 and 361)

Taxonomic History: *Baetis femorata* Walsh, 1862 (hom.: *B. femorata* Say, 1823); *Baetis interlineata* Walsh, 1863 (renam.); *Siphloplecton interlineatum* (Walsh), 1863 (curr. comb., McDunnough 1924a).

Larval Descriptions: Daggy (1945); Burks (1953).

Larval Habitus: Daggy (1945).

Determination: Identification of *S. interlineatum* larvae is **Moderately Easy**. See comments above for *S. basale*.

Previous Wisconsin Records: Lillie and Hilsenhoff (1992); Randolph and McCafferty (1998).

New County Records: LA CROSSE: 1L, Pond 6, IV-29-1983 (UW); **LINCOLN:** 3L, Prairie R., R and H Town Line Rd., 0.5 mi. E. of St. Rd. 17, Russell Twp., Sec. 2, IV-12-2002, THK (THK).

Biological Information: Larvae of *S. interlineatum* more likely occur in moderate to rapid current than *S. basale* (Burks 1953; Lillie and Hilsenhoff 1992). They are commonly encountered in shallow water.

Figure 360. *Siphloplecton interlineatum,* larva.

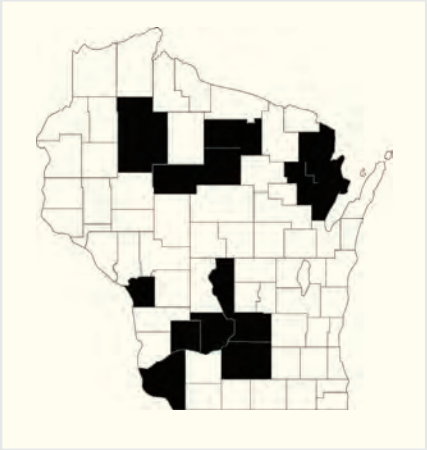


Figure 361. Wisconsin records of *Siphloplecton interlineatum.*

19 NEOEPHEMERIDAE

The Family Neoephemeridae consists of the exclusively North American *Neoephemera* and three Old World genera (Kluge 2014). The family was not known from Wisconsin until Schmude et al. (2012) reported it from Ashland County, making it the most recently discovered family of mayflies in the state.

Neoephemera

Comments: There are four species of *Neoephemera* in North America, with the greatest species diversity in the southeastern United States. The larvae resemble oversized *Caenis*.

Determination: Identification of *Neoephemera* larvae in Wisconsin is **Moderately Easy**, with only one species known from the state. Figure 362 shows the larva of another species, *N. youngi* Berner, which was superior to the larvae of *Neoephemera* available from Wisconsin.

Larval Keys: Berner (1956); Bae and McCafferty (1998).

Figure 362. *Neoephemera youngi,* larva.

Neoephemera bicolor McDunnough, 1925 (Figs. 363 and 364)

Larval Descriptions: Berner (1956); Bae and McCafferty (1998).

Determination: Identification of *N. bicolor* larvae is **Moderately Easy**. They are larger than most species of Caenidae and have large operculate gills in contrast to the Ephemerellidae.

Previous Wisconsin Records: Schmude et al. 2012. The photograph in Figure 363 is of the larval exuviae from reared specimens representing the only records of *Neoephemera* from Wisconsin.

Status: *Neoephemera bicolor* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: *Neoephemera bicolor* occurs in rivers and large streams with slow to moderate current. Larvae occupy clumps of debris, branches, and roots of emergent vegetation where they are protected from the current (Berner 1956; Edmunds et al. 1976). In the White River in Ashland County, one of only two known sites for the species in Wisconsin, larvae were associated with shoreline vegetation (Schmude et al. 2012).

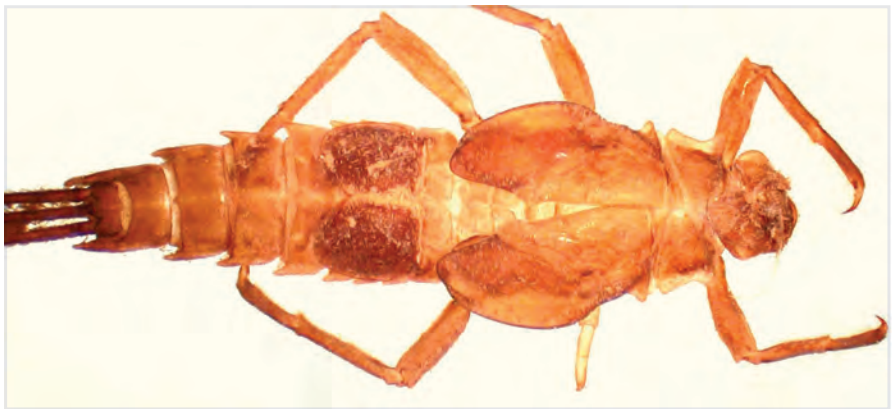


Figure 363. *Neoephemera bicolor,* larval exuviae.

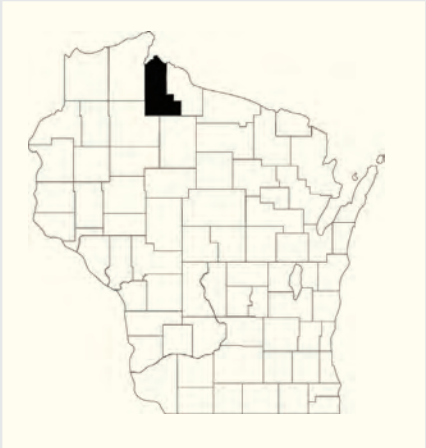


Figure 364. Wisconsin records of *Neoephemera bicolor.*

20 OLIGONEURIIDAE

The Family Oligoneuriidae in North America formerly included species of *Isonychia* but currently is limited to nine recognized species of *Homoeoneuria* and *Lachlania* (Anonymous 2014a). The family is represented by just one species known from Wisconsin.

Homoeoneuria

Comments: There are only five North American species of *Homoeoneuria,* and they are some of the most curious mayflies. They superficially resemble soft-bodied, burrowing mayflies such as *Hexagenia* and *Ephoron*, but lack the elongate mandibular tusks of those taxa and have rows of long setae on prothoracic legs. Only one species, *Homoeoneuria ammophila*, is known from the Upper Midwest. *Homoeoneuria alleni* Pescador and Peters occurs mainly in the Missouri River drainage system and is not expected in Wisconsin (McCafferty et al. 2007).

Larval Key: Pescador and Peters (1980).

Homoeoneuria ammophila (Spieth), 1938 (Figs. 365 and 366)

Taxonomic History: *Homoeoneuria ammophila* (Spieth), 1938 (curr. comb., Edmunds and Allen 1957); *Oligoneuria ammophila* Spieth, 1938 (orig.).

Larval Descriptions: Spieth (1938) and Burks (1953), both as *Oligoneuria ammophila*; Pescador and Peters (1980).

Larval Habitus: Spieth (1938) and Burks (1953), both as *Oligoneuria ammophila*; Lillie (1995).

Determination: Identification of *H. ammophila* larvae is **Moderately Easy**. They are soft-bodied, but lack the elongate mandibular tusks and fossorial legs of most burrowing mayflies, such as larvae of *Hexagenia* and *Ephoron*. The rows of long setae on the prothoracic legs resemble those found on larvae of *Isonychia.* The dark transverse lines on the abdominal terga are distinctive in the field.

Previous Wisconsin Records: Lillie (1992); Randolph and McCafferty (1998).

Status: *Homoeoneuria ammophila* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: *Homoeoneuria ammophila* is a sandy-river specialist that was listed as a species of special concern in Wisconsin by Lillie (1995). Larvae require shifting sand substrates, where they usually remain partially buried (Burks 1953; Edmunds et al. 1976; Randolph and McCafferty 1998; Klubertanz and Hess 2001). It is abundant in the appropriate habitats of the Black and Sugar Rivers (Lillie 1995), and occurs in the Sugar River of extreme northern Illinois (Klubertanz and Hess 2001). The larvae are awkward swimmers (Edmunds et al. 1976). The biology of *H. ammophila* is otherwise unknown (Pescador and Peters 1980).

Figure 365. *Homoeoneuria ammophila,* larva.

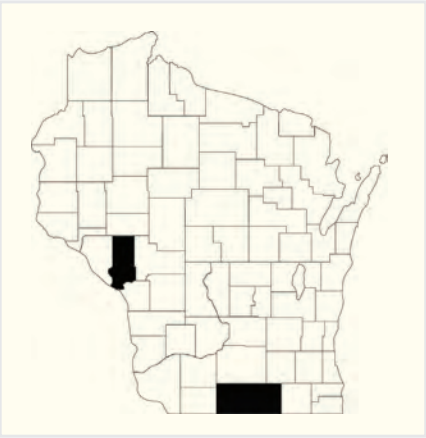


Figure 366. Wisconsin records of *Homoeoneuria ammophila.*

21 PALINGENIIDAE

The species of the Family Palingeniidae previously were placed with the Ephemeridae and the Pentageniidae (McCafferty and Edmunds 1976). The family currently consists of one North American genus and at least six Old World genera (Kluge 2014).

Pentagenia

Comments: There is only one extant species of *Pentagenia*, with a second species (*P. robusta* McDunnough) presumed extinct (Anonymous 2014a). The larvae are large, soft-bodied, burrowing mayflies.

Determination: Identification of *Pentagenia* larvae in Wisconsin is **Moderately Easy**.

Larval Keys: Burks (1953); McCafferty (1975).

Pentagenia vittigera (Walsh), 1862 (Figs. 367 and 368)

Taxonomic History: *Palingenia vittigera* Walsh, 1862 (orig.); *Pentagenia quadripunctata* Walsh, 1863 (syn.); *Pentagenia vittigera* (Walsh), 1862 (curr. comb., Walsh 1863b).

Larval Description: Needham (1920); McCafferty (1972).

Larval Habitus: Needham (1920); Traver (1935); McCafferty (1972, 1975); Edmunds et al. (1976).

Determination: Identification of *P. vittigera* larvae is **Moderately Easy**. They are superficially similar to other burrowing mayflies, but have a dorsolateral ridge of tubercles along each mandibular tusk (Fig. 7e). This character does not occur in species of the related families Ephemeridae and Polymitarcyidae.

Previous Wisconsin Records: Hamilton (1959); Lillie et al. (1987); Lillie and Hilsenhoff (1992); Lillie (1995).

Status: *Pentagenia vittigera* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b). In their extensive study of the lower Wisconsin River, Lillie and Hilsenhoff (1992) found only one larva, indicating its scarcity. Surveys of adults at lights or light traps could be used to improve detection of this species, based upon frequent observation of them at lights along the Missouri River in Nebraska.

Biological Information: *Pentagenia vittigera* is perhaps the most poorly known mayfly of large rivers in North America (Burks 1953; McCafferty 1975; Edmunds et al. 1976; Randolph and McCafferty 1998). Larvae may prefer areas of faster current than species of *Hexagenia* (Fremling 1970). They live in burrows in hard clay or silt banks (Edmunds et al. 1976; Randolph and McCafferty 1998).

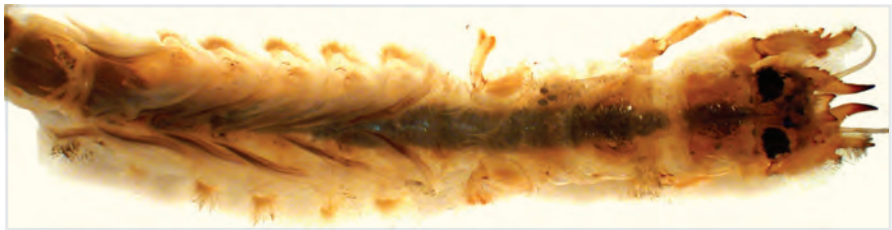


Figure 367. *Pentagenia vittigera,* larva.

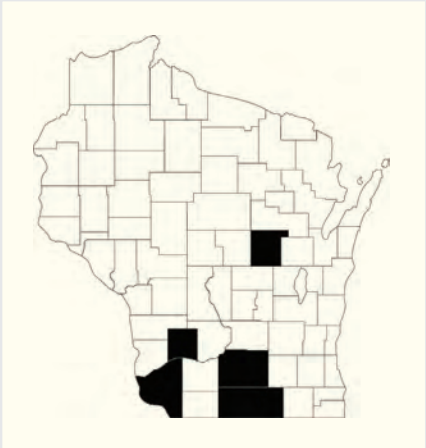


Figure 368. Wisconsin records of *Pentagenia vittigera.*

22 POLYMITARCYIDAE

The burrowing larvae of the Family Polymitarcyidae are soft-bodied, but in Wisconsin are smaller in size than the larvae of the Ephemeridae and Potamanthidae. The family is known from Holarctic, Oriental, Neotropical, and Ethiopian regions (Kluge 2014). There are four North American genera, with two of them known from Wisconsin.

Key to the Genera of Polymitarcyidae

1. Mandibular tusk with numerous tubercles on upper surface (Fig. 369a); protarsus rounded and clearly jointed with tibia (Fig. 369b) . . . . . ***Ephoron***

Mandibular tusk with one to three tubercles on inner margin, but not on dorsal surface (Fig. 369c); protarsus flattened and broadly fused with tibia (Fig. 369d); not known from Wisconsin . . . . . ***Tortopus primus***

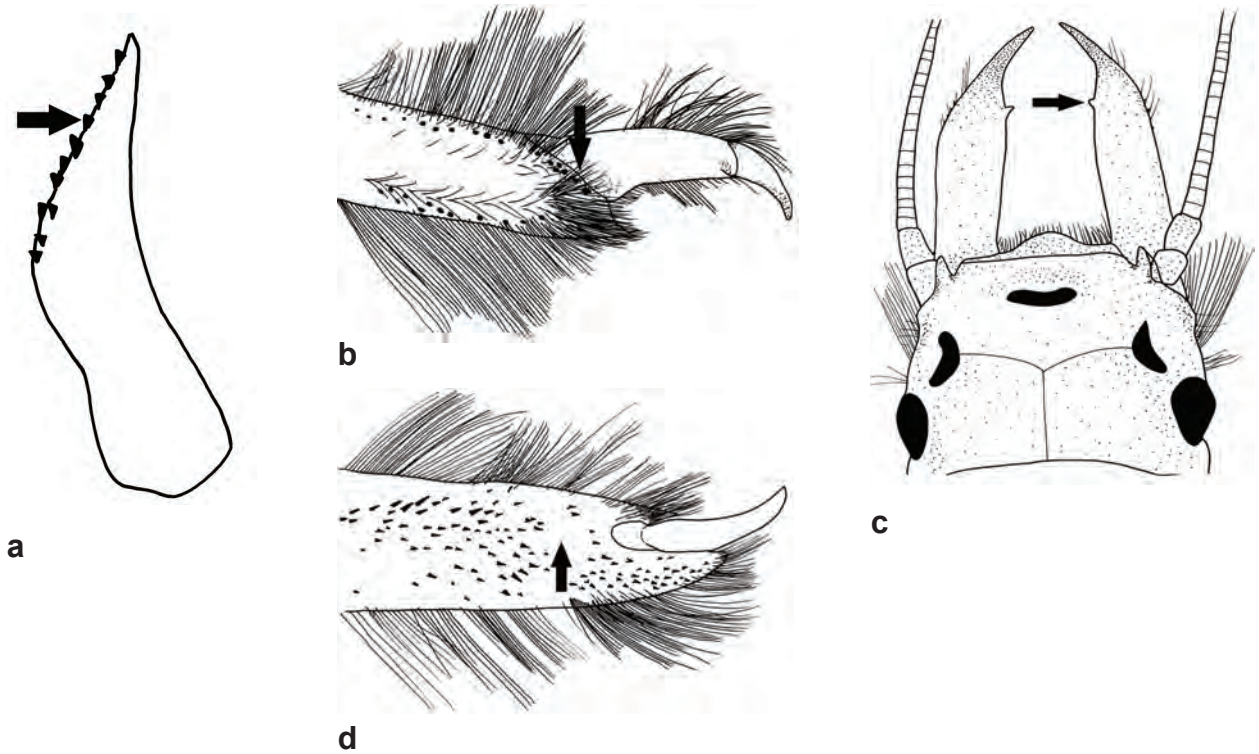


Figure 369. Polymitarcyidae. **a,** *Ephoron album,* mandible (lateral); **b,** *E. album,* front tibia and tarsus; **c,** *Tortopus primus,* head (dorsal); **d,** *T. primus,* front tarsus.

Ephoron

Comments: There are two species of the pale, soft-bodied *Ephoron* in Wisconsin. They form tubular burrows (Edmunds et al. 1976), most commonly in soft substrates.

Determination: Identification of *Ephoron* larvae is **Moderately Easy** for the genus and **Fairly Easy** for species within the genus. Separation of the species based upon gill tracheation is preferred over the number of tubercles on the mandibular tusks, which was used in some older keys.

Larval Keys: Burks (1953); McCafferty (1975).

Key to the Species of *Ephoron*

1. Gills II–VI with darkly pigmented lateral tracheal branches (Fig. 370a) . . . . . ***E. leukon***

Gills II–VI without pigmented lateral tracheal branches (Fig. 370b) . . . . . ***E. album***

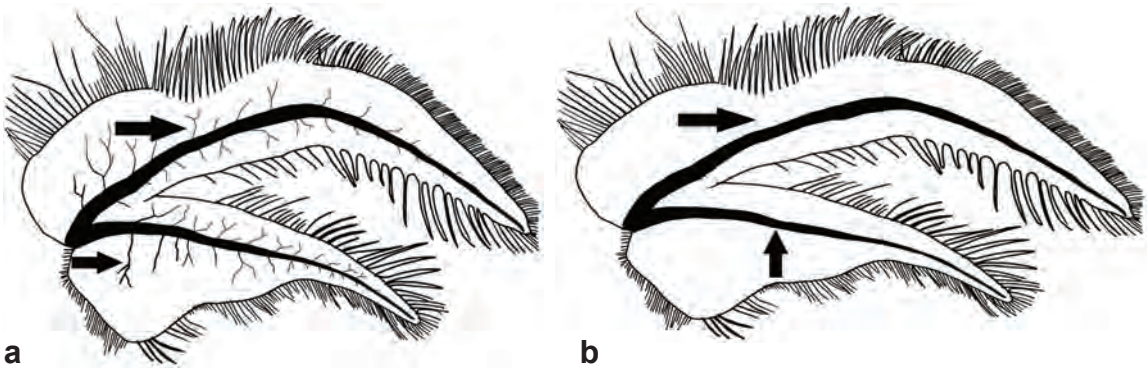


Figure 370. *Ephoron* (Polymitarcyidae). **a,** *E. leukon,* gill V; **b,** *E. album,* gill V.

Ephoron album (Say), 1824 (Figs. 371 and 372)

Taxonomic History: *Baetis alba* Say, 1824 (spell.); *Baetis albus* Say, 1824 (orig.); *Ephoron album* (Say), 1824 (curr. comb., McDunnough 1926); *Palingenia alba* (Say), 1824 (comb.); *Polymitarcys albus* (Say), 1824 (comb.).

Larval Description: Edmunds (1948).

Larval Habitus: Needham (1905, 1920), as *Polymitarcys albus*; McCafferty (1975); Edmunds et al. (1976).

Determination: Identification of *E. album* larvae is **Fairly Easy**. Gill tracheae have few, if any, darkly pigmented lateral branches (Figs. 370b, 371). Faded specimens are inseparable from those of *E. leukon*.

Previous Wisconsin Records: Britt (1962); Randolph and McCafferty (1998).

New County Records: GRANT: 4L, Wisconsin R., Woodman, VI-13-1986, R. A. Lillie (UW); **KENOSHA:** 2L, Fox R., Co. Rd. C, 42.511622°N 88.179215°W, VII-23-2008, R. A. Lillie (WiDNR); **LA CROSSE:** 1L, Black R., St. Rd. 35, S. side of bridge, VII-10-2013, K. L. Schmude (UWS); **ONEIDA:** 7L, Wisconsin R., Hat Rapids Rd., 45.570006°N 89.481128°W, VII-2-2008, K. L. Schmude and A. Reynolds (UWS); **PEPIN:** 2L, Chippewa R., St. Rd. 35, W. side, VII-10-2013, K. L. Schmude (UWS); **VERNON:** 12L in three vials, Kickapoo R., VII-18-1974, VII-30-1974, and VIII-13-1974 (UW).

Biological Information: Larvae of *E. album* occur in moderate to large rivers, canals, and lakes, covering a wider array of habitats than *E. leukon* (Burks 1953; McCafferty 1975). Larvae inhabit silt and clay substrates under riffles (McCafferty 1975; Edmunds et al. 1976; Ferro and Sites 2007). In Wisconsin, larvae of *E. album* are more known from fewer and more scattered counties.

Figure 371. *Ephoron album,* larva.

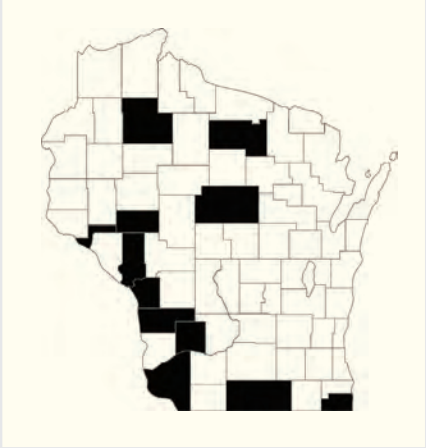


Figure 372. Wisconsin records of *Ephoron album.*

Ephoron leukon Williamson, 1802 (Figs. 373 and 374)

Larval Description: Ide (1935a).

Larval Habitus: Ide (1935a); Burks (1953).

Determination: Identification of *E. leukon* larvae is **Fairly Easy**. Usually, the gill trachea have numerous, dark, lateral branches (Figs. 370a, 373). Young larvae or faded specimens may not show this character and may be inseparable from *E. album*.

Previous Wisconsin Records: Hilsenhoff et al. (1972); Shapas and Hilsenhoff (1976); Jacobs (1990); Randolph and McCafferty (1998).

New County Records: MARATHON: 4L, Eau Claire R., VII-18-1973 (UW); **POLK:** 1L, St. Croix R., Nevers Landing, 1 mi. S. of Wolf Creek, 45°32'10"N 92°43'25"W, VII-13-2011, THK (THK); **PRICE:** 10L, S. Fork Flambeau R., St. Rd. 13, T39NR1E S18, VI-24-1998, R. A. Lillie (WiDNR); **ST. CROIX:** 9L in two vials, Apple R., River's Edge Club and Park, Raleigh Rd., 200 ft. N. of St. Rd. 64, 45°7'33"N 92°38'45"W, VII-13-2011, THK (THK); **SAWYER:** 40L, Chippewa R., Townline Rd., T37NR7W S35, VI-23-1998, R. A. Lillie (WiDNR); 12L (including blackwing), N. Fork Flambeau R., VIII-2-1972 (UW).

Biological Information: Larvae of *E. leukon* occur in a variety of streams and rivers with rocks and gravel in riffles, including both medium and large rivers (Burks 1953; McCafferty 1975; Edmunds et al. 1976; Burian and Gibbs 1991). They form tubular burrows in the silty substrate, most commonly near stones in water less than 5 feet deep (Ide 1935a; Edmunds et al. 1976). Larvae may be nocturnal, coming nearer to the top of the burrow during the evening (Ide 1935a). In Wisconsin, *E. leukon* is more commonly encountered in northern counties.

Figure 373. *Ephoron leukon,* larva.

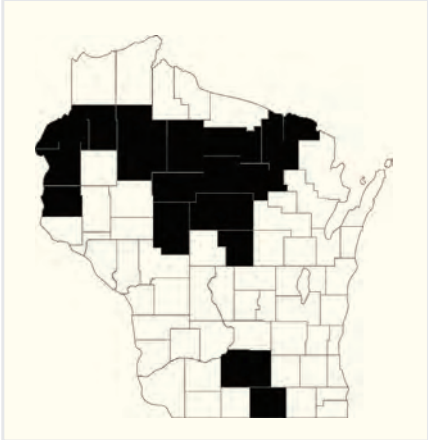


Figure 374. Wisconsin records of *Ephoron leukon.*

Tortopus

Comments: Larvae of *Tortopus* resemble other soft-bodied, burrowing mayflies. There are two species from North America. *Tortopus primus* is the only species known from the Midwest (McCafferty 1975).

Determination: Identification of *Tortopus* larvae in Wisconsin is **Moderately Easy**.

Larval Key: McCafferty (1975).

Tortopus primus (McDunnough), 1924 (Fig. 375)

Taxonomic History: *Campsurus manitobensis* Ide, 1941 (syn.); *Campsurus primus* McDunnough, 1924 (orig.); *Tortopus manitobensis* (Ide), 1941 (syn.); *Tortopus primus* (McDunnough), 1924 (curr. comb., Ulmer 1942).

Determination: Identification of *T. primus* larvae is **Moderately Easy**. Large size and distinctive mandibular tusks (Fig. 369c) aid identification.

Previous Wisconsin Records: None. Nearest records of *T. primus* are from Illinois (McDunnough 1924b; Burks 1953) and Iowa (McCafferty et al. 2003a). The species is likely in Wisconsin, particularly from the Mississippi River.

Biological Information: Larvae of *T. primus* are inhabitants of deep-cut clay banks and rotted wood in large rivers (Edmunds et al. 1976; McCafferty 1994; Randolph and McCafferty 1998).

Figure 375. *Tortopus primus,* larva.

23 POTAMANTHIDAE

The Family Potamanthidae contains only one genus in North America, and in Wisconsin, only two recognized species. The remainder of the family consists of two currently recognized genera in Europe and Asia (Kluge 2014).

Anthopotamus

Comments: *Anthopotamus* is known only from North America, where there are four currently recognized species. The larvae are large, dorsoventrally flattened, and prominently patterned. They are unusual among Wisconsin's tusked mayflies in not being soft-bodied and not dwelling in tubular burrows in the substrate.

Determination: Identification of *Anthopotamus* larvae is **Easy** for the genus and **Fairly Easy** for species within the genus.

Larval Keys: McCafferty (1975), as *Potamanthus*; Bae and McCafferty (1991).

Key to the Species of *Anthopotamus*

1. Mandibular tusk more or less evenly tapered, gradually decreasing in diameter towards tip, and with a few short, stout setae on distal half of dorsal surface (Fig. 376a) . . . . . ***A. myops***

Mandibular tusk with an abrupt constriction in basal half, and with apical half mostly devoid of stout setae (Fig. 376b) . . . . . ***A. verticis***

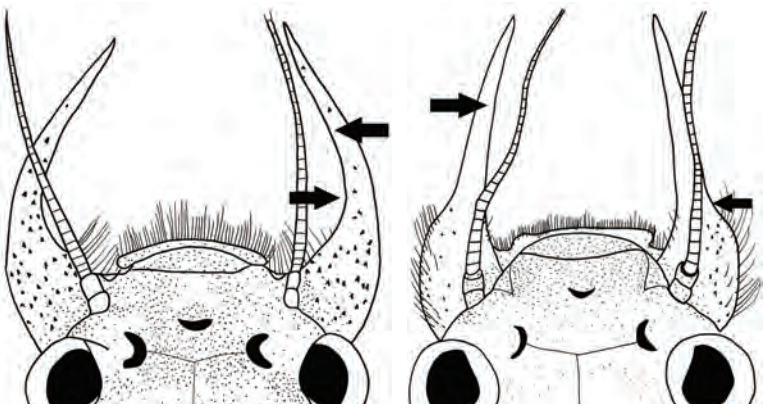


Figure 376. *Anthopotamus* (Potamanthidae). **a,** *A. myops,* head (dorsal); **b,** *A. verticis,* head (dorsal).

Anthopotamus myops (Walsh), 1863 (Figs. 377 and 378)

Taxonomic History: *Anthopotamus inequalis* (Needham), 1909 (syn.); *Anthopotamus myops* (Walsh), 1863 (curr. comb., McCafferty and Bae 1990); *Anthopotamus rufous* (Argo), 1927 (syn.); *Ephemera myops* Walsh, 1863 (orig.); *Potamanthus inequalis* Needham, 1909 (syn.); *Potamanthus medius* Banks, 1908 (syn.); *Potamanthus myops* (Walsh), 1863 (comb.); *Potamanthus rufous* Argo, 1927 (syn.); *Potamanthus rufus* Argo, 1927 (syn.).

Larval Descriptions: Ide (1935a), as *Potamanthus rufous*; McCafferty (1975), as *P. myops*; Bae and McCafferty (1991).

Larval Habitus: McCafferty (1975), as *Potamanthus myops*.

Determination: Identification of *A. myops* larvae is **Fairly Easy**. Their mandibular tusks gradually decrease in diameter over their length and have sparsely scattered setae over the distal half of each tusk (Fig. 376a). These characters effectively separate both young and mature larvae from *A. verticis*.

Previous Wisconsin Records: Bae and McCafferty (1991); Randolph and McCafferty (1998).

New County Records: CLARK: 3L, Black R., Bryan Rd., 44.501753°N 90.636741°W, VII-3-2008, K. L. Schmude (UWS); **IOWA:** 6L, E. Branch Pecatonica R., X-20-1980 (UW); **KENOSHA:** 8L, Fox R., Co. Rd. C, 45.511622°N 88.179215°W, VII-23-2008, R. A. Lillie (WiDNR).

Biological Information: *Anthopotamus myops* is more common than *A. verticis* in Wisconsin, especially in the lower half of the state. It also is the most widespread and common *Anthopotamus* in most of the eastern states (Bae and McCafferty 1991). Larvae occur in riffles and runs of medium to large rivers with loose gravel and rubble substrates (McCafferty 1975; Ferro and Sites 2007). Within these habitats, larvae usually are associated with rocks and woody debris in moderate current (McCafferty 1975).

Figure 377. *Anthopotamus myops,* larva.

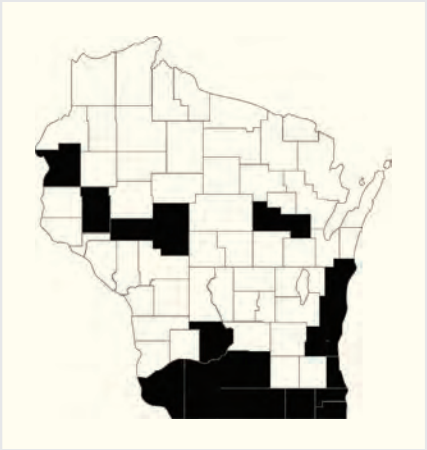


Figure 378. Wisconsin records of *Anthopotamus myops.*

Anthopotamus verticis (Say), 1839 (Figs. 379 and 380)

Taxonomic History: *Anthopotamus diaphanus* (Needham), 1907 (syn.); *Anthopotamus verticis* (Say), 1839 (curr. comb., McCafferty and Bae 1990); *Anthopotamus walkeri* (Ide), 1935 (syn.); *Baetis verticis* Say, 1839 (orig.); *Ecdyurus verticis* (Say), 1839 (comb.); *Ephemera flaveola* Walsh, 1862 (syn.); *Heptagenia verticis* (Say), 1839 (comb.); *Potamanthus betteni* Morgan, 1913 (syn.); *Potamanthus diaphanus* Needham, 1907 (syn.); *Potamanthus flaveola* (Walsh), 1862 (syn.); *Potamanthus verticis* (Say), 1839 (comb.); *Potamanthus walkeri* Ide, 1935 (syn.).

Larval Description: Ide (1935a), as *Potamanthus flaveola* and *P. walkeri*; Bae and McCafferty (1991).

Larval Habitus: Needham (1920).

Determination: Identification of *A. verticis* larvae is **Fairly Easy**. Although tergal patterning differs from *A. myops*, the abrupt constriction in the diameter of the mandibular tusks in *A. verticis* (Fig. 376b) is a more reliable character in both young and mature larvae.

Previous Wisconsin Records: Bae and McCafferty (1991); Randolph and McCafferty (1998).

New County Records: ASHLAND: 1L, Flambeau R., Creamery Rd., 46.01025°N 90.36851°W VI-13-2000, K. L. Schmude, C. Brennan, J. Denninger, and J. Mielke (UWS); **CHIPPEWA:** 1L, Chippewa R., Cornell, VI-19-1997 (WiDNR); **CLARK:** 1L, Black R., V-5-1980 (UW); **DUNN:** 3L, Red Cedar R., IX-5-1968 (UW); **JACKSON:** 2L, Black R., Mason Boat Launch, Old Hwy. 54, VII-11-2013, K. L. Schmude (UWS); **PRICE:** 13L, Flambeau R., St. Rd. 70, 45.85259°N 90.60031°W, VI-14-2000, K. L. Schmude, C. Brennan, and J. Denninger (UWS); **ST. CROIX:** 1L, Apple R., X-12-1980 (UW).

Biological Information: Little has been published regarding the biology of *A. verticis*. In Iowa, McCafferty et al. (2003a) found it in larger streams than *A. myops*. Burian (1997) in Connecticut reported it from cobble substrates with a thick periphyton of filamentous green algae.

Figure 379. *Anthopotamus verticis,* larva.

Figure 380. Wisconsin records of *Anthopotamus verticis.*

24 PSEUDIRONIDAE

The Family Pseudironidae most recently was a subfamily of the Heptageniidae, but was elevated to family status by McCafferty (1991). The family currently contains one monotypic genus limited to North America.

Pseudiron

Comments: There currently is only one recognized species of *Pseudiron*.

Determination: Identification of *Pseudiron* larvae is **Easy**.

Pseudiron centralis McDunnough, 1931 (Figs. 381 and 382)

Taxonomic History: *Pseudiron meridionalis* Traver, 1935 (syn.).

Larval Descriptions: Burks (1953); Pescador (1985).

Larval Habitus: Berner and Pescador (1988); Lillie (1995).

Determination: Identification of *P. centralis* larvae is **Easy**. The species is the only Wisconsin flat-headed mayfly with bowed legs, and easily is recognized in the field. It also is much paler than other flat-headed mayflies. It was included in the Heptageniidae until relatively recently.

Previous Wisconsin Records: Lillie (1992); Lillie and Hilsenhoff (1992); Lillie (1995); Randolph and McCafferty (1998).

New County Records: BUFFALO: 5L, Buffalo R., Segerstrom Rd., 44.575616°N 91.54415°W, VI-5-2008, K. L. Schmude, M. Payne, and A. Reynolds (UWS); **JACKSON:** 1L, Black R., St. Rd. 71, VII-11-2013, K. L. Schmude (UWS); **LA CROSSE:** 2L, Black R., St. Rd. 35, N. side of rd., VII-10-2013, K. L. Schmude (UWS).

Status: *Pseudiron centralis* is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List (Anonymous 2014b).

Biological Information: *Pseudiron centralis* is a specialist of shifting sand substrates of medium to large rivers, such as in the Wisconsin River (Burks 1953; Edmunds et al. 1976; Pescador 1985; Lillie and Hilsenhoff 1992; Randolph and McCafferty 1998). Larvae occur in strong current, where they face upstream and feed on chironomid larvae (Edmunds et al. 1976; Pescador 1985; Vogel 1994).

Figure 381. *Pseudiron centralis,* larva.

Figure 382. Wisconsin records of *Pseudiron centralis.*

25 SIPHLONURIDAE

The species of the Siphlonuridae are not commonly collected by those who sample riffle areas of trout streams in spring and summer. They, in general, are inhabitants of backwaters and other depositional habitats. The family is most easily confused with the Baetidae and the Ameletidae. Most species are large, attractively patterned, and with large gills. The Siphlonuridae has Holarctic distribution (Kluge 2014).

Key to the Genera of Siphlonuridae

1. Each gill with double lamellae on at least some segments (Fig. 383a) . . . . . ***Siphlonurus***

Each gill always with a single lamella (as in Fig. 383b) . . . . . ***Parameletus***

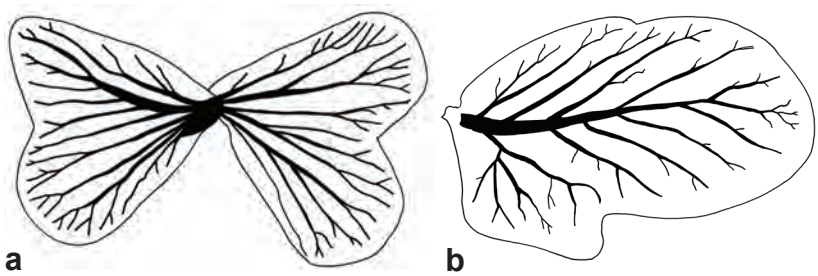


Figure 383. Siphlonuridae. **a,** *Siphlonurus* sp., gill II; **b,** *Parameletus midas,* gill II.

Parameletus (Fig. 384)

Comments: Of the four species of *Parameletus* from North America, only *Parameletus* sp. A (as *P. chelifer*) has been reported from Wisconsin. The other two species of *Parameletus* from the Northeast United States are *P. croesus* (McDunnough) and *P. midas* (McDunnough). Characters for separating larvae of *Parameletus* are not known, and adults of *P. chelifer* from Wisconsin have not been collected from the state. Conservatively, therefore, I list this taxon only at the generic level until adults are reared or collected. Larvae of *Parameletus* have extremely large gills for their size, though the gills often become detached during handling.

Figure 384. *Parameletus midas,* larva.

Parameletus sp. A (Fig. 385)

Larval Habitus: Lillie (1995), as *P. chelifer*.

Determination: Identification of *Parameletus* larvae is **Moderately Easy** for the genus, if gills are present on specimens. Identification is **Problematic** for species within the genus, as characters to separate larvae are not known. No intact larva of *Parameletus* from Wisconsin was available for photography. A larva of *P. midas* from Maine is shown in Figure 384 as an example of the genus.

Previous Wisconsin Records: Lillie (1995), as *P. chelifer*.

Status: *Parameletus* sp. A is listed as a Species of Special Concern on the Wisconsin Department of Natural Resources Natural Heritage Working List as *P. chelifer* (Anonymous 2014b). The paucity of records may be because of its unusual habitat and small size.

Biological Information: Larvae of *Parameletus* occur most commonly in woodland, swamp, and forest pools and backwaters with little or no current and the presence of emergent vegetation (Hilsenhoff 1995).

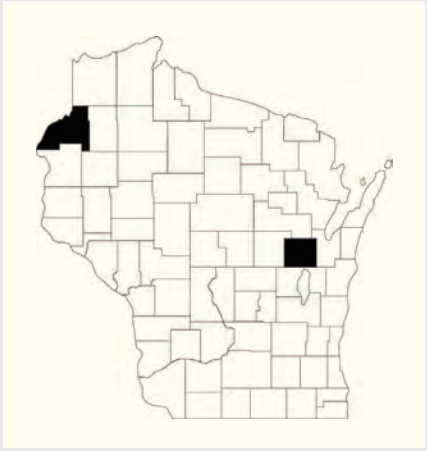


Figure 385. Wisconsin records of *Parameletus* sp. A.

Siphlonurus

Comments: The fairly diverse *Siphlonurus* has nineteen extant species in North America. Only four species are known from Wisconsin, including the first state records of *S. phyllis* and *S. rapidus* given below. *Siphlonurus* larvae are most commonly associated with depositional and shoreline areas with little current and an abundance of roots and accumulated plant matter (Edmunds et al. 1976; Burian and Gibbs 1991; DuBois 1993).

Determination: Identification of *Siphlonurus* larvae is **Moderately Easy** for the genus, but **Moderately Easy to Problematic** for species within the genus.

Larval Keys: Traver (1935); Burks (1953).

Key to the Species of *Siphlonurus*

1. Gills III–VI with double lamellae, with dorsal lamella being more pronounced in later instars (Fig. 386a). **2**

Gills III–VI each with a single lamella (Fig. 386b). **3**

2. Each abdominal sternum of mature larva with dark markings restricted to a pair of oblique dashes lateral to a pair of submedian spots, with sterna VIII–IX of dark specimens more extensively with a pair of purplish oblique bands on each segment extending from near posterolateral corner to oblique dash (Fig. 386c); terga lacking a distinct mid-dorsal dark stripe (Fig. 387); body length of mature larvae 11–13 mm . . . . . ***S. alternatus***

Each abdominal sternum of mature larva marked as above, but also with a distinct median stripe between submedian spots (less prominent to absent in immature larvae, Fig. 386d), with sterna VIII–IX of mature larvae marked similar to more anterior segments (Fig. 386e); terga of immature larvae usually with mid-dorsal dark stripe between rows of oblique dashes (Fig. 386f); body length of mature larvae 14–16 mm. . . . . ***S. phyllis***

3. Each abdominal sternum of mature larvae with a pair of dark triangles narrowed to a point in posterolateral corner of segment . . . . . ***S. quebecensis***

Abdominal sterna mostly pale, with limited dark spots or streaks . . . . . ***S. rapidus / S. typicus***

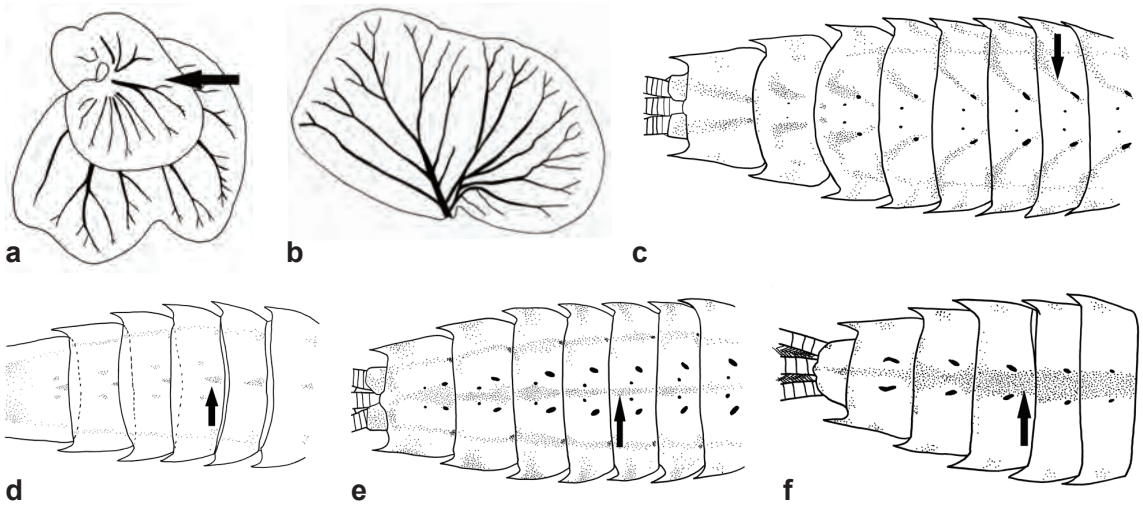


Figure 386. *Siphlonurus* (Siphlonuridae). **a,** *S. alternatus,* gill IV; **b,** *Siphlonurus* sp., gill IV; **c,** *S. alternatus,* abdominal sterna; **d,** *S. phyllis,* abdominal sterna, young larva; **e,** *S. phyllis,* abdominal sterna, mature larva; **f,** *S. phyllis,* terga V–X, young larva.

Siphlonurus alternatus (Say), 1824 (Figs. 387 and 388)

Taxonomic History: *Baetis alternata* Say, 1824 (spell.); *Baetis alternatus* Say, 1824 (orig.); *Baetis annulata* Walker, 1853 (syn.); *Baetis annulatus* Walker, 1853 (syn.); *Baetis femorata* Provancher, 1876 (syn.); *Siphlurella alternata* (Say), 1824 (comb.); *Siphlurus alternans* (Say), 1824 (spell.); *Siphlurus alternatus* (Say), 1824 (comb.).

Larval Descriptions: Needham and Betten (1901), as *Siphlurus alternatus*; Burks (1953).

Larval Habitus: Needham and Betten (1901); Needham et al. (1935); Burks (1953); Leonard and Leonard (1962); Edmunds et al. (1976).

Determination: Identification of *Siphlonurus alternatus* larvae is **Moderately Easy**. The species is the only common member of the genus in Wisconsin with dorsal flaps near the bases of gills III–VI (Fig. 386a). The flap on gill VI may be very small. *Siphlonurus phyllis* has similar gills but is separable based upon coloration of abdominal sterna and size.

Previous Wisconsin Records: Muttkowski (1918); Shapas and Hilsenhoff (1976); Randolph and McCafferty (1998).

New County Records: BAYFIELD: 1L, woodland pond, VII-31-1975 (UW); **FLORENCE:** 1 male subimago, Pine R., VII-9-1968 (UW); **MARINETTE:** 5L (including blackwing), Menominee R., Jones, 1.5 mi. NW. of Faithorn, T37NR22E S8, VI-24-1997 (WiDNR); 34L in two vials, Twin Pond, VII-14-1982 (including blackwing) and VI-20-1983 (UW); **RUSK:** 22L in three vials, Flambeau R., Washington, T33NR7W S22, VI-19-1997 (WiDNR); **SAWYER:** 4L, Flambeau R., Hervas, T37NR4W S35, VI-19-1997 (WiDNR); 1L, Flambeau R., Oxbo Rd., T39NR3W S14, VI-18-1997 (WiDNR); **TREMPEALEAU:** 2L (including blackwing), pond, VI-13-1989 (UW); **WAUSHARA:** 4A, Redgranite, VI-12-1973, J. C. Palton (UWO).

Biological Information: *Siphlonurus alternatus* is the best-known species in the genus in Wisconsin. It inhabits cool-water streams (Randolph and McCafferty 1998). More specifically, Burian and Gibbs (1991) reported that the species in Maine prefers depositional areas of second- and third-order streams, where vegetation and detritus accumulates, as well as along the margins of ponds and lakes. Leonard and Leonard (1962) also reported it as preferring areas of limited current. My limited number of records of blackwing larvae (13 June to 14 July) and adults (12 June to 9 July) from Wisconsin is comparable to emergence dates of June to August for *S. alternatus* from Maine (Burian and Gibbs 1991).

Figure 387. *Siphlonurus alternatus,* larva.

Figure 388. Wisconsin records of *Siphlonurus alternatus.*

Siphlonurus phyllis McDunnough, 1923 (Figs. 389 and 390)

Larval Description: Berner (1983).

Determination: Identification of *S. phyllis* larvae is **Slightly Difficult**. They have similar gill structure to larvae of *S. alternatus*, having a dorsal flap near the base of each gill III–VI. The abdominal sterna are more boldly marked than in *S. alternatus*, with a median stripe in mature larvae (Fig. 386e).

Previous Wisconsin Records: None. The first Wisconsin records of *S. phyllis* are given below. The nearest record of this boreal species was from northeastern Minnesota (Berner 1983).

New Wisconsin Records: ASHLAND: 1L, Glidden Slough, VII-12-1982 (UW); 2L, Slough 3, VII-7-1994 (UW).

Biological Information: In Minnesota, Berner (1983) found *S. phyllis* in shallow water along the overflow of a beaver bond.

Figure 389. *Siphlonurus phyllis,* larva.

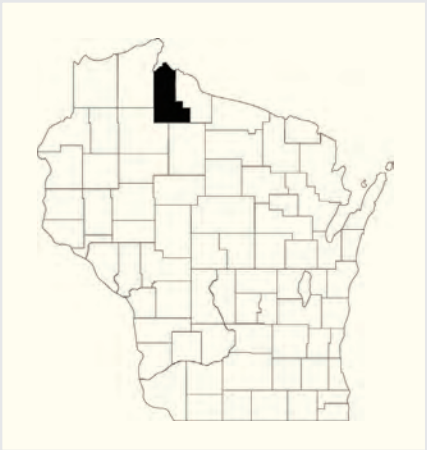


Figure 390. Wisconsin records of *Siphlonurus phyllis.*

Siphlonurus quebecensis (Provancher), 1878 (Fig. 391)

Taxonomic History: *Baetis canadensis* Provancher, 1876 (hom.); *Siphlurus quebecensis* Provancher, 1878 (orig.); *Siphlonurus triangularis* Clemens, 1915 (syn.).

Larval Descriptions: Clemens (1915b), as *S. triangularis*; Burks (1953); Leonard and Leonard (1962).

Determination: Identification of *S. quebecensis* larvae is **Fairly Easy**. They have single lamellae on gills III–VI, separating them from *S. alternatus* and *S. phyllis*, and have distinctive ventral coloration of the abdomen. Young larvae may not be identifiable.

Previous Wisconsin Records: Shapas and Hilsenhoff (1976); Randolph and McCafferty (1998).

Biological Information: In Maine, Burian and Gibbs (1991) described the habitat of *S. quebecensis* as depositional reaches of second- to third-order streams, as well as shorelines of ponds and lakes. Ide (1930a) collected and reared mature larvae from a calm side-channel of a stream in Ontario. Leonard and Leonard (1962) and Randolph and McCafferty (1998) noted that the species prefers cool-water and spring-fed streams. Single records from 2 May (Oneida Co.) and 8 June (Price Co.) are within the emergence dates for *S. quebecensis* in Maine (Burian and Gibbs 1991).

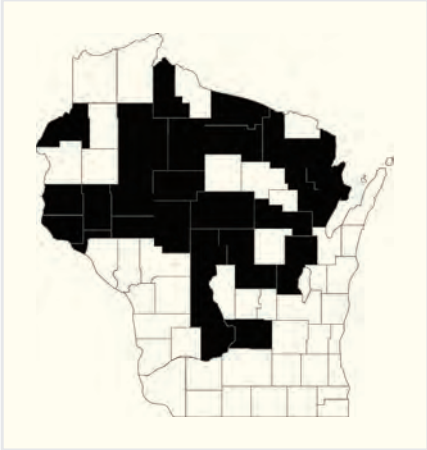


Figure 391. Wisconsin records of *Siphlonurus quebecensis.*

Siphlonurus rapidus McDunnough, 1924 (Fig. 392)

Determination: Identification of *S. rapidus* larvae is **Problematic**. Characters for distinguishing the species from other species lacking dorsal flaps on gills III–VI have not been published.

Previous Wisconsin Records: None. Hilsenhoff (1995) reported *S. rapidus* from Wisconsin but gave no supporting data. The first formal state records based upon adults are given below. Nearest published records were from the Upper Peninsula of Michigan (Randolph and McCafferty 1998).

New State Records: BAYFIELD: 1M, 18-Mile Crk., VI-4-1973 (UW); **ONEIDA:** 1M, N. Branch Pelican R., V-22-1974, vial 011413S (UW); **PRICE:** 2M, N. Branch Levitts Crk., VI-11-1970 (UW); **SHAWANO:** 4M in two vials, Embarrass R., Leopolis, V-31-1972, T. Steinke, vials 083111I (UWO) and 083111J (THK).

Status: Unknown. Targeted sampling of *S. rapidus* at the sites listed above is recommended, through either rearing or collection of adults, to confirm its continued presence in the state.

Biological Information: In Maine, Burian and Gibbs (1991) described the habitat of *S. rapidus* as depositional areas in second- to third-order streams, as well as shorelines of ponds and lakes. All of the Wisconsin specimens were taken as adults adjacent to lotic habitats in the northern half of the state.

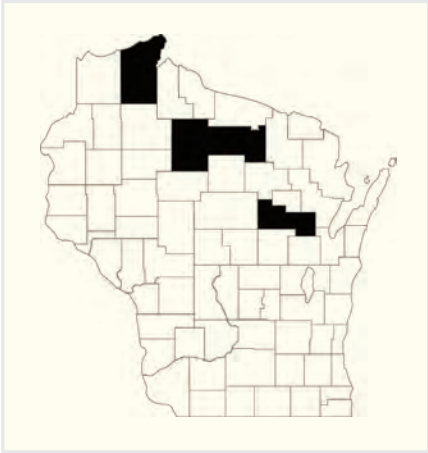


Figure 392. Wisconsin records of *Siphlonurus rapidus.*

Siphlonurus typicus (Eaton), 1885

Taxonomic History: *Siphlonurus berenice* McDunnough, 1923 (syn.); *Siphlonurus bernice* McDunnough, 1923 (syn. spell.); *Siphlonurus novangliae* McDunnough, 1924 (syn.); *Siphlurus typicus* Eaton, 1885 (orig.).

Larval Description: Provonsha and McCafferty (1982).

Determination: Identification of *S. typicus* larvae is **Problematic**. Characters for distinguishing them from other species lacking dorsal flaps on gills III–VI have not been published.

Previous Wisconsin Records: None. Nearest records of *S. typicus* are from northwestern Indiana and Lower Michigan (Randolph and McCafferty 1998). The species possibly occurs in Wisconsin, in lentic habitats not often sampled.

Biological Information: Burian and Gibbs (1991) reported *S. typicus* in Maine from a variety of temporary, lentic habitats including forest pools and flood plain puddles.

CHECKLIST OF WISCONSIN MAYFLY SPECIES

Acanthametropodidae

Acanthametropus pecatonica

Ameletidae

Ameletus: *A. lineatus*, *subnotatus*

Arthropleidae

Arthroplea bipunctata

Baetidae

Acentrella: *A. parvula*, *turbida*

Acerpenna: *A. macdunnoughi*, *pygmaea*

Anafroptilum: *A. album*, *bifurcatum*, *conturbatum*, *minor, victoriae*

Baetis: *B. brunneicolor*, *flavistriga* complex, *intercalaris*, *pluto*, *tricaudatus*

Callibaetis: *C. ferrugineus*, *fluctuans*, *pallidus*, *pictus*, *skokianus*

Cloeon dipterum

Diphetor hageni

Fallceon quilleri

Heterocloeon: *H. amplum*, *curiosum*

Iswaeon anoka

Labiobaetis: *L. dardanus*, *ephippiatus, frondalis*, *longipalpus, propinquus*

Neocloeon: *N. alamance*, *triangulifer*

Paracloeodes minutus

Plauditus: *P. cestus, cingulatus*, *dubius*, *punctiventris*

Procloeon: *P. fragile, pennulatum*, *rivulare, rubropictum*, *rufostrigatum, simplex*, *viridoculare*

Pseudocentroptiloides: *P. morihari, usa*

Baetiscidae

Baetisca: *B. lacustris, laurentina, obesa*

Behningiidae

Dolania americana

Caenidae

Brachycercus: *B. harrisella, ojibwe*

Caenis: *C. amica, anceps, diminuta, hilaris, latipennis, punctata, tardata*, *youngi*

Cercobrachys: *C. etowah*, *fox*, *lilliei*, *winnebago*

Sparbarus: *S. lacustris, maculatus*, *nasutus*

Susperatus prudens

Ephemerellidae

Attenella attenuata

Dannella: *D. lita*, *simplex*

Drunella: *D. cornuta*, *cornutella*

Ephemerella: *E. aurivillii, catawba, dorothea, excrucians*, *invaria*, *needhami*, *subvaria*

Eurylophella: *E. aestiva*, *bicolor*, *funeralis*, *lutulenta*, *temporalis*

Serratella serrata

Teloganopsis deficiens

Ephemeridae

Ephemera simulans

Hexagenia: *H. atrocaudata, bilineata*, *limbata*, *rigida*

Litobrancha recurvata

Heptageniidae

Epeorus vitreus

Heptagenia: *H. elegantula*, *flavescens*, *pulla*

Leucrocuta: *L. aphrodite, hebe*, *maculipennis*

Maccaffertium: *M. exiguum, luteum*, *mediopunctatum, mexicanum, modestum*, *pulchellum*, *terminatum, vicarium*

Macdunnoa persimplex

Nixe: *N. inconspicua*, *lucidipennis*

Rhithrogena: *R. impersonata*, *jejuna, manifesta, undulata*

Spinadis simplex

Stenacron interpunctatum

Stenonema femoratum

Isonychiidae

Isonychia: *I. bicolor, rufa, sayi, sicca*

Leptohyphidae

Tricorythodes: T. albilineatus, allectus, explicatus, robacki, stygiatus

Leptophlebiidae

Choroterpes basalis

Habrophlebiodes americana

Leptophlebia: L. cupida, nebulosa

Paraleptophlebia: P. adoptiva, debilis, guttata, mollis, ontario, praepedita

Metretopodidae

Metretopus borealis

Siphloplecton: *S. basale*, *interlineatum*

Neoephemeridae

Neoephemera bicolor

Oligoneuriidae

Homoeoneuria ammophila

Palingeniidae

Pentagenia vittigera

Polymitarcyidae

Ephoron: *E. album*, *leukon*

Potamanthidae

Anthopotamus: *A. myops*, *verticis*

Pseudironidae

Pseudiron centralis

Siphlonuridae

Parameletus sp. A

Siphlonurus: *S. alternatus*, *phyllis*, *quebecensis*, *rapidus*

GLOSSARY OF TERMS

Abdomen: most posterior of the major regions of the insect body, in mayflies consisting of ten visible segments posterior to the thorax.

Anterior: front; the surface or relative direction along the long axis of the insect body that is towards the head.

Antenna: sensory structure on dorsal surface of head capsule, filamentous in mayfly larvae.

Apex (adj. **apical):** the distal end of any structure; farthest from point of attachment.

Bifid: cleft, forked, or divided into two parts.

Blackwing: larva nearing emergence, with blackened wingpads containing folded subimagal wings.

Body length: distance from anterior-most part of the body (including mouthparts) to the posterior tip of the tenth tergum, not including the caudal filaments.

Caudal filament: any of the segmented filamentous appendages ("tails") at the tip of the abdomen, including the cerci and median caudal filament.

Cerci: the pair of lateral caudal filaments or tails, not including the median caudal filament.

Clypeus: sclerites of the head between the frons and labrum.

Coxa: basal segment of the leg articulating with thorax and trochanter.

Denticle: tooth-like projection, as found along ventral curvature of tarsal claw.

Distal: farther away from origin or point of attachment.

Dorsal: upper side; relative direction towards the top of the insect in anatomical position.

Emergence: act of molting from larval to winged form; in mayflies, the transition from an aquatic larva to a terrestrial subimago.

Epicranial suture: Y-shaped articulation of plates on the dorsal surface of the head between the compound eyes.

Femur (pl. **femora):** third and generally most prominent segment of the leg, between trochanter and tibia.

Fibrilliform: consisting of many thread-like structures.

Fimbriate: having a fringed margin.

Flagellum: terminal, multisegmented, whip-like portion of the antenna.

Forceps: elongate, paired reproductive structures at the apex of the abdomen in male adults, lateral of the penes.

Fossorial: morphology suited for digging or burrowing.

Frons: portion of the dorsal surface of the head between the diverging arms of the epicranial suture.

Frontoclypeus: portion of the head including the frons and clypeus.

Galea-lacinia: fused galea and lacinia at the apex of the maxilla, not including the palpus.

Glossae: innermost paired lobes at apex of labium, between paraglossae.

Habitus: general appearance and posture of the body.

Imago: winged, adult mayfly produced by shedding of the subimagal cuticle.

Incisor: tooth-like projection near apex of mandible or maxilla.

Instar: insect between successive molts.

Labium: most ventral mouthpart, consisting of paired lobes and palpi.

Labrum: most dorsal mouthpart, consisting of single flap-like structure.

Lamella: thin and plate-like in structure.

Lanceolate: spear-shaped in structure, tapering to relatively sharp point.

Larva: developmental stage between egg and adult, restricted by some to insects with complete metamorphosis, but more commonly used in recent mayfly literature than nymph and naiad; aquatic immatures in mayflies.

Lateral: surface or relative direction away from the midline of the body.

Lentic: freshwater habitats lacking flow.

Longitudinal: parallel to the long axis of the body.

Lotic: freshwater habitats with flowing water.

Macula: mark or spot of coloration.

Mandibles: paired chewing mouthparts ventral of labrum and dorsal of maxillae.

Maxillae: paired mouthparts ventral of mandibles and dorsal of labium.

Medial: relatively closer to the midline of the body.

Mesal: along the midline of the body.

Mesonotum: dorsal sclerites of the mesothorax.

Mesoscutum: scutum of the mesothorax.

Mesosternum: ventral sclerite of the mesothorax.

Mesothorax: middle thoracic segment, bearing the middle pair of legs and the front wingpads.

Metanotum: dorsal sclerites of the posterior thoracic segment.

Metasternum: ventral sclerite of the posterior thoracic segment.

Metathorax: posterior thoracic segment, bearing the hind pair of legs and the hind wingpads.

Naiad: immature, aquatic life stage of mayflies and certain other aquatic insect orders; used in older literature, but replaced with "larva" in recent mayfly publications.

Notum: dorsal sclerites of the thorax.

Nymph: immature life stage of insects lacking complete metamorphosis; used in older literature, but replaced with "larva" in recent mayfly publications.

Occiput: posterior portion of dorsal surface of head capsule.

Ocellus: simple light-sensing organ on dorsal surface of head.

Operculum: lid or cover, as in gill covers of some mayflies.

Osmobranchiae: soft, finger-like extension of integument used for osmoregulation, as at coxal bases of some mayflies.

Palmate: pattern consisting of numerous branches radiating out from a central point.

Palpifer: lobe of maxilla bearing a palpus.

Palpus (syn. **palp):** finger-like structure on lateral surface of maxilla or labium that is used for food handling.

Paraglossae: lobes on labium located lateral of glossae and medial of labial palpi.

Parthenogenesis: reproduction in which an unfertilized egg produces a viable embryo.

Pectinate: comb-like structure.

Pedicel: second segment of antenna, between scape and flagellum.

Penes: paired reproductive structures at apex of abdomen containing genital ducts in male adults; located between the forceps.

Pleuron: lateral aspect of any body segment.

Posterior: surface or relative direction along the long axis of the body that is towards the rear of the body or caudal filaments.

Pronotum: dorsal sclerites of the prothorax.

Prosternum: ventral sclerite of the prothorax.

Prostheca: sclerite attached to median margin of mandible between incisors and molar region.

Prothorax: anterior segment of thorax, located behind the head.

Protuberance: bump; structure rising above the general area.

Proximal: closer to origin or point of attachment.

Psammophilous: preferring sandy substrates.

Quadrate: roughly rectangular.

Raptorial: morphology suited for prey capture.

Rearing: process of obtaining adults from field-collected larvae, thereby positively associating larval and adult stages.

Scape: basal segment of antenna.

Sclerite: hardened plate of exoskeleton.

Sclerotized: hardened, after process of sclerotization.

Serrate: having a saw-toothed edge.

Seta: bristle.

Spatulate: spoon-shaped; flattened with broad apex.

Spicule: minute, unsocketed spine.

Sternum: ventral surface of the thorax or abdomen.

Subimago: winged stage of development, unique to mayflies, occurring between larva and adult (imago).

Synonym: taxonomic name determined as equivalent to another.

Tarsus: distal region of leg, bearing one or more claws at apex.

Tergum: dorsal surface of the abdomen.

Terminal: at the end of a structure, or the last of a series.

Thorax: major body region between head and abdomen, bearing legs and wingpads.

Tibia: fourth segment of leg, between femur and tarsus.

Total length: distance from anterior-most part of the body (including mouthparts) to the posterior-most tip of the caudal filaments.

Trachea: tube of the respiratory system, including any within gills.

Transverse: perpendicular to long axis of body or structure.

Trochanter: second segment of leg, between coxa and femur.

Truncate: blunt; not ending in a tapered point.

Tubercle: small bump or mound-like structure.

Type specimen: designated, scientific standard for a species or other taxon.

Ventral: underside; relative direction towards the bottom of the insect in anatomical position.

Vertex: dorsal portion of the head, posterior of the frons, bordered laterally by the compound eyes, and anterior of the occipital suture.

Villopore: patch of short setae near proximal end of ventral surface of femur.

Wingpad: lobe on posterolateral margin of mesonotum or metanotum representing site of developing wing.

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